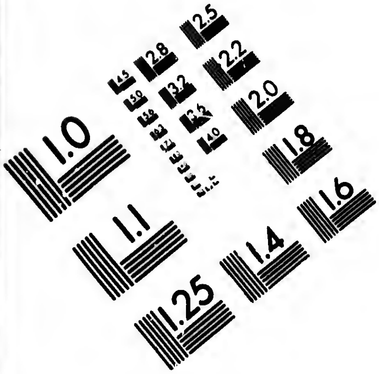

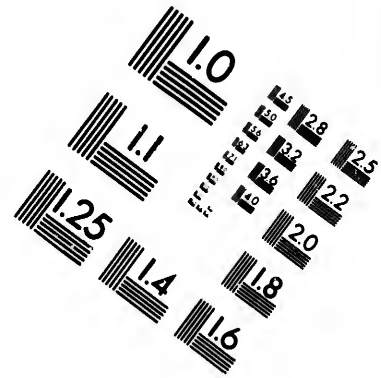

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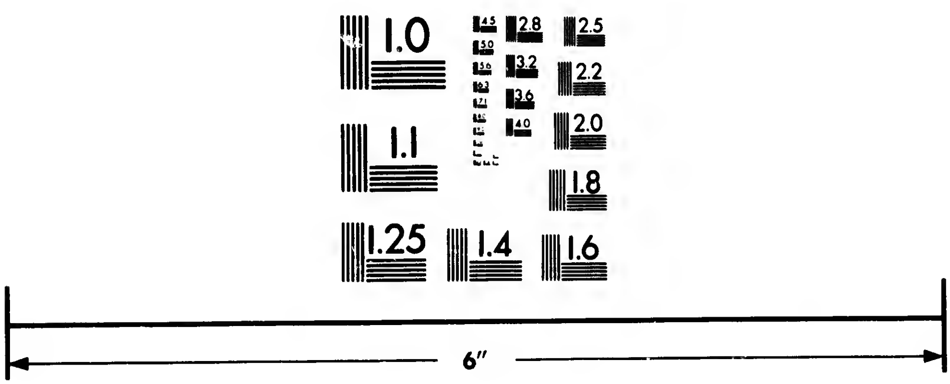

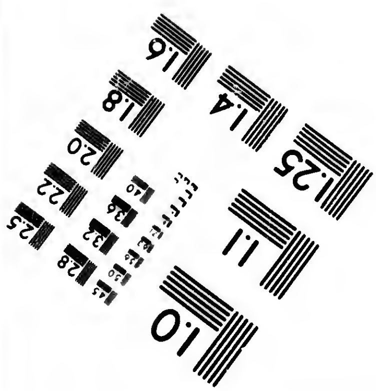

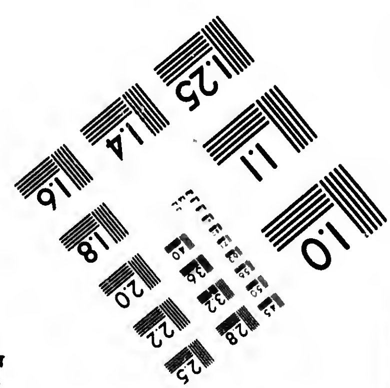

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CHAMBERS'S

INFORMATION FOR THE PEOPLE.

A POPULAR ENCYCLOPÆDIA.

FIFTEENTH AMERICAN EDITION,

WITH

NUMEROUS ADDITIONS AND MORE THAN FIVE HUNDRED ENGRAVINGS.

VOL. I.

PHILADELPHIA:
PUBLISHED BY JAS. B. SMITH & CO.,
NO. 610 CHESTNUT STREET
1859.

PREFACE

TO THE AMERICAN EDITION.

The following was intended by its accomplished authors, Messrs. William and Robert Chambers, of Edinburgh, to form a complete *Popular Cyclopædia*, or book of general *Information for the People.* It is the first attempt to place a considerable work of the character of an encyclopædia within the reach of all classes of the people. The plan on which the work was formed was to select only the subjects on which it is important for the people generally to be informed. The minutiæ of biography and topography, scientific technicalities, and other matters required only for occasional reference, are omitted; and thus what usually fills up the greater part of an encyclopædia is at once dismissed. There remains for the full accomplishment of the plan, "a series of articles on the most important branches of science, physical, mathematical and moral, natural history, political history, geography and literature." This furnishes such a course of reading, as, if studied and received into the mind, will make a well-informed man. The portions of a large and costly encyclopædia, which have been omitted, are such as do not form any part of the standing knowledge of any person whatever, besides those for whom it may have a technical, professional, or local interest. "It will be understood, then, that the 'Information for the People' is not meant as an encyclopædia unfailing in reference for all departments of human knowledge, but as an encyclopædia including such knowledge only as tends to improve every mind possessing it—such knowledge as expands, liberates, and fertilizes—with the addition of only a very few articles of which the interest and value are of a more limited nature. The ruling object has been to give what may be expected to prove the means of *self-education* to all such classes of society as are debarred from the receipt of knowledge in more favourable circumstances."

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CHAMBERS'S

INFORMATION FOR THE PEOPLE.

ASTRONOMY.

ASTRONOMY (from the Greek, *astron*, a star, and *nomos*, a law) is, comprehensively, that science which explains the nature and motions of the bodies filling infinite space, including our own globe, in its character of a planet or member of the solar system. The science may be divided into two departments—1. *Descriptive Astronomy*, or an account of the systems of bodies occupying space; 2. *Mechanical Astronomy*, or an explanation of the physical laws which have produced and which sustain the arrangements of the heavenly bodies, and of all the various results of the arrangement and relations of these bodies. *Uranography* is a subordinate department of the science, presenting an account of the arrangements which have been made by astronomers for delineating the starry heavens, and working the many mathematical problems of which they are the subject.

DESCRIPTIVE ASTRONOMY.

The early ideas of mankind respecting the objects described by astronomy, proceeded upon appearances which the uninstructed eye placed before them, and were far from being true. It was supposed that the earth was, as it seems, a fixed plane, or, at the most, a fixed sphere, with an outer sphere, forming the heavens, revolving around it once in the twenty-four hours. Even philosophers deemed the earth the central and most important object in the system, and regarded the heavenly bodies, the sun, moon, planets, and stars, as comparatively small objects, fixed in the different crystal spheres, each of which observed its own laws of revolution, according to the apparent motions of the bodies fixed in it. It was not till after much study and investigation that even the most enlightened minds arrived at a knowledge of the truth; nor was it for some time longer that the idea of the earth not being in the centre of the system, or any thing but a small and subordinate part of it, was generally admitted. There is no room here to trace all the steps by which the truth was ascertained, or to argue the uninstructed mind out of all its first and erroneous impressions. But it may be hoped that when the actual constitution of the heavens has been described, it will be possible to form some notion of how the objects in their real character and real arrangements come to appear as they do to our eyes.

The field contemplated by the astronomer is no less than INFINITE SPACE. So, at least, he may well presume space to be, seeing that every fresh power which he adds to his telescope allows him to penetrate into remoter regions of it, and still there is no end. In this space, systems, consisting of suns and revolving planets, and other systems again, consisting of a numberless series of such lesser systems, are suspended by the influence of gravitation, operating from one to another, yet each body at such a distance from another, as, though the mind of man can in some instances measure, it can in none conceive. We begin with what is usually called the Solar System—that is, the particular solar system to which our earth belongs.

THE SOLAR SYSTEM.

The solar system, so named from *sol* (Latin), the sun, consists of the sun in the centre, twenty-nine planets, and an unknown number of bodies named comets. The word planet is from the Greek, *planao*, to wander, because the few such bodies known to the ancients were chiefly remarkable in their eyes on account of their constantly shifting their places with reference to the other luminaries of the sky. Comets are so named from *coma* (Latin), a head of hair, because they seem to consist of one bright spot, and a long brush streaming from behind it.

Planets.—Eleven of the planets are called *primary*, because they move directly around the sun, and eighteen *secondary*, because they move round primary planets. The secondary planets are also denominated satellites, from *satelles* (Latin), originally signifying a life-guardsman, but, by a wider application, one who follows and serves another. Only four of the primary planets have satellites.

The primary planets are Mercury, Venus, the Earth, Mars, Vesta, Ceres, Pallas, Juno, Jupiter, Saturn, and Herschel, or Uranus. Most of these names are derived from the fabulous divinities of ancient Greece. The Earth has one satellite, the Moon; Jupiter has four; Saturn, seven; and Uranus is supposed to have six.

The planets move round the sun on nearly one level or plane, corresponding with the centre of his body, and in one direction, from west to east. The secondary planets, in like manner, move in planes round the centres of their primaries, and in the same direction, from west to east. These are denominated revolutionary motions; and it is to be observed that they are double in the case of the satellites, which have at once a revolution round the primary, and a revolution, in company with the primary, round the sun. The path described by a plane in its revolution is called its *orbit*.

Each planet, secondary as well as primary, and the sun also, has a motion in its own body, like that of a bobbin upon a spindle. An imaginary line, forming, as it were the spindle of the sun or planet, is denominated the *axis* and the two extremities of the axis are called the *poles*. The axes of the sun and planets are all nearly at a right angle with the plane of the revolutionary movements. The motion on the axis is called the rotatory motion, from *rota*, the Latin for a wheel. The sun, the primary planets, and the satellites, with the doubtful exception of two attending on Uranus, move on their axes in the same direction as the revolutionary movements, from west to east.

The Sun is a sphere or globe, of 882,000 miles in diameter, or 1,384,472 times the bulk of the earth, moving round its axis in 25 days. When viewed through a telescope, the surface appears intensely bright and luminous, as if giving out both heat and light to the surrounding planets. But on this surface there occasionally appear dark spots, generally surrounded with a border of less dark appearance; some of which spots have been calculated to be no less than 45,000 miles in breadth, or nearly twice as much as the circumference of the earth. The region of the sun's body on which the spots appear, is confined to a broad space engirdling his centre. They are sometimes observed to come into sight at his western limb, to pass across his body in the course of twelve or thirteen days, and then disappear. They are sometimes observed to contract with great rapidity, and disappear like something melted and absorbed into a burning fluid. Upon the bright parts of the sun's body there are also sometimes observed streaks of unusual brightness, as if produced by the ridges of an agitated and luminous fluid. It has been surmised, that the sun is a dark body, enveloped in an atmosphere calculated for giving out heat and light, and that the spots are produced by slight breaks or openings in that atmosphere, showing the dark mass within. Though so much larger than the earth, the matter of the sun is of only about a third of the density or compactness of that of our planet, or little more than the density of water.

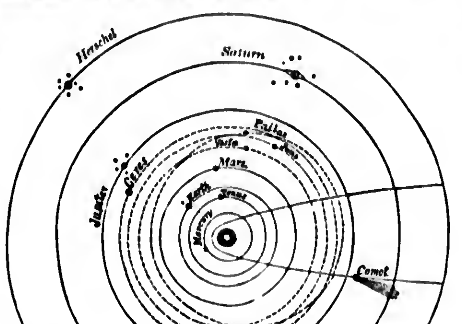
The sun is surrounded to a great distance by a faint light, or luminous matter of extreme thinness, shaped like a lens or magnifying-glass, the body of the sun being in the centre, and the luminous matter extending in the plane of the planetary revolutions, till it terminates in a point. At particular seasons, and in favourable states of the atmosphere, it may be observed, before sunrise or after sunset, in the form of a cone pointing obliquely above the place where the sun is either about to appear or which he has just left. It is termed the *Zodiacal Light*.

Rate of movement of the Planets in miles per minute.

Mercury	1796
Venus	1334
Earth	1131
Mars	905
Vesta	905
Juno	905
Ceres	693
Pallas	693
Jupiter	490
Saturn	363
Uranus	255
Moon	38

Densities of Planets compared with water, which is considered as 1.

The Sun	1, 2-13ths.
Mercury	9, 1-6th.
Venus	5, 11-15ths.
Earth	4, ½
Mars	3, 2-7ths.
Jupiter	1, 1-24th.
Saturn	0, 13-32ds.
Uranus	0, 99-100ths.



Inclinations of Orbits to the Ecliptic.

Mercury,	7° 0' 9" 1.
Venus,	3° 23' 28" 5.
Mars,	1° 51' 6" 2.
Vesta,	7° 8' 9" 0.
Juno,	13° 4' 9" 7.
Ceres,	10° 37' 26" 2.
Pallas,	34° 34' 55" 0.
Jupiter,	1° 18' 51" 3.
Saturn,	2° 29' 35" 7.
Uranus,	0° 46' 28" 4

The Solar System.

Mercury, the nearest planet to the sun, is a globe of about 3140 miles in diameter, rotating on its axis in 24 hours and 5½ minutes, and revolving round the central luminary, at a distance of 37,000,000 of miles, in 88 days. From the earth it can only be seen occasionally in the morning or evening, as it never rises before, or sets after the sun, at a greater distance of time than 1 hour and 50 minutes. It appears to the naked eye as a small and brilliant star, but when observed through a telescope, is horned like the moon, because we only see a part of the surface which the sun is illuminating. Mountains of great height have been observed on the surface of this planet, particularly in its lower or southern hemisphere. One has been calculated at 10¾ miles in height, being about eight times higher, in proportion to the bulk of the planet, than the loftiest mountains upon earth. The matter of Mercury is of much greater density than that of the earth, equalling lead in weight; so that a human being placed upon its surface would be so strongly drawn towards the ground as scarcely to be able to crawl.

Venus is a globe of about 7800 miles in diameter, or nearly the size of the earth, rotating on its axis in 23 hours, 21 minutes, and 19 seconds, and revolving round the sun, at the distance of 68,000,000 of miles in 225 days. Like Mercury, it is visible to an observer on the earth only in the morning and evening, but for a greater space of time before sunrise and after sunset. It appears to us the most brilliant and beautiful of all the planetary and stellar bodies, occasionally giving so much light as to produce a sensible shadow. Observed through a telescope, it appears horned, on account of our seeing only a part of its luminous surface. The illuminated part of Venus occasionally presents slight spots. It has been ascertained that its surface is very unequal, the greatest mountains being in the southern hemisphere, as in the case of both Mercury and the Earth. The higher mountains in Venus range between 10 and 22 miles in altitude. The planet is also enveloped in an atmosphere like that by which animal and vegetable life is supported on earth and it has consequently a twilight. Venus performs its revolution round the sun in 225 days. Mercury and Venus have been termed the Inferior Planets, as being placed within the orbit of the Earth.

The Earth, the third planet in order, and one of the smaller size, though not the smallest, is important to us, as the theatre on which our race have been placed to "live, move, and have their being." It is 7902 miles in mean diameter, rotating on its axis in 24 hours, at a mean distance of 95,000,000 of miles from the sun, round which it revolves in 365 days, 5 hours, 56 minutes, and 57 seconds. As a planet viewed from another of the planets, suppose the moon, "it would present a pretty, variegated, and sometimes a mottled appearance. The distinction between its seas, oceans, continents, and islands, would be clearly marked: they would appear like brighter and darker spots upon its disc. The continents would appear bright, and the ocean of a darker hue because water absorbs the greater part of the solar light that falls upon it. The level plains (excepting, perhaps, such regions as the Arabian deserts of sand) would appear of a somewhat darker colour than the more elevated and mountainous regions, as we find to be the case on the surface of the moon. The islands would appear like small bright specks on the darker surface of the ocean; and the lakes and mediterranean seas like darker spots or broad streaks intersecting the bright parts, or the land. By its revolution round its axis, successive portions of the surface would be brought into view, and present a different aspect from the parts which preceded."*

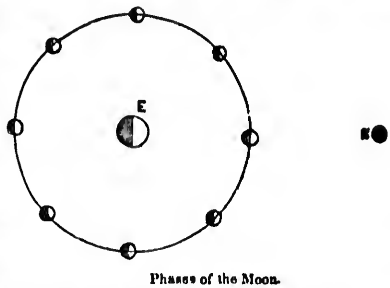
The form of the earth, and probably that of every other planet, is not strictly spherical, but spheroidal; that is, flattened a little at the poles, or extremities of the axis. The diameter of the earth at the axis is 26 miles less than in the cross direction. This peculiarity of the form is a consequence of the rotatory motion, as will be afterwards explained.

The earth is attended by one satellite, the *Moon*, which is a globe of 2160 miles in diameter, and consequently about a 49th part of the bulk of the earth, revolving round its primary in 27 days, 7 hours, 43 minutes, and 11 seconds, at the distance of 240,000 miles. The moon is 400 times nearer the earth than the sun is; but, its diameter being at the same time 400 times less than that of the sun, it appears to us of about the same size. The moon rotates on her axis in exactly the same time as she revolves round the earth. She consequently presents at all times the same part of her surface towards the earth.

Telescopic appearance of the Moon.

Inspected through a telescope, her surface appears of unequal brightness, and extremely rugged. The dark parts, however, are not seas, as has been supposed, but more like the beds of seas, or great alluvial plains. No appearance of water, or of clouds, or of an atmosphere, has been detected. The surface presents numerous mountains, some of them about a mile and three quarters in height, as has been ascertained by measurement of the shadows which they cast on the neighbouring surface. The tops of the mountains of the moon are generally shaped like a cup or basin, with a small eminence rising from the centre, like many volcanic hills on the earth. It has hence been surmised that the moon is in a *volcanic state*, as the earth appears to have been for many ages before the creation of man, and that it is perhaps undergoing processes calculated to make it a fit scene for animal and vegetable life.

The moon, turning on its axis once in a little more than 27 days, presents every part of its surface in succession to the sun in that time, as the earth does in 24 hours. The *day* of the moon is consequently nearly a fortnight long, and its *nights* of the same duration. The light of the sun, falling upon the moon, is partly absorbed into its body; but a small portion is reflected or thrown back, and becomes what we call *moonlight*. The illuminated part, from which we derive moonlight, is at all times increasing or diminishing in our eyes, as the moon proceeds in her revolution around our globe. When the satellite is at the greatest distance from the sun, we, being between the two, see the whole of the illuminated surface,



Phases of the Moon.

which we accordingly term *full moon*. As the moon advances in her course, the luminous side is gradually averted from us, and the moon is said to wane. At length, when the satellite has got between the earth and the sun, the luminous side is entirely lost sight of. The moon is then said to *change*. Proceeding in her revolution, she soon turns a bright edge towards us, which we call the *new moon*. This gradually increases in breadth, till a moiety of the circle is quite filled up; it is then said to be *half moon*. The luminary, when on the increase from *new* to *half*, is termed a crescent, from *crescens*, Latin for increasing; and this word has been applied to other objects of the same shape—for instance, to a curved line of buildings.

In the early days of the new moon, we usually see the dark part of the body faintly illuminated, an appearance termed the *old moon in the new moon's arms*. This faint illumination is produced by the reflection of the sun's light from the earth, or what the inhabitants of the moon, if there were any, might be supposed to consider as moonlight. The earth, which occupies one invariable place in the sky of the moon, with a surface thirteen times larger than the apparent size of the moon in our eyes, is then *at the full*, shining with great lustre on the sunless side of its satellite, and receiving back a small portion of its own reflected light. The light, then, which makes the dark part of the moon visible to us, may be said to perform three journeys, first from the sun to the earth, then from the earth to the moon, and finally from the moon back to the earth, before our eyes are enabled to perceive this object.

* Dick's Celestial Scenery, 135.

Mars, the fourth of the primary planets, is a globe of 4189 miles in diameter, or little more than a half of that of the earth; consequently, the bulk of this planet is only about a 5th of that of our globe. It performs a rotation on its axis in 24 hours, 39 minutes, and $21\frac{1}{3}$ seconds, and revolves round the sun, at a distance of 142,000,000 of miles, in 686 days, 22 hours, and 18 seconds. Mars appears to the naked eye of a red colour; from which circumstance it was, probably, that the ancients bestowed upon it the name of the god of war. Inspected through a telescope, it is found to be occasionally marked by large spots and dull streaks, of various forms, and by an unusual brightness at the poles. As the bright polar parts sometimes project from the circular outline of the planet, it has been conjectured that these are masses of snow, similar to those which beset the poles of the earth.

Vesta, Ceres, Pallas, and *Juno* are four small globes, revolving between the orbits of Mars and Jupiter, in paths near and crossing each other, and which are not only much more elliptical than the paths of the other planets, but also rise and sink much further from the plane of the general planetary revolutions.

Vesta is of a bulk only 1-15,000th part of the bulk of the earth, with a surface not exceeding that of the kingdom of Spain. It revolves round the sun in 3 years, 66 days, and four hours, at a mean distance of 225,500,000 miles. Though the smallest of all the planets, it gives a very brilliant light, insomuch that it can be seen by the naked eye.

Juno is 1425 miles in diameter, and presents, when inspected through the telescope, a white and well-defined appearance. Its orbit is the most eccentric of all the planetary orbits, being 253,000,000 of miles from the sun at the greatest, and only 126,000,000, or less than one-half, at the least distance. In the half of the course nearest to the sun, the motion of the planet is, by virtue of a natural law afterwards to be explained, more than twice as rapid as in the other part.

Ceres has been variously represented as of 1624 and 160 miles in diameter. The astronomer who calculated its diameter at 1624 miles, at the same time believed himself to have ascertained that it has a dense atmosphere, extending 675 miles from its surface. It is of a reddish colour, and appears about the size of a star of the eighth magnitude. Ceres revolves round the sun, at a distance of 260,000,000 of miles, in four years, 7 months, and 10 days.

Pallas has been represented as of 2099 miles in diameter, with an atmosphere extending 468 miles above its surface. Another astronomer has allowed it a diameter of only 80 miles. It revolves round the sun, at a mean distance of 266,000,000 of miles, in 4 years, 7 months, and 11 days. However unimportant it may appear beside the larger planets, it has a peculiar interest in the eyes of astronomers, on account of its orbit having a greater inclination to the plane of the ecliptic than those of all the larger planets put together.

These four planets, which are sometimes called *asteroids*, have only recently become known to mankind. Ceres was discovered at Palermo in Sicily, on the 1st of January, 1801, by M. Piazzi, who gave it this name in honour of the tutelary goddess of his native country. Pallas was discovered at Bremen, in Lower Saxony, on the 28th of March, 1802, by Dr. Olbers. Juno was discovered by Mr. Harding, at the observatory of Lilienthal, near Bremen, on the 1st of September, 1804. Vesta was discovered on the 29th of March, 1807, by the same astronomer who had discovered Pallas.

Jupiter is the largest of all the planets. Its diameter is nearly eleven times that of the earth, or 89,170 miles, and its volume or mass is consequently 1281 times that of our globe. The density of Jupiter is only a fourth of that of the earth, or about the lightness of water; and a human being, if transferred to it, would be able to leap with ease over a pretty large house. It performs a rotation on its axis in 9 hours, 55 minutes, and 33 seconds, or about two-fifths of our day. It revolves round the sun, at a distance of 490,000,000 of miles, in 4330 days, 14 hours, and 39 minutes, or nearly twelve of our years. Viewed through a telescope, Jupiter appears surrounded by dark lines, or belts, which occasionally shift, melt into each other, or separate, but sometimes are observed with little variation for several months. These belts are generally near the equator of the planet, and of a broad and straight form; but they have been observed over his whole surface, and of a lighter, narrower, and more streaky and wavy appearance. It is supposed that the dark parts are lines of the body of the planet, seen through openings in a bright cloudy atmosphere.

Jupiter is attended by four satellites, which revolve round it, in the same manner as the moon round our globe, keeping, like it, one face invariably presented to their primary. They are of about the same size, or a little larger diameter than our moon; the first having a diameter of 2508, the second of 2068, the third of 3377, and the fourth of 2890 miles. The first revolves round the primary planet in 1 day, 18 hours, 28 minutes; the second in 3 days, 13 hours, 14 minutes; the third in 7 days, 3 hours, 43 minutes; and the fourth in 16 days, 16 hours, 32 minutes. These satellites frequently eclipse the sun to Jupiter; they are also eclipsed by the primary planet, but never all at the same time, so that his dark side is never altogether without moonlight.

The satellites of Jupiter were discovered by Galileo, being among the first results of the invention of the telescope. They have been of great use in several astronomical calculations of importance, particularly in suggesting the theory of the gradual propogation of light. It having been observed that their eclipses always took place sooner than was to be expected when the earth was near Jupiter, and later when it was at the greatest distance, an astronomer solved the difficulty by supposing that light required some time to travel—a conjecture which was afterwards confirmed by other observations.

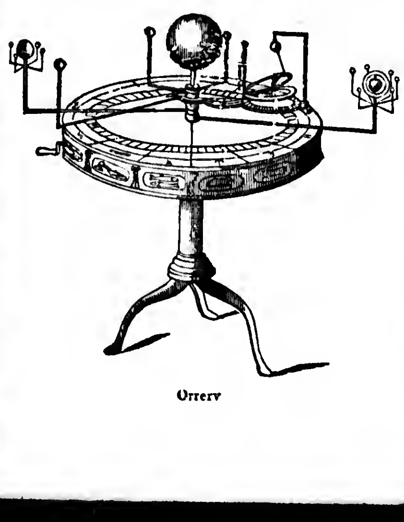
Saturn, seen through a telescope, is the most remarkable of all the planets, being surrounded by a ring, and attended by seven satellites. In bulk this is the second of the planets, being 79,042 miles in diameter, or about 995 times the volume of the earth. Its surface appears slightly marked by belts like those of Jupiter. It performs a rotation on its axis in 10 hours, 16 minutes, and revolves round the sun, at a distance of 900,000,000 of miles, in 10,746 days, 19 hours, 16 minutes, or about $29\frac{1}{2}$ of our years. At such a distance from the sun, that luminary must be diminished to one-eightieth of the size he bears in our eyes, and the heat and light in the same proportion. The matter of Saturn is one-eighth of the density of our earth.

The ring of Saturn surrounds the body of the planet in the plane of its equator. It is thin like the rim of a spinning-wheel, and is always seen with its edge presented more or less directly towards us. It is luminous with the sun's light, and casts a shadow on the surface of the planet, the shadow of which is also sometimes seen falling on part of the ring. The distance of the inner edge from the planet is calculated at about 19,000 miles; its entire breadth from the inner to the outer edge is 28,538; the thickness is not more than 100. In certain positions of the planet, we can see its surface at a considerable angle, and the openings or loops which it forms on the sides of the planet. At other times we see its dark side, or only its edge. From observations made upon it in favourable circumstances, it is found to be apparently divided near the outer edge by a dark line of nearly 1800 miles in breadth, as if it were divided into two concentric rings. From other appearances, it has been surmised to have other divisions, or to be a collection of several concentric rings. It is also occasionally marked by small spots. The ring of Saturn rotates on its own plane in 10 hours, 32 minutes, 15 seconds, and a part of a second, being about the same time with the rotation of the planet.

The seven satellites of Saturn revolve around it, on the exterior of the ring, and almost all of them in nearly the same plane. They are so small as not to be visible without a powerful telescope. The two inner ones are very near to the outer edge of the ring, and can only be discerned when that object is presented so exactly edgeways as to be almost invisible. They have then been seen passing like two small bright beads along the minute thread of light formed by the edge of the ring. The three next satellites are also very small; the sixth is larger, and placed at a great interval from the rest. The seventh is the largest; it is about the size of the planet Mars, and is situated at nearly thrice the distance of the sixth, or about 2,300,000 miles from the body of Saturn. The revolutions of these satellites range from 1 to 79 days; and it has been ascertained of some of them that, according to the usual law of secondary planets, their rotations on their axes and their revolutions round their primary are performed in the same time, so that, like our moon, they always present the same face to the centre of their system. The orbit of the seventh satellite is much inclined to the plane of Saturn's equator.

Uranus, or *Herschel*, the remotest planet known in the solar system, is a globe of 35,112 miles in diameter, rotating on its axis in 7 hours, and performing a revolution round the sun, at a distance of 1,800,000,000 of miles, in 84 of our years. It was discovered, on the 13th of March, 1781, by Sir William Herschel, at Bath. The sun to this remote planet must appear only a 400th part of the size which he bears in our eyes. Two satellites are known, and other four are suspected, to attend upon Uranus. The two which have been observed circulate round their primary in orbits almost perpendicular to the ecliptic, and are further supposed to move in a direction contrary to that of all the other planetary motions—namely, from east to west.

Some idea may be obtained of the comparative size of the principal objects of the solar system, by supposing a globe of two feet diameter, placed in the centre of a level plain, to represent the sun; a grain of mustard-seed, placed on the circumference of a circle 164 feet in diameter, for Mercury; a pea, on a circle of 284 feet, for Venus; another pea, on a circle of 430 feet, for the Earth; a large pin's head, on a circle of 654 feet, for Mars; four minute grains of sand, in circles of from 1000 to 1200 feet, for Vesta, Ceres, Pallas, and Juno; a moderate sized orange, on a circle of nearly half a mile in diameter, for Jupiter; a small orange, on a circle four-fifths of a mile in diameter, for Saturn; and a small plum or full-sized cherry, on a circle of a mile and a half in diameter, for Uranus. It is calculated that the united mass of the whole of the planets is not above a 600th part of the mass of the sun. The sun and planets are represented, with an approximation to correctness, in philosophical toys termed orreries, of which the appearance is conveyed in the preceding engraving.



Orrery

COMETS.

Comets are light vapoury bodies, which move round the sun in orbits much less circular than those of the planets. Their orbits, in other words, are very long ellipses or ovals, having the sun near one of the ends. Comets usually have two parts, a body or nucleus, and a tail; but some have a body only. The body appears as a thin vapoury luminous mass, of globular form; it is so thin, that, in some cases, the stars have been seen through it. The tail is a lighter or thinner luminous vapour surrounding the body, and streaming far out from it, in one direction. A vacant space has been observed between the body and the enveloping matter of the tail; and it is equally remarkable that the tail has in some instances appeared less bright along the middle, immediately behind the nucleus, as if it were a stream which that nucleus had in some measure parted into two.

In ignorant ages, the sudden appearance of a comet in the sky never failed to occasion great alarm, both on account of its threatening appearance, and because it was considered as a sign that war, pestilence, or famine, was about to afflict mankind. Knowledge has dispelled all such fancies; but yet we are not well acquainted with the nature of comets.

Out of the great multitude—certainly not less than 1000—which are supposed to exist, about 150 have been made the subject of scientific observation. Instead of revolving, like the planets, nearly on the plane of the sun's equator, it is found that they approach his body from all parts of surrounding space. At first, they are seen slowly advancing, with a comparatively faint appearance. As they approach the sun, the motion becomes quicker, and at length they pass round him with very great rapidity, and at a comparatively small distance from his body. The comet of 1680 approached within one-sixth of his diameter. After passing, they are seen to emerge from his rays, with an immense increase to their former brilliancy and to the length of their tails. Their motion then becomes gradually slower, and their brilliancy diminishes, and at length they are lost in distance. It has been ascertained that their movement round the sun is in accordance with the same law which regulates the planetary movements, being always the quicker the nearer to his body, and the slower the more distant. In the remote parts of space their motions must be extremely slow.

Three comets have been observed to return, and their periods of revolution have been calculated. The most remarkable of these is one usually denominated Halley's Comet, from the astronomer who first calculated its period. It revolves round the sun in about seventy-five years, its last appearance being at the close of 1835. Another, called Enke's Comet, from Professor Enke of Berlin, has been found to revolve once in 1207 days, or 3⅓ years; but, in this case, the revolving body is found, at each successive approach to the sun, to be a little earlier than on the previous occasion, showing that its orbit is gradually lessening, so that it may be expected ultimately to fall into the sun. This fact has suggested that some part of that space through which the comet passes, must be occupied by a matter presenting some resistance to the movement of any denser body; and it is supposed that this matter may prove to be the same which has been described as constituting the zodiacal sight. It is called a *resisting medium*; and future observations upon it are expected to be attended with results of a most important nature, seeing that, if there be such a matter extending beyond the orbit of the earth, that planet, in whose welfare we are so much interested, will be exposed to the same ultimate fate with Enke's Comet.

The third, named Beila's Comet, from M. Beila of Josephstadt, revolves round the sun in 6¾ years. It is very small, and has no tail. In 1832, this comet passed through the earth's path about a month before the arrival of our planet at the same point. If the earth had been a month earlier at that point, or the comet a month later in crossing it, the two bodies would have been brought together, and the earth, in all probability, would have instantly become unfit for the existence of the human family. Comets are often affected in their motions by the attraction of the planets. Jupiter, in particular, has been described by an astronomer as a perpetual stumbling-block in their way. In 1770, a comet got entangled amidst the satellites of that planet, and was thereby thrown out of its usual course, while the motions of the satellites were not in the least affected.

Comets often pass unobserved, in consequence of the part of the heavens in which they move being then under daylight. During a total eclipse of the sun, which happened sixty years before Christ, a large comet, not formerly seen, became visible, near the body of the obscured luminary. On many occasions, their smallness and distance render them visible only by the aid of the telescope. On other occasions, they are of vast size. The comet now called Halley's, at its appearance in 1456, covered a sixth part of the visible extent of the heavens, and was likened to a Turkish scymitar. That of 1680, which was observed by Sir Isaac Newton, had a tail calculated to be 123,000,000 of miles in length, a space greater than the distance of the earth from the sun. There was a comet in 1744, which had six tails, spread out like a fan across a large space in the heavens. The tails of comets usually stretch in the direction opposite to the sun, both in advancing and retiring, and with a slight wave at the outer extremity, as if that part experienced some resistance.

THE STARS.

The idea at which astronomers have arrived respecting the stars, is, that they are all of them suns, resembling our own, but diminished to the appearance of mere specks of light by the great distance at which they are placed. As a necessary consequence to this supposition, it may be presumed that they are centres of light and heat to systems of revolving planets, each of which may be further presumed to be the theatre of forms of beings, bearing some analogy to those which exist upon earth.

The stars, seen by the naked eye on a clear night, are not above a thousand in number. This, allowing a like number for the half of the sky not seen, gives about two thousand in all of visible stars. These are of different degrees of brilliancy, probably in the main in proportion to their respective distances from our system, but also perhaps in some measure in proportion to their respective actual sizes. Astronomers class the stars under different *magnitudes*, not with regard to apparent size, for none of them present a measurable disc, but with a regard to the various quantities of light flowing round them: thus, there are stars of the first magnitude, the second magnitude, and so on. Only six or seven varieties of magnitude are within our natural vision; but with the telescope vast numbers of more distant stars are brought into view; and the magnitudes are now extended by astronomers to at least sixteen.

The stars are at a distance from our system so very great, that the mind can form no idea of it. The brilliant one called Sirius or the Dog-star, which is supposed to be the nearest, but merely because it is the most luminous, has been reckoned by tolerably clear calculation to give only 1-20,000,000th part of the light of the sun hence, supposing it to be of the same size, and every other way alike, it should be distant from our earth not less than 1,960,000,000,000,000,000 miles. An attempt has been made to calculate the distance of Sirius by a trigonometrical problem. It may be readily supposed that the position of a spectator upon the earth with respect to celestial objects must vary considerably at different parts of the year: for instance, on the 21st of June, he must be in exactly the opposite part of the orbit from what he was on the 21st of December—indeed, no less than 190,000,000 of miles from it, or twice the distance of the earth from the sun. This change of position with relation to celestial objects is called *parallax*. Now, it has been found that Sirius is so distant, that an angle formed between it and the two extremities of the earth's orbit is too small to be appreciated. Were it so much as one second, or the 3600th part of a degree, it could be appreciated by the nice instruments we now possess; but it is not even this. It is hence concluded that Sirius must be at least 19,200,000,000 of miles distant, however much more! Supposing this to be its distance, its light would take three years to reach us, though travelling, as it does, at the rate of 192,000 miles in a second of time!

It is ascertained beyond doubt, that some stars, at one time visible, and registered by ancient astronomers, are not now to be seen; while many instances are on record of stars which have come into sight for a time, and then gradually vanished. A large star suddenly became visible 125 years before Christ, and attracted the attention of Hipparchus, who was thereby induced to draw up a catalogue of stars, the first ever made. In the year 389, a star blazed forth in the constellation Aquila,* and after remaining for three weeks as bright as the planet Venus, disappeared. A star appeared in the region of the heavens between Cepheus and Cassiopeia, in the years 945, 1264, and 1572, and is supposed to be one which comes within our sight once every three hundred and nineteen years, or thereby. At its last appearance, it was very attentively observed by the celebrated Danish astronomer Tycho Brahe, who published a volume respecting it. Its appearance was so sudden, that in returning from his laboratory to his dwelling-house, he found a group of country people gazing at it, and was satisfied it had not been in that quarter of the sky half an hour before. It was then as bright as Sirius, and continued till it surpassed Jupiter when brightest, and was visible at mid-day. It disappeared entirely about eighteen months after being first observed. Another bright star appeared, in the constellation Serpentarius, in October 1604, and remained for a year. It is mentioned by contemporary writers, that at the birth of Charles II. in 1630, a large star, never before observed, appeared in the day-time, as if to mark something extraordinary in the fortunes of the child that day ushered into existence. Other instances have been noticed in still more recent times; but, upon the whole, this is a point in which astronomical observation is defective. It seems, however, to be clearly ascertained, that some, if not all of the stars, have periodical motions throughout space, some more rapid than others. In several of the instances where the period is short, there is no want of positive knowledge. It has been ascertained, for instance, that the star Omicron, in Cetus, has a periodical movement occupying

* It may be stated here, in anticipation of more particular explanations to be given afterwards that the starry heavens are by astronomers mapped out into a series of constellations, or assemblages of stars, each of which bears the name of some figure or other object, as *Aquila* the Eagle, *Cetus* the Whale, *Castor and Pollux*, twin demigods of the Greek mythology, &c. Each particular star in a constellation, in the order of its magnitude, is distinguished by a letter of the Greek alphabet and, when these are exhausted, with a number.

334 days. It is seen as bright as a star of the second magnitude for about a fortnight: then gradually diminishes for three months, till it becomes invisible, in which state it remains for five months, when it again becomes visible, and gradually increases till it regains its former brightness, more or less—for it does not always reach the same degree of lustre. The star Algol, in the constellation Perseus, continues visible during a period of sixty-two hours, when it suddenly loses its splendour, and from a star of the second magnitude is reduced, in three hours and a half, to the fourth; after which it begins to increase, and in three hours and a half resumes its former size There are eleven other stars which exhibit analogous phenomena, some of them at intervals of five hundred years, to which we may look forward without any danger of mistake. Astronomers have not yet made sufficiently extensive observations to settle whether our own sun have any motion through space; but that it has such a motion, has been surmised without any apparent reference to this branch of inquiry.

Another variety in the nature of these luminaries is their being in some instances, not *single* stars, as they appear to the naked eye, but a group of two or more, evidently, from their motions, forming one system. The star Castor, one of the twins, is found, when much magnified, to consist of two stars, of between the third and fourth magnitude, within five seconds (a very small space) of each other. Sir William Herschel made observations upon more than 500 stars of this kind, where the distance is not more than half a minute (also a very small space); and to this list a foreign astronomer has added five times that number. Nor is there reason to suppose that, in *all* these instances, one of the stars is at a great distance behind the other, and that they are only brought together by the accident of our position. Many of the double stars no doubt are thus accidentally brought together; but of a great number it has been fully ascertained that they are each a system, with a reciprocal relation to each other. They are therefore called *Binary Stars.* It is generally observed that they move round each other within a certain time, and in elliptical orbits; the revolution of Castor, for instance, is supposed to be accomplished in 334 years; of ξ of Ursa Major, in 58¼ years; of 70 Ophiunci in 78 years. In fact, there is the same variety in this branch of the starry system as in its other departments, and the revolutions of the few binary stars that have been accurately surveyed range from forty-three to twelve hundred years. Several of these duplicate stars have made a revolution since they were first observed, and are now advancing in their second period. One, ζ Hercules, was seen double, in 1782, by Sir William Herschel; in 1795, it was hardly distinguishable to be double; in 1802, it was double no longer, the one being eclipsed by the other, though a small part of one was still jutting out at the side of the other; astronomers are now watching to observe them once more become separate. Whether one of these stars serves to the other as a sun, or whether both are suns, or whether the organized life with which they are probably stored, be of a kind which can endure a perpetual light and heat thrown from the one to the other—or in what other manner these immense worlds are put to use—it would be vain to inquire. One remarkable peculiarity in them is, the variety of tints apparent in the light emitted by a considerable number of them; but no accurate account has yet been given of the reason of this wonderful difference of colour in the stars.

Perhaps the most magnificent of all the starry phenomena is the *Milky Way.* This, as is generally known, is a broad belt, of whitish lustre, which stretches round the whole sky, being parted into two streaks for a large part of the circuit. The ancients formed the mean idea of this light, that it was the milk spilt by the nurse of Mercury, one of the deities; and hence its name. When examined by a telescope, it is found to consist entirely of stars, "scattered by millions," as Sir John Herschel beautifully describes them, "like glittering dust, on the black ground of the general heavens." The average magnitude of these stars is about the tenth or the eleventh, and hence their invisibility to the naked eye. It is a very remarkable circumstance, that, though the stars of the larger magnitudes are scattered with considerable equality over the whole heavens, there is a notable clustering of the smaller ones towards the body of this ring. Sir William Herschel, by gauging, as it were, the depth of our starry system in this and other parts, arrived at what he believed to be an approximation to the figure of the system itself—namely, an elongated cake-shaped mass, parting flat-wise into two at one particular part of the exterior (where the Milky Way is double), and in which our solar system was placed somewhat nearer the one extremity than the other. Where the distance between two stars is so great as we have seen, and we can suppose the distance between all the rest to be no less, what must be the entire extent of this star-system, composed as it is of millions of millions of distinct bodies!

NEBULÆ.

Within the bounds of what has here been called the star-system, great numbers of bodies have been discovered, which, from their cloud-like appearance, are called *Nebulæ.* There is one of magnificent appearance in the girdle of the constellation Andromeda, and another still more splendid in the sword-hilt of Orion, both visible to the naked eye. Some of these objects are of most irregular form, stretching like a fragment of semi-pellucid membrane over the sky, with patches of brighter matter scattered irregularly throughout their extent. In others, the bright patches are of greater intensity, so as to have the decided appearance of *gatherings* of the matter towards a particular point. Others there are, in which these bright parts seem nearly disengaged from the surrounding thin matter, or only bedded on a slight background composed of it. In a fourth class, we see detached masses, approaching more or less to a spherical form, and with various measures of comparative brightness towards the centre, until they resemble a star with only a slight *bur* around it. It is a new and startling surmise of astronomers, that these are examples of a series of states in which nebulous matter exists, during a process forming it into solar systems more or less analogous to our own—belated portions, so to speak, of the same soft and diffused material, which, countless ages ago, was condensed into the defined bodies forming the remainder of our star-system!

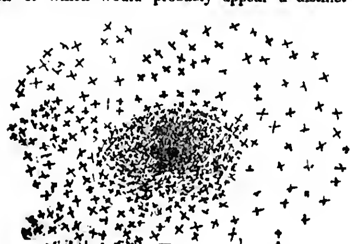
There is much, it must be owned, to support this hypothesis, startling as it is. The physical laws known to operate in our own solar system are in perfect harmony with it. It has been shown that such matter, in agglomerating, would necessarily assume a spherical form, just as a drop of dew takes that shape on the point of a thorn, namely, by the law of attraction. Particles of any fluid matter, flowing towards a centre, will, unless in the extraordinary circumstances of their meeting in a direct line (circumstances which scarcely ever occur), form a whirl or vortex. The meeting of two currents of the ocean forming a whirlpool, or of two currents of air forming a whirlwind, or even such a trivial and familiar phenomenon as the sinking of water through a funnel, are examples of the working of this law of matter. Hence, then, a rotatory motion would be an almost unavoidable result of the agglomeration of a mass of nebulous matter. In this we can, of course, see the origin of such a motion as that which our sun is known to have upon his axis.

And not only are the formation and movements of suns to be thus accounted for, but it has been shown that the same laws will explain how a whole planetary system may have been made up. As the process of condensation in a nebular mass proceeds, the whirling motion must always become more rapid, just as a sling, when the string is allowed to wind up round our finger, flies always the faster as the string shortens. While the rotatory motion is thus increasing, the centrifugal force may become too great to permit the outer and probably softer portion to adhere to the mass; and this outer and softer portion will therefore be left off as a ring surrounding the principal mass at a little distance. Other portions may thus be successively detached, till a considerable number of rings will be left encircling the central mass. Only if the matter of these rings be of a uniform character, can it be expected that they should continue as rings. Almost necessarily, there will be inequalities in their composition, causing them to break up into pieces, each of which, by virtue of gravity, will then collapse into a sphere. A sphere, thus formed, must needs retain the same revolutionary motion as the ring of which it once formed a part, and at the same time it must acquire a rotatory motion in the same direction. Thus we have a set of primary planets, the bodies of which have only to undergo the same processes as the central mass, in order to throw off satellites. The two rings which surround Saturn appear an example of two exterior portions of that planet as yet not advanced from the intermediate state, but which may in time become additions to the number of his satellites. The zodiacal light may also be a residue, of extreme thinness, of the matter of which our system was formed.

It might be supposed that this hypothesis, ingenious as it is, could scarcely be stretched to account for the formation of solar systems in which there are two suns revolving round each other. But this difficulty is easily overcome. It has been shown that the nebulous matter, in certain cases, may assume that arrangement. On the surface of a flowing stream, in which slight repulsions of water from the banks produce little eddies, how common is it to see two of those miniature whirlpools come within each other's influence, and then go on wheeling round each other: *precisely in that manner* do the two suns of a binary star carry on their revolutions, and from circumstances of a similar nature, though upon so much greater a scale, may these revolutions have originated.

REMOTE STAR-SYSTEMS.

Our own star-system, inconceivably vast as it is, is but an item of the heavenly inventory. Far beyond its bounds, the telescope of Herschel has descried similar systems in great numbers, each hanging in some tolerably defined shape in the vast empyrean, and each capable of being resolved, not exactly into stars, though these are in some instances visible, but into what has been expressly called *star-dust*, a collection of small brilliant particles, each of which would probably appear a distinct sun



Remote Star System.

under a stronger power of artificial vision. Observations have been made upon these star-systems chiefly in the direction of the thinner parts of our own system, where the sky is clearest of our own stars, and where of course they are most distinct from other and nearer objects. But even in these limited fields of the sky very great numbers have been seen—between 1000 and 2000 in the northern hemisphere alone—a number, we must recollect, exceeding that of all the ordinarily visible stars in the same moiety of the heavens.

They are of various forms, but in general, as has been said, tolerably well defined, and therefore differing entirely from the irregularly diffused matter of our nebulæ. Many appear as spherical clusters, with a crowding of the star-dust towards the centre: of this kind there is a brilliant example in the constellation Hercules. It has been remarked, that in the worlds about the centre of such clusters, the visible heavens must be inconceivably brilliant, though they will have no appearances resembling our milky way. There is another spherical class, in which the external parts are the most brilliant: in these cases, the visible heavens of a world near the centre will probably be almost entirely composed of milky way. From our earth these annular clusters are presented in various points of view, some so nearly edgewise, that we can barely see the long line of thin matter in the centre. There is one of most peculiar form, namely, an oval, with a regularly formed space of more brilliant matter extending across it in something like the form of a dumb-bell!! Surprising to relate, there are more than one bearing a strong resemblance to the form which has been presumed as that of our own star-system, namely, a flattened mass, with a brilliant annular exterior, parting flatwise into two at one part! In the *Magellanic clouds*, a nebulous object in the southern hemisphere, there is one remote star-system (30 Doradûs), described by Sir John Herschel as "consisting of a number of loops united in a kind of unclear centre or knot, *like a bunch of ribbons disposed in what is called a true lover's knot!*" "We are," says an astronomer who possesses eloquence worthy of his noble science, "lost in mute astonishment at these endless diversities of character and form. But in the apparent aim of things near and around us, we may perhaps discern some purpose which such variety will also serve. It seems the object or result of known material arrangements, to evoke every variety of creature, the condition of whose being can be made productive of a degree of durability; and perhaps it is one end of this wonderful evolution of firmaments of all orders, that there too th law of variety may prevail, and room be found for unfold ing the whole riches of the Almighty."*

The vast general distance of these clusters, their distinctness from our own system, and their relative distances, have been determined by the comparative powers of the telescopes employed in observing them. Some of them are distant from us many thousands of times the distance of Sirius, the nearest of our own stars. The astronomer last quoted speaks of the telescope representing us as in the centre of a sphere, whose circumference is 35,000 times as far from us as that star, "and beyond whose circuit, infinity, boundless infinity, stretches unfathomed for ever."

URANOGRAPHY.

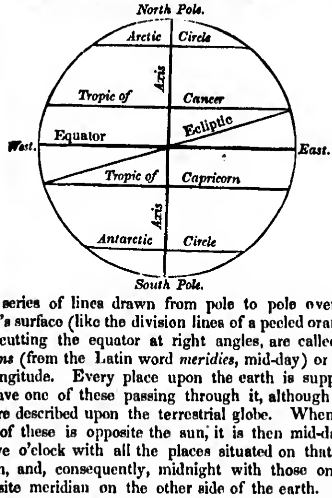
Under this term (delineation of the heavens) may be comprehended all those arrangements which have been made by astronomers for artificial representation of the heavens, and for the working of the many mathematical problems of which the heavenly bodies are the subject.

The stars, as they appear in their places on the apparent concave sphere of the heavens, are represented in proper arrangement on the *celestial globe*, which is expressly designed as a miniature of that sphere, but bearing also the fanciful figures assigned to the constellations

* Views of the Architecture of the Heavens, by J. P. Nichol, LL.D. 1837.

and the lines necessary for the working of various problems. It is required that, in the first place, we give a brief description of the terrestrial globe, or similar miniature representation of the earth.

Astronomers, for the convenience of their science, have supposed certain lines to pass through and around the globe. One, passing through the centre, between north and south, is called the *axis* of the globe, from a Greek word signifying axle. The two extremities are called the *poles*, from the Greek word *polos*, signifying a pivot. A line girding the globe in the middle is styled the *equator;* all to the north and south of which are respectively called the northern and southern hemispheres. The circuit of the earth, both in its girth between east and west, and between north and south, is divided into 360 parts, called degrees. At the distance of twenty-three and a half nearly of these degrees from the equator, in both directions, are two parallel lines called the *tropics*, and at the same distance from each pole is a parallel circle, styled in the one case the *arctic*, and in the other the *antarctic* circle. The space between the tropics is called the *torrid zone*, because the sun, being always vertical in some part of that space, produces a greater degree of heat than what is felt elsewhere. The spaces between the tropics and the arctic and antarctic circles are called the *temperate*, and the spaces within these latter circles the *frigid zones*. Lastly, a line which cuts the equator obliquely, touching upon opposite points of the tropics, is called the *ecliptic*. The ecliptic and equator are called greater circles, because they cut the earth at the thickest parts; the others are called lesser circles.



A series of lines drawn from pole to pole over the earth's surface (like the division lines of a peeled orange), and cutting the equator at right angles, are called *meridians* (from the Latin word *meridies*, mid-day) or lines of longitude. Every place upon the earth is supposed to have one of these passing through it, although only 24 are described upon the terrestrial globe. When any one of these is opposite the sun, it is then mid-day or twelve o'clock with all the places situated on that meridian, and, consequently, midnight with those on the opposite meridian on the other side of the earth. The exact situation of a place upon the earth's surface, or its latitude and longitude, is determined by means of these circles. They are all divided, as already hinted, into 360 parts, which parts are called *degrees;* these degrees again into 60 equal parts, called *minutes*; the minute into 60 others, called *seconds*, and so on. They are all indicated by certain signs placed behind the figure, and near the top of it—thus, 8° 5′ 7″ is 8 degrees, 5 minutes, 7 seconds. A degree is 60 geographical miles, or about 69 English statute miles; a minute is the 60th part of that; and so on. The *latitude* of a place is its distance measured in that manner from the equator. If it lies north of that line, it is in north latitude; if south of it, in south latitude. There being only 360 degrees in the circumference of the earth, and the distance from the equator to either of the poles being only a fourth part of it, a place can never have more than 90 degrees of north or south latitude. The *longitude* of a place is the distance of its meridian from another, which is called the first meridian. The first meridian is quite arbitrary, and it is a matter of indifference through what point we draw it, provided it be settled and well known which one we adopt, so as to prevent mistakes. Foreigners fixed upon the principal observatories of their respective countries. In Germany, the island of Ferro is generally adopted; in France, the observatory of Paris; and in England, that of Greenwich. Longitude is reckoned either east or west of the first meridian; and 180 is therefore the utmost degree of longitude. Some geographers, however, reckon longitude all the way round the globe. From the shape of the earth, which is flat at the poles, the degrees of longitude decrease as we approach these in either direction. In order to measure latitude, each globe is furnished with a brass meridian circle, on which the degrees are marked. Longitude is measured by a similarly graduated circle, termed the artificial horizon, in which the globe is suspended.

The other great circle, called the Ecliptic, is divided into twelve parts, called signs, which bear the name of the constellations through which this circle passes in the heavens, as shall be afterwards explained. There are other smaller circles which run round the earth, parallel to the equator; these are called *parallels of latitude*, because, being everywhere at the same distance from the equator, the latitude of every point contained in any one of them is the same.

The celestial globe, representing that apparent outer sphere, the sky, in the centre of which the earth seems suspended, is marked by lines similar to those upon the terrestrial globe, each line upon the latter being supposed to have a corresponding line opposite to it in the heavens. Thus, the celestial sphere is divided into the same number of degrees as the terrestrial. The celestial poles correspond to those parts of the heavens to which the terrestrial poles always point. The celestial equator corresponds also to the terrestrial, and is, like it, everywhere 90 degrees distant from the poles. The equator of the earth thus lies directly under that of the heavens: the ecliptic does exactly the same, and cuts the former also at an angle of 23 degrees, 28 minutes.

The place where the ecliptic cuts the equator at the vernal equinox, is called the first point of Aries; and from this point the distance of all celestial bodies eastward and westward of it is measured. This is called their *right ascension*, and corresponds to the terrestrial longitude. Their latitude is determined by their distance from the equator, and is called their *declination*. The declination of the sun or other heavenly body is therefore called north or south declination, according to its proximity to the north or south pole of the heavens. Hence it follows, that when the sun's declination is 10 degrees north, he is vertical at a place whose latitude is 10 degrees north. But the right ascensions do not so correspond with the longitudes, simply because the first point of the constellation Aries does not correspond to the first meridian (Greenwich); and because the longitudes are not measured quite round as the right ascensions are.

The sun, which is always in the ecliptic, has, of course, no latitude, but he passes through all the degrees of longitude in a year. When any other celestial object has the same longitude as the sun, it is said to be in *conjunction* with him; and when the difference of longitude amounts to 180 degrees, half the circle of the heavens, it is said to be in *opposition* to him. Both these terms are comprehended in that of *syzygy*, which, when applied to any celestial object, means that it is either in conjunction or opposition to him. What is called an *equinoctial colure*, is a great circle supposed to be drawn through the pole of the ecliptic and the points where it intersects the equator. The *solstitial colure* is a similar circle, which passes through the solstitial points at right angles to it

The former colure is a secondary to the ecliptic, and the latter a secondary to both it and the equator. The equinoctial points are Aries and Libra, where the ecliptic cuts the equator. The solstitial points are Cancer and Capricorn; and when the sun is in either of them, he is at his farthest distance above or below the equator.

Allusion has already been made to the constellations, or fanciful figures, marked on celestial globes, to aid in distinguishing the position of the stars. The earliest astronomers seem to have adopted the idea of thus mapping out the starry heavens, being no doubt at first led to do so by the slight resemblances borne by various groups of stars to familiar terrestrial objects. Thus, a group in the northern part of the sky bears some resemblance to an ancient wain, or to a plough—as also to the hinder part of an animal, with its tail extended. Hence, it has been variously called *the Plough*, *Ursa Major*, or the Greater Bear, and *Charles's Wain*—the last term being in honour of the illustrious French king Charlemagne. (In ordinary globes, Ursa Major is alone marked.) Another group, in the southern heavens, conveys the idea of a man's figure, and has been called Orion, from an early Greek semi-divine hero of that name. Some of the

Constellation Orion.

names of the constellations were conferred by Chaldean observers several hundred years before o r era: others have been given within the last few ages. Particular stars of large magnitude also bear particular names, generally Arabic, having been affixed by Arabian astronomers, as Aldebaran, Dubhe, Alioth, &c. Arcturus and the group of small stars called the Pleiades, are alluded to in the book of Job, which is well known to be one of the earliest of the scriptural compositions, and probably not less than 3000 years old.

Twelve of the constellations are placed in that part of the heavens which is opposite to the ecliptic in the terrestrial globe; that is to say, the plane of the planetary motions, if extended to the stars, would strike the part occupied by these constellations. This part of the celestial globe is called the *Zodiac*, and these are named the Zodiacal Constellations, or, more commonly, the *Signs of the Zodiac*. The zodiac is a zone or belt, extending eight or ten degrees on each side of the ecliptic. It is divided into twelve parts, each of thirty degrees, called the signs of the zodiac. The names of the signs, and the days in which the sun enters them, are as follow:—*Spring signs*—Aries, the Ram, 21st of March; Taurus, the Bull, 19th of April; Gemini, the Twins, 20th of May. *Summer signs*—Cancer, the Crab, 21st of June; Leo, the Lion, 22d of July; Virgo, the Virgin, 22d of August. These are called northern signs, being north of the equator *Autumnal signs*—Libra, the Balance, 23d of September, Scorpio, the Scorpion, 23d of October; Sagittarius, the Archer, 22d of November. *Winter Signs*—Capricornus the Goat, 21st of December; Aquarius, the Water-bearer 20th of January; Pisces, the Fishes, 19th of February These are called southern signs. Within the zodiac are performed the revolutions of all the principal planets.

MECHANICAL ASTRONOMY.

It is the province of Mechanical Astronomy to explain the physical laws which have produced, and which sustain, the arrangements of the bodies occupying space, as well as all the various results of the arrangement and relations of those bodies.

It may in the first place be proper to explain what is meant by a *physical law*. In the operations of nature, certain results are invariably observed to take place as a consequence of certain circumstances. This has suggested to the mind of man, that there is an *order* in all things, by virtue of which they are regulated to the best general purposes, the authorship of the *order* being no doubt the same as the authorship of matter itself, that is to say, referable to the Divine Being. Any particular regulation which we find imposed upon matter, we term a law of matter, or a physical law.

LAWS OF ATTRACTION AND MOTION.

We have first to consider the laws by virtue of which *particles and masses of matter attract each other*, as far as these are concerned in the province of Mechanical Astronomy.

Particles of matter, when brought close together, or within insensible distances, have a tendency to cohere, or stick together, and this operates in all cases, unless there be opposing influences of superior force. It is termed the *attraction of cohesion*.

Particles of matter have also a tendency to move or be drawn towards each other. This is called the *attraction of gravitation*, because it is what the weight or gravity of an object depends upon.

Under the influence of the attraction of cohesion, particles of fluid matter, when suspended at a proper distance from other objects, arrange themselves round a centre, and take a globular form. The dew-drop, suspended from the point of a thorn or blade of grass, is a familiar example of matter thus acting. If two such drops are brought close together, they will unite; a new and common centre will be instantly established for both, and they will resolve themselves into a new mass equally globular as before.

Under the influence of the law of gravitation, when any two masses of matter are brought to a proper distance from each other, they will, if there be no sufficient obstacle, rush together, and then remain in union.

We may see this law operating if we take two fragments of cork, no matter how small, and set them afloat on the surface of a cup of water. If kept a considerable way apart, the impediments to their mutual attraction are too strong, and they therefore do not meet. But, if brought within a short distance of each other, we shall observe them begin mutually to exercise an influence over each other, and immediately they will rush together, and so remain.

Material laws are equally ready to act on a large as a small scale, and on a small as upon a large one. The same attraction of cohesion, which causes the tear drawn from our eye by sympathetic feeling to be round, produced the spherical form of the vast orbs which people space. These, being originally fluid masses, gathered themselves round a centre, by the irresistible force of the law of the attraction of cohesion. So are the planets restrained in their position regard. the central luminary, by the force of the same law of gravitation which causes an apple dropping from a tree to fall upon the ground, or two tea-stalks floating in our evening cup to go together, and range themselves as closely side by side as possible.

We have next to consider the laws which regulate the *motion* of masses of matter.

A mass of matter set in motion upon the surface of the earth, or within the compass of the atmosphere, invariably comes sooner or later to a stop. If we roll a ball along the surface, it goes briskly for a while, then slowly, and finally it stops and remains at rest. What causes it to stop is the resistance it meets with from the roughness of the ground, and the opposing fluid (atmosphere) in which it moves. It is precisely when as much force has acted in opposition to its motion, as was exerted in setting it agoing, that it comes to a pause. Were it not, however, for this opposing force, the ball, once set in motion, would travel on and on for ever.

Just so the orbs of space, once set in motion, go on and on perpetually, there being nothing whatever to oppose their progress. This applies as well to their spinning or rotatory motion on their axes, as to their progress along their orbits. If a top were set a-spinning on a smooth marble tablet, underneath the exhausted receiver of an air-pump, it would be found to keep in motion for a far longer space of time than in any ordinary circumstances, for then there would be comparatively little air to give resistance to its rotation, and the chief opposition would lie in its friction against the tablet. Could the air be entirely drawn away, and the top be made to spin in a state of suspension, it would be in precisely the same circumstance as an orb revolving on its axis in space, and in that case it would never stop as long as all the circumstances remained unaltered.

But the orbitual revolutions of planets are circular—why should they be so? Because these orbs are under the influence of both the law of attraction and the laws of motion. Assuming the nebular hypothesis to be true, the impulse which they originally obtained tended to throw them off in a direct line into space, in the plane of the ecliptic. But the law of attraction prevented this result, and caused them to assume a circular course round the parent orb. They were propelled by the one cause (the centrifugal or centre-quitting force), but restrained by another (the centripetal or centre-seeking force, that is to say, attraction), and they therefore settled into paths where the two forces balanced each other.

To explain. If we take any circular body, say a common grinding-stone, and, having first put a few pieces of clay upon its rim, cause it to revolve quickly in a horizontal manner, it will be found that the pieces of clay, one after another, fly off in straight lines from the rim. The cause of this is, that each particular part of the rim of the grinding-stone, at every instant of its revolution, is describing a straight-forward movement, and has itself, from the revolutionary motion, a tendency to go straight on, and is only kept in its place by being fixed to the rest of the stone. Every bit of clay that flies off receives, at the instant of its parting, the force of the straight-forward impulse which at that moment affected the part of the rim where it rested; and hence its going off in a straight line. It is to be observed, however, that the earth immediately begins to act upon the flying piece of clay, and draws it downwards to itself in a bending line, its last movements being in fact a part of a circle. This is the power of attraction, which, in this case, is exercised in much greater force by the earth than by the grinding-stone; were the grinding-stone the sole mass of matter near by, and the opposing force of the atmosphere withdrawn, we should see the clay begin to fly round the stone in a circular course.

And this naturally brings us to consider the comparative powers of attraction exercised by different objects. A large mass has a much greater power of attraction than a small one. When two of unequal bulk are brought near each other, we shall only be sensible, perhaps, of the large one drawing the small one to it, and see no attractive power in the small one whatever. In reality, each mass, however small in comparison, exercises a certain degree of attractive power; and this power will depend expressly upon its relative bulk and density, according to fixed regulations of the nicest kind.

One great and important law presides over the attraction which one mass exercises over another. This relates to the *distance* between the two masses. We shall suppose two globes of unequal size. When the small one is removed to as great a distance from the large one as there is space between the surface of the large one and its centre (that is to say, the distance of a semi-diameter of the large one), the attractive force is diminished one-half. When it is removed to twice that distance, or two semi-diameters, the attraction is diminished to a fourth. When it is removed to the distance of three semi-diameters, the force is lessened to a ninth; to four semi-diameters, a sixteenth; to five, a twenty-fifth, and so on; the diminution being always as the squares of the amount of semi-diameters of distance, or these sums multiplied by themselves. The moon is distant from the earth sixty of the earth's semi-diameters; consequently, the attractive power exercised by the earth over the moon is only a 3600th part of what it would exercise at its surface.

In the revolution, then, of a planet round the sun, and of a satellite round a planet, there are various forces at work, all of them in the nicest proportion to each other, and to the mass of each body. There is first the amount of motion resulting from the original impulse; then the amount of attraction exercised by the central and larger over the smaller orb—the one pulling outwards and the other pulling inwards, but both in union attended with the result of a circular or revolutionary motion.

Gravity has not the same force at all parts of the earth's surface. At the equator, the centrifugal force produced by the rotating motion is greatest; it declines in both directions towards the poles. In proportion as the centrifugal force is greater, the attractive power of the mass of the earth is less, for the first of these forces is directly counteractive of the other. There is of course least attractive power at the equator; and bodies are there drawn with less force towards the centre of the earth than would be found to be the case elsewhere. Yet this difference is not great, for even at the equator the attractive force is 288 times that of the centrifugal. Neither does the difference tell in the weighing of objects, for in that case two equivalents are used, and if a certain object is lighter, so also is the weight put into the opposite scale. The difference was first detected, in consequence of pendulum clocks being found to go slower as they were brought towards tropical latitudes. It was ascertained that the pendulum of a clock which went right at London, required to be one-eighth of an inch shorter (by which means its motion was accelerated) when it was placed upon the equator. This effect, however, is not altogether owing to the increase of centrifugal force, but partly also to the greater distance of the equator from the centre. And it was from a speculation as to the slower movements of pendulums at the equator, that Sir Isaac Newton first conceived the idea of the spheroidal form of the earth, which he ascertained to be of less diameter at the poles than at the equator, as 229 is to 230, or by twenty-six miles.

The orbits of the planets, it has been already seen, are not strictly circles, but rather ellipses, the sun being in each case placed in one of the *foci*, that is, the centre of one end of the ellipse. How should this circumstance affect the revolutionary motion? It might be supposed that, when the planet came to the part of its course where it is nearest to the sun, the attractive force would be greater, and that some derangement might take place. But this is not the case. At that part of the course the planet moves faster than elsewhere, and thus baffles the greater attractive force. This phenomena is particularly apparent in comets, which have so eccentric an orbit. These bodies move with inconceivably greater speed when near the sun than in the remote parts of their orbits.

It was a discovery of the German astronomer Kepler, in the seventeenth century, that, notwithstanding the increased speed, a revolving orb goes over exactly the same amount of its circuit as when it moves more slowly. Suppose a multitude of lines radiating from the sun, at equal distances from each other, the orb would be found to cross from one to another of these, in exactly the same time when it was *farthest* from the sun as when it was *nearest*. In scientific language, it describes equal areas in equal times.

Another discovery of Kepler established that there is a relation between the times respectively required by the planets for their revolutions, and their various distances from the sun. At a first glance, we are struck by the fact that the periods of revolution increase more than in proportion to the distances. For example, the period of Mercury is about 88 days, and that of the Earth 365, being in proportion as 1 to 4.15 (or about 4 1-7th), while their distances, respectively 37,000,000 and 95,000,000 of miles, are in the less proportion of 1 to 2.56 (or a little more than 2½); and a similar remark holds good in every instance. If we take the squares of the distances, we arrive at nothing satisfactory, for it considerably exceeds the proportion of the periods. If, however, we take the squares of the periods of two planets, we find they are in exactly the same proportion to each other as the *cubes* of the mean distances. Some may find a difficulty in understanding the nature of this calculation; but its ingenuity and its results form one of the highest boasts of astronomical science. "When we contemplate," says Sir John Herschel, "the constituents of the planetary system from the point of view which this relation affords us, it is no longer mere analogy which strikes us—no longer a general resemblance among them, as individuals independent of each other, and circulating about the sun, each according to its own peculiar nature, and connected with it by its own peculiar tie. The resemblance is now perceived to be a true *family* likeness; they are bound up in one chain—interwoven in one web of mutual relation and harmonious agreement—subjected to one pervading influence, which extends from the centre to the farthest limits of that great system, of which all of them, the earth included, must henceforth be regarded as members."*

The solar system, though composed of many different masses distant from each other, is to be considered with respect to other masses as *one mass*, having a centre of gravity, by which its position with respect to other masses is regulated. The nearest stars no doubt exercise the force of gravitation upon it, so as to keep it in its position; and it also acts in the same way upon them. It is therefore not strictly correct to speak of the solar system or any part of it as *suspended* in space, for that term implies a hanging from a fixed point. It is in reality kept at its place by attractive influences exerted all round it by other masses. In like manner, we are to suppose our star-cluster as poised by the same forces in the midst of other clusters; and these again poised by others—an idea which leads us on and on through the fields of infinity, till the mind loses itself in an effort beyond its finite powers, and pauses contented to wonder and adore!

* Treatise on Astronomy, 183.

DIURNAL AND ANNUAL MOTION OF THE EARTH.

The earth is to be considered as a globe of nearly 8000 miles in diameter, performing a rotatory motion on its axis once every twenty-four hours. This motion is at the rate of 1042 miles an hour to places at the equator, but only 644 miles at London, and a gradually diminishing amount in places nearer to the poles.

From the situation of the earth with respect to the sun, it necessarily follows that only one-half of its surface should be exposed at a time to the light and heat diffused from that body. This is the case with all the planets. When any one part of the earth is presented to the sun, it is day at that part, and all the other heavenly objects are lost in the blaze of the great luminary. When, on the contrary, any part is averted from the sun, it is dark at that part, and the light of the stars is allowed to tell upon our organs. Each part is thus brought once every twenty-four hours towards the sun; in short, this is the cause of what we familiarly know as day and night.

There is a minute difference between the *civil* or *legal day* and what is called the *sidereal day*. The entire orb of the earth in reality revolves in 23 hours, 56 minutes, 4 seconds, or 3 minutes, 56 seconds, less than 24 hours. This is called a sidereal day, because the earth is then in the same relation to the stars as it was the day before. The fixed stars are so immensely distant from our earth, that its whole orbit is in respect to them but a point; so that no sensible difference is produced by its revolving round the sun. But the sun being much nearer us, any movement made by the earth can be appreciated. The time which elapses from the sun's being on the meridian of any place to its returning to the same spot next day, is exactly 24 hours, and is called an astronomical day. The natural day would always be the same as the sidereal day, if the earth had no other motion than that upon its axis. But in the same time that it has performed one of its daily revolutions eastward, it has also advanced about a degree westward, or in the opposite direction, which is the course it takes round the sun; so that, before the sun can shine exactly upon the same meridian, the earth must make up as it were its lee-way, and this it does in 3 minutes, 56 seconds, the difference of time between a natural and sidereal day. If the earth, then, had no other than its diurnal motion, we should have 366 days in the year.

When any spot on earth comes directly opposite to the sun, it is noon at that spot, and at every place in the same longitude. At the same moment, it is an hour before noon at the meridian of longitude fifteen degrees to the west of the same spot, and an hour earlier for every fifteen degrees farther to the west; because, as the earth moves from west to east, it requires so much time to bring those places to the same point, namely, opposite to the sun. In like manner, it is an hour after noon for every fifteen degrees to the eastward of the spot where it is noon, because at those places the sun has already been for so many hours past meridian. Thus the hour of the day varies in every part of the globe where the longitude or meridian line is different. When it is twelve o'clock noon with us in any particular part in Britain, it will be twelve o'clock at midnight in a corresponding point on the opposite side of the globe, near New South Wales; and the intermediate hours, sooner or later, will all lie in the countries between these two points, exactly according to their position or degrees of longitude.

The earth is at a mean distance of 95,000,000 of miles from the sun, and performs its revolution round him in a sidereal year, which is 365 days, 6 hours, 9 minutes, 11 seconds, mean solar time. The earth travels at the rate of 68,000 miles per hour. Its orbit is, as already stated, not a circle, but an ellipse, the sun being situated in one of the foci, that is, not in the centre, but near one of the ends of the oval-shaped figure. Neither does the earth go round the sun in an upright or perpendicular position; its axis is slanting or oblique. The degree of obliquity is 23 degrees 28 minutes. The points at which the ecliptic cuts the equator, are called *nodes:* the period of time at which it does this, *equinoxes* (a Latin term, signifying equal nights, for the days and nights are then of equal length all over the world). In consequence of this obliquity, during one part of the earth's course, the north pole is turned towards the sun, and the south is dark; and during another part of its course, the south pole is turned to the sun, and the north is dark: and this is the cause of the difference of seasons, which will be better understood by referring to the annexed figure.

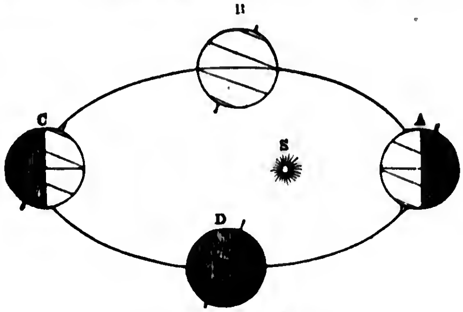


Illustration of the Seasons.

THE SEASONS.

Let S represent the sun, and A B C D the earth at various places of its annual circuit; when the earth is at B or D, these are the periods of the equinox, when the line of the equator intersects or cuts through the line of the ecliptic. At this period, one-half of the globe is illuminated from pole to pole, or there is over all the earth an equal day and night of twelve hours. But when the earth has proceeded to A, the pole or axis still keeping the same position, or pointing to one particular place in the starry heavens, it will be turned more directly from the sun; a greater proportion of his rays will shine on any particular spot of the southern half of the globe, and the period of day, or sunlight, will exceed that of darkness by the proportion of the light and shade parted in the circle of the earth. It will be observed, also, that within the circle of the south pole, the sun will shine continually as the earth revolves on its axis, or, in short, to the inhabitants of that part of the globe the sun will never set for several months. When the earth has proceeded on to D, one-half of its annual course is finished, or this is the spring equinox, or equal day and night. At C, again, the earth has arrived at our longest day in summer, when the axis is turned to the sun, and the regions around the pole are in the light for a greater period, while darkness, or night, prevails for a less. It will be seen, too, that now the pole and circle around it revolve in perpetual light; or to the inhabitants of that region, the sun never sets for some months, but they have one continued and uninterrupted day. At the other, or south pole, the same changes take place, only matters are reversed—there it is summer while we have winter, and the winter of the north pole is the summer of the south. In the middle regions of the earth, or around the equator, the sun's place does not suffer a very great change; and, accordingly, there the heat is nearly of the same intensity all the year through; and the length of their days and nights is nearly equal, or nearly the same as at the periods of the equinoxes. But the orbit in which the earth travels round the sun is not an exact circle; it is, as we have already mentioned, an ellipse, and the sun is placed near one end of it, as at the small circle and letter S. In consequence of this circumstance, the sun is much nearer us at one period of the year than another, and this happens in our winter; accordingly, the sun appears about one-thirtieth part larger in January than in June. But in proportion as the earth approaches in her orbit to the sun, her motion is quickened, and she passes over the winter half year in nearly eight days' less time than the summer. It is principally from this circumstance, as well as the shorter period of the day, that although the sun be nearer us in winter, and consequently his power of imparting heat greater, yet the actual quantity imparted is, on the whole, much less in the one season than the other. We have said that the north pole of the earth always points to a particular spot in the heavens; this is not, strictly speaking, correct; the pole or axis makes a circle round the centre of the axis of the ecliptic in a long period of years, and it is this motion that gives rise to the precession of the equinoxes, which will be afterwards described under that title.

ABERRATION OF LIGHT.

Although the most convincing proof of the earth's orbitual motion is not to be found in any circumstance of which the senses can take immediate cognisance, but is afforded by the full development of the planetary system, there is, however, one direct proof of it in a phenomenon discovered by Bradley, an illustrious astronomer. It is called the aberration of light, and is manifested by a small difference between the apparent and true places of a star, occasioned by the motion of light combined with that of the earth in its orbit. Vision, it is well known, arises from rays of light proceeding from any object, and entering the eye; and we see the object in the direction in which the rays have come. If both the body giving forth light and that one which receives it be at rest, the former will be seen in its true place, at least in so far as aberration is concerned; but let either of the bodies move, and this will not be the case. In order to render this plain, suppose a shower of hail to fall perpendicularly upon a number of tubes—say the pipes of an organ; if the organ remain stationary, the hailstones will descend sheer from the top to the bottom, without any deviation right or left; but move the organ in any direction, and they will strike the side opposite to the direction in which the motion is made. Now, it is just in this way that the eye misses the perpendicular ray, and, meeting an oblique one, receives an impression that the star lies in that direction. The object thus appears displaced, and the amount of displacement is *aberration.* The earth travels at the rate of about nineteen miles per second, and therefore is every instant changing its direction. Time is also occupied by light in traversing space, which it does at the amazing rate of 192,000 miles per second; so that also requires to be calculated for by astronomers. The effect of aberration is to make a star apparently describe a small ellipse in the heavens, in the centre of which it would be seen if the earth were motionless. The reader must carefully distinguish between aberration and refraction; their effects are the same—namely, to displace the ray projecting object—but they proceed from very different causes. Besides these corrections which astronomers have to make in their calculations, there is another, resulting from what is called parallax, which may be as well introduced in this place.

PARALLAX.

The word parallax, in its general signification, denotes change of place; but in astronomical books it has a conventional meaning, and implies the difference of apparent positions of any heavenly luminary when viewed from the surface of the earth and from its centre. The centre of the earth is the general station to which all astronomical observations are referred; the situation of a heavenly body, observed from the surface of the earth, is called the apparent place; and that at which it would be seen from the imaginary place of observation at the centre of the earth, the true or mean place. Hence the altitudes of the heavenly bodies are depressed by parallax, which is greatest at the horizon, and decreases as the altitude of the object increases. This may be rendered very plain, by supposing that two persons placed individually at the end of a straight line, look at a candle removed at, say, 100 yards distant from them. It is evident that the burning body will appear to be projected upon the wall of an apartment, or any other background, at very different positions to each of the spectators. The angle which this difference of position makes is similar to parallax. The farther they remove from the light, allowing them still to remain at the same distance from each other, the more obtuse the angle would become, and the less the parallax. Thus, the fixed stars, being so far removed from us, when viewed from any two positions upon the earth's surface, are seen at the same place upon the celestial sphere, and hence have no perceptible parallax. It is different, however, with the luminaries belonging to our system; and by this means astronomers have been enabled to estimate the quantity of space which separates us from them. For a complete account of the means by which this is accomplished, we must refer the reader to more elaborate treatises than the present. A general and correct enough idea of it may be formed from the familiar example we have given. In the same manner, suppose two observers, one in the northern the other in the southern hemisphere, at stations on the same meridian, observe on the same day the meridian altitudes of the sun's centre. "Having thence derived the apparent zenith distances," says Sir J. Herschel, whose language would be deprived of clearness were it abridged, "and cleared them of the effects of refraction, if the distance of the sun were equal to that of the fixed stars, the sum of the zenith distances thus found would be precisely equal to the sum of the latitudes north and south of the places of observation; for the sum in question would then be equal to the meridional distance of the stations across the equator. But the effect of the parallax being in both cases to increase the apparent zenith distances, their observed sum will be greater than the sum of the latitudes by the whole amount of the two parallaxes. This angle, then, is obtained by subducting the sum of the latitudes from that of the zenith distance; and this once determined, the horizontal parallax is easily found, by dividing the angle so determined by the sum of the signs of the two latitudes." It may be observed, that the angles are determined by means of very nice instruments. The parallax thus obtained is called the *daily* or geocentric, in contradistinction to the annual or heliocentric, by which, in general, is understood the difference of place of a heavenly body, as seen from the earth and from the sun; in particular, however, it denotes the angle formed by two lines from the ends of the diameter of the earth's orbit to a fixed star, which, as we have already observed, from the immense distance of the latter, is inappreciable. Some idea of the importance of parallax may be obtained from the fact, that before the sun's was determined, the distance of that luminary from us was not estimated at within 13,000,000 of miles of its true amount. Its parallax is, of course, a very minute quantity, only 8″ 6.

OF SOLAR, SIDEREAL, AND ANOMALISTIC YEARS

There are three different periods at which the sun may, in different senses, be said to return to the same position—when he returns to the same equinox at which he was before; when he returns to the same point in his orbit, or the ecliptic; and when, being in perigee (least distance from the earth), or apogee (farthest distance from the earth), he comes back to either again; or, which is the same thing, when, having been at a given distance from any of these points, he returns to the same point with respect to them. Each of these may be said to be a completion of the revolution of the sun (strictly speaking, it is a revolution of our own earth round him), and a revolution thus performed is called *a year*. The first and shortest is the equinoctial, solar, or tropical year; for his time of returning from tropic to tropic, they being situations holding the same relation to the equinox for the time being, is obviously the same as that from equinox to equinox. The value of this year is 365 days, 5 hours, 49 minutes, nearly. But although the earth has thus returned to the same equinox, it has not made the entire circuit of its orbit, but must travel a little further to arrive at the same point it was in a year before. This arises from a backward movement of the equinoctial point. (See "Precession of the Equinoxes.") The second is the sidereal year, which consists, as we said before, of 365 days, 6 hours, 9 minutes, 9 seconds, 6, reckoned in mean solar time, or *a day more*, reckoned in sidereal time. Here, then, there is a remarkable difference between solar and sidereal time, which requires explanation. If the reader will recollect what was said with regard to a solar and sidereal *day*, the discrepancy between the times of the years will become apparent. In the course of twelve months, all the little daily deficiencies, as it were, amount to twenty-four hours, which constitutes the difference between the two years. The sun's apparent *annual* motion among the stars is performed contrary to the apparent *diurnal* motion of the sun and stars; hence the stars gain every day three minutes, fifty-six seconds on the sun, which makes them rise that portion of time earlier every day. In the course of a year, the sun will fall behind the stars a whole circumference of the heavens, or one revolution, which deficiency he must make up to complete the number of days in a year. It is evident, then, that the sun apparently, or the earth really, turns 366 times round upon its axis; and had it no other motion, there would be as many days in a year. After the earth or sun has completed a sidereal year, before it can finish an anomalistic year, it must describe a farther arc of 11″ 8 to arrive at its original position in perihelion, the latter having moved forward to that amount. In so doing it occupies 4′ 39″ 7, which must be added to the sidereal period, making the anomalistic year 365 days, 6 hours, 13 minutes, 49 seconds, 3, in length. All these periods have their uses in astronomy; but the one in which mankind are most particularly interested is the tropical year, or that on which the seasons depend, and which is a compound phenomenon, depending chiefly and directly on the annual revolution of the earth round the sun, but subordinately also, and indirectly, on its rotation round its own axis.

MEASUREMENT OF TIME.

Although the sidereal day, from its uniformity, is well adapted for astronomical purposes, yet it is scarcely sufficiently marked for the ordinary wants of life. No person but an astronomer ever attends to the culmination of a star; on this account the diurnal return of the sun to the same meridian has been universally adopted as the measure of time; and this is called a *civil day*. Most nations reckon the beginning of their day from midnight, but astronomers count from noon to noon. The day thus determined is called the astronomical or solar day, and, being regulated by the true motion of the sun, the time which is measured by it is called true or apparent time. Two causes conspire to render astronomical days unequal; first, the variable velocity of the sun in his orbit, and, second, the obliquity of the ecliptic. A mean astronomical day, which is independent of any causes of inequality, has been obtained by astronomers introducing into the system two imaginary suns. These two fictitious bodies are supposed to move uniformly, the first in the ecliptic, the second in the equator, and as the circles are both equal, the actual motion of each of the bodies is equal. To those desirous of studying this part of the subject, we would recommend a perusal of the article *Astronomy* in the seventh edition of the Encyclopædia Britannica, page 778, where it is well illustrated. The correction or equation, by which apparent time is reduced to mean time, is technically called the *equation of time*. There are only four days in the year when the apparent and mean time are the same, and the equator of time nothing. In the interval between the first and second of these, that is, December 24th and April 15th, and, again, in that between the third and fourth, that is, June 15th and September 1st, the apparent is always later than the mean time, or the clock is before the sun; in the other intervals which complete the year, the reverse is the case, and the clock is after the sun. The greatest difference between solar and true time amounts to between fifteen and sixteen minutes. Tables of equation are constructed for the purpose of correcting the differences.

THE MOON.

Next to the sun, the moon is to the inhabitants of the earth the most remarkable and important of all the heavenly bodies. The mean horizontal parallax of the moon is 57′ 48″; and her mean distance from the earth 236,847 miles. Like the sun, the moon advances in the heavens in a motion contrary to that of the stars. Notwithstanding the vast distance she is from us, it is little more than one-fourth of the sun's diameter, and the globe of that magnificent luminary would nearly *twice* include the whole orbit of the moon! It has various motions; as a secondary planet, it revolves round the earth, which is its primary. Along with the latter, it revolves round the sun, and it has a rotatory motion upon its own axis. Owing to the sun's apparent movement in the heavens being in the same direction with that of the moon, only slower, the latter has to make up for that slowness in the same way as we have mentioned with regard to the earth and the time it takes constitutes the difference between the sidereal and synodic month or lunation. The sidereal month is 27 days, 7 hours, 43 minutes, 11 seconds, 5, in which time the moon performs a complete revolution round her primary; and the other is 29 days, 12 hours, 44 minutes, 2 seconds, 87, the time which elapses between two new moons, or two conjunctions of the sun with the moon. It happens that its revolution upon its axis is performed in the same time as its revolution round the earth, so that the same side of her orb is always presented to the latter planet. Although the moon's rotation on her axis is uniform, her motion in her orbit is not so, and we are by this means enabled at times to obtain a peep of the equatorial portions of her eastern and western sides. Her axis, also, is not perpendicular to her orbit, and a small part of each of her poles alternately become visible. These phenomena are known by the name of *librations* of the moon, and they are of two distinct kinds, the result of different causes.

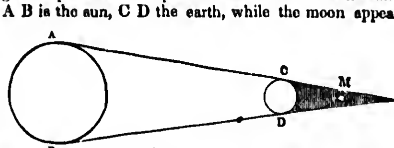
The wisdom and beneficence of the Deity are strikingly displayed in the economy of moonlight, as distributed to our globe during various seasons of the year. The remarkable phenomenon of the *harvest* moon is familiar to every one. During the time that our satellite is full, and for a few days before and after, in all about a week, there is less difference between the time of her rising on any two successive nights, than when she is full in any other month of the year. By this means, an immediate supply of light is obtained after sunset, so beneficial for gathering in the fruits of the seasons. To conceive of this phenomenon, it must be recollected that the moon is always opposite to the sun when she is full; that she is full in the signs Pisces and Aries, these being the signs opposite to Virgo and Libra, which the sun passes through in September and October, our harvest months. Thus, although, whenever the moon enters the two former signs (and she does so twelve times in a year), the same circumstance takes place with regard to the time of her rising; yet it is not observed on these other occasions, just because she is not *full* at the time. The reason of there being little difference in the time at which she rises on several consecutive nights, is, that at these periods her orbit is nearly parallel with the horizon. The harvest moons are as regular in south latitude as with us in north latitude, only they happen at different periods of the year.

ECLIPSES.

Eclipses are caused by the positions of the earth and moon with respect to each other and to the sun. An eclipse of the sun takes place when the moon is between the sun and earth; and an eclipse of the moon is the result of the earth being between the sun and moon. In other terms, the shadow of the earth cast upon the moon causes a lunar eclipse, and that of the moon upon the earth causes a solar eclipse.

The following figure explains an eclipse of the sun A B is the sun, M the moon, and C D the earth. The

shadow of the moon falls upon a part of the earth's surface; and there, accordingly, the sun appears in eclipse, the body of the moon being placed between. Another diagram represents an eclipse of the moon. In this instance, A B is the sun, C D the earth, while the moon appears



as a small circle M involved in the shadow thrown by the earth.

The places of the earth's orbit and the moon's do not exactly coincide, but cross or intersect each other; and the consequence is, that, in general, the moon, when she is in conjunction with the sun, either passes on one side or the other, and therefore does not intercept the sun's rays, or produce an eclipse. An eclipse of this kind can only take place when the earth and moon are in conjunction in that part of their orbits which cross each other (called the nodes), because it is then only that they are both in a right line with the sun. If the orbit of the moon were parallel to that of the earth, an eclipse would happen every month. Partial eclipses, again, are caused when the moon, in passing the earth, is not directly in a line with the sun, but a little on either side; the consequence of which is, the edge of one side of the moon only dips into the sun's disc. When the sun is eclipsed, the total darkness is confined to one particular part of the earth, but the lunar eclipses can be seen from every part of the earth, when the moon is above the horizon; and both circumstances prove that the earth is a good deal larger than the moon. The moon arrives very nearly at the same situation with respect to the earth, after making 223 revolutions, which are performed in eighteen years, of 365 days, 15 hours, 7 minutes, and 43 seconds, each; so that, after a period of about eighteen years, the series of eclipses recommences nearly in the same order, a circumstance observed by the ancients. The mean number of eclipses which occur in a year is about four, and there are sometimes as many as seven. There must necessarily be two solar eclipses, but it is possible that there may not be even one lunar. A remarkable eclipse, called an annular (or circular) solar eclipse, happens when the moon being in conjunction with the sun, the edge of the latter appears for a few minutes as a narrow ring of light encircling all round the dark disc of the moon. A great solar eclipse, visible in England, will take place in March 15, 1858, and a still more remarkable one, when the whole disc will be nearly covered, in August 19, 1887.

THE SATELLITES.

The earth, we have seen, is attended in her annual circuit round the sun by one satellite, the moon, which revolves round her as a centre. Strictly speaking, both move round a common centre of gravity in an elliptic orbit, the regularity of which is disturbed by their mutual attractions, so that it is undulated or waved, thus, ———. The number of undulations in a whole revolution is, however, only thirteen, so that the deviation from the ellipse is exceedingly trifling. Jupiter, Saturn, and Uranus, are all attended by satellites, as we have seen; and they form, as it were, each of the primaries with its attendant moons, a sort of miniature system, entirely similar in the laws by which they are governed to the great system to which they all belong, where the sun may be termed the primary planet, and the primary planets the satellites. Their orbits are circles or ellipses of small eccentricity, the primary occupying one focus. Of these systems, that of which Jupiter forms the head, has been studied with the greatest attention. The discovery of Jupiter's satellites by Galileo, was one of the first fruits of the invention of the telescope, and forms a remarkable era in the history of astronomy. From it resulted a solution of the great problem of the longitude, and the grand discovery of the aberration of light. It also established completely the Copernican system, and confirmed the laws of Kepler. The satellites of Jupiter revolve from west to east like our moon, but they are much less in comparison with their primary than it, whilst their orbits are of smaller dimensions, and less inclined to the ecliptic of their primary than that of our satellite. The largest of them is about 3377 miles, and the least about 2068 miles in diameter. The satellites of Saturn have been much less studied, and have fewer peculiarities. Those of Uranus, however, are remarkable, insomuch as their orbits are nearly perpendicular to the ecliptic, and in these orbits they are supposed to have a retrograde motion—that is, from *east* to *west*, instead of from *west* to *east*, like the other planetary bodies. No satisfactory cause for this departure (if it be one) from the general rule can be given. It is by accurate observation of the satellites that the densities of the planets, or their weight as proportioned to their bulks, have been ascertained; as also, by watching their frequent eclipses, that the velocity with which light travels from the heavenly bodies to the earth has been brought within our calculation.

PERTURBATIONS.

The name of *perturbations* has been applied to those inequalities in the lunar and planetary motions, which arise from the universality of attraction. Thus, not only does the sun attract the earth, and the earth the moon, but the latter attracts the preceding, and both are again influenced in their movements by the great centre of the system to which they belong. Not only is this the case, but every individual planet in the system attracts, and is attracted by, all the rest, although certainly in a very trifling degree when compared with that exercised by the sun over the whole of them. But in those miniature systems, such as the moon and earth, Jupiter and his satellites, &c., the perturbations thus arising, though insensible in short intervals, become apparent when accumulated, and derange the elliptic motions and relations. The calculation of the effects of these disturbing forces is famous in the history of analysis, under the name of *The Problem of the Three Bodies*. It is so worded, because the Sun, Moon, and Earth, and the Sun, Jupiter, and Saturn, form each separately a system little influenced by the rest. Any thing like an attempt to exhibit the method by which these nice calculations are made, is impossible in this place: of its difficulty, some idea may be formed, when we consider, what is apparent to every one, that the bodies under investigation are continually shifting their relative distances from each other, and altering the intensity of the disturbing force, which evidently must materially increase the abstruseness of the calculation. One of the principal effects produced on our globe by this play of gravitation is called

THE PRECESSION OF THE EQUINOXES.

The equinoctial points, we have already explained, are Aries and Libra, where the ecliptic cuts the equator. They are also termed nodes, and the line which joins the two is called the line of the nodes. The longitudes of the stars, as has been also observed, are counted on the ecliptic from the vernal equinox Aries. Now, if the line of the nodes is invariable, the longitude of the stars will of course remain the same from age to age. But, on comparing the actual state of the heavens with the recorded observations of ancient astronomers, it is perceived that the longitudes of the stars have considerably increased; so that, to explain the circumstance, we must either suppose that the whole firmament has moved in the order of the zodiacal signs, or else that the equinoctial points have gone backwards, or retrograded westward; since these points depend entirely upon the motion of the earth, which was far more likely to be disturbed by some cause or other, than that the countless multitude of stars should have a motion relative to these points. Accordingly, the phenomenon has been explained, by attributing to them a retrograde motion from *east* to *west*, in consequence of which the sun arrives at them sooner than if they had remained at rest. Hence the equinoxes, spring and autumn, and the other seasons, happen before he has completed an entire circuit. This motion, however, is extremely slow, amounting only to a degree in about seventy-six years; so that the equinoctial points will take nearly 26,000 years to make an entire revolution of the heavens. This motion was known in very ancient times, and its discovery is ascribed to Hipparchus, who lived about 140 years before Christ. The consequence of this retrograde movement is, that the sun's place amongst the zodiacal signs, at any season of the year, is greatly different from what it formerly was. The vernal equinox now happens in the constellation Pisces; the summer solstice in Gemini; the autumn equinox in Virgo; and the winter solstice in Sagittarius. Astro nomers, however, still count the signs from the vernal equinox, which always corresponds to the intersection of the ecliptic with the equator; and on this account it is necessary carefully to distinguish between them.

The cause of precession is to be found in the combined action of the sun and moon upon the protuberant mass of matter accumulated at the earth's equator, the attraction of the planets being scarcely sensible. The attracting force of the sun and moon upon this shell of matter is of a twofold character; one is parallel to the equator, and the other perpendicular to it. The tendency of the latter force is to diminish the angle which the plane of the equator makes with the ecliptic; and were it not for the rotatory motion of the earth, the planes would soon coincide; but by this motion the planes remain constant to each other. The effect produced by the action of the force in question is, however, that the plane of the equator is constantly, though slowly, shifting its place in the manner we have described.

NUTATION.

The action of the sun and moon in producing precession is various, at different periods of the year, according to the relative distance of the earth from them. Twice a year, the effect of the sun in producing it is nothing; and twice a year, namely, at the solstices, it is at maximum. On no two successive days is it alike, and, consequently, the precession of the equinoctial points must be unequal, and the obliquity of the ecliptic subject to a half-yearly variation; for the sun's force, which changes the obliquity, is variable, while the rotation of the earth, which counteracts it, is constant. By this means, the plane of the equator is subject to an irregular motion, which is technically called the *solar nutation*. Its amount, however, is so exceedingly small, as not to be appreciable by observation. That resulting from the moon's action, however, is sufficiently so, as to have been discovered by Bradley before theory had indicated its existence. Its period depends upon the revolution of the moon's nodes, which is performed in $18\frac{2}{3}$ years, and in about that period of time the axis of the world describes a small circle in the heavens, about eighteen seconds in diameter, contrary to the order of the signs. This apparent vibratory motion is denominated the nutation of the earth's axis. The two phenomena of precession and nutation are intimately connected, or rather are constituent parts of the same phenomenon, and dependent upon the same cause, as noticed above under Precession. It is impossible here to enter more minutely into the subject, or explain it more in detail. For an admirable account of it, we refer the reader to Herschel's Treatise on Astronomy, p. 333. We also would direct the inquirer to the same admirable work, for further information upon the subject of perturbations, comprising all the complicated varieties of motion. In general, they may be said to arise from the play of attractions kept up by the whole of the planets amongst themselves, they with the sun, and the sun with them; the distances of the bodies from each other, which are always varying; and the masses of matter, and the shape of the bodies, which are invariable. In concluding this part of our subject, we may remark, that it is by means of the perturbations of those planets which have no satellites, that astronomers have arrived at a knowledge of their masses. Every planet produces an amount of perturbation in the motions of any other, proportioned to its *mass*, and to the degree of advantage or *purchase* which its situation in the system gives it over their movements.

[WORKS ON ASTRONOMY.

Of the various treatises on Astronomy, which may be read with pleasure by those who wish to pursue the study in detail, we shall mention a few which are easily obtainable in this country. The two books of Dr. Dick, entitled, "*Celestial Scenery*" and "*The Sidereal Heavens*," are written in a delightful style, and imbody the recent discoveries in this interesting and important science. The work of Whewell on Astronomy and General Physics, is of the same popular character. Professor Kendall's work, entitled, "*Uranography: or, A Description of the Heavens, designed for Schools and Academies, accompanied by an Atlas of the Heavens, showing the Places of the principal Stars, Clusters, and Nebulæ*," is an excellent manual for practical purposes. It was prepared particularly for the use of the students at the Observatory of the Philadelphia High School, where the author is a professor. It is chiefly a translation from the admirable German original of J. J. von Littrow, Director of the Vienna Observatory, and the maps which accompany it are copied from Littrow's "*Atlas of the Starry Heavens.*" By adding the discoveries of Struve and Mædler, the new atlas is greatly improved. By the use of this atlas, the student may easily make himself familiar with the names and positions of the several constellations; and a proper degree of attention to the comparison of the atlas with the stars themselves, will enable one who wishes to make a particular study of this science, to fix in his mind the map of the heavens as firmly as almost every intelligent person has in his mind the general figure of the earth's surface. Although few persons make a study of astronomy as *amateurs*, there are many who would be delighted with so much knowledge of the subject gleaned from the atlas, as would enable them to recognise the most remarkable and conspicuous of the heavenly bodies. To such persons the atlas is invaluable.

Among the older treatises of Astronomy, that of Ferguson has always been most popular, on account of that plain, sensible, Franklin-like style which distinguishes the self-taught author. Dr. Gregory's "*Astronomy*," and the "*Astronomical Lectures*" of Dr. John Keill, are excellent for the elementary parts, though superseded in a great measure by recent discoveries and improvements. The great works of Lalande, Delambre, Newton, and Laplace, are of course intended only for the use of the most accomplished mathematicians, who make astronomy their favourite pursuit.—*Am. Ed.*]

GEOLOGY.

Basalt.—The Giants' Causeway.

Section I.—EXPLANATIONS—ORDER OF ROCKS.

Geology (from the Greek, *ge*,* the earth, and *logos*, discourse) may be defined as the science which describes the solid materials of the earth, the order in which they are arranged, the causes which have effected that arrangement, and the organic remains which are found in them. The investigations of the science are, in present circumstances, limited to the external crust of the earth.

The solid parts of this crust consist of a variety of substances, to which, whether they be hard or soft, the term *rock* is applied. Rocks are distinguished both by peculiarities in their constitution, and peculiarities in their form and arrangement.

At some places the surface of the earth is found to consist of a hard rock of crystalline or glassy texture, generally called granite, though subject to a considerable number of varieties. Granite is never, except in peculiar circumstances, found in the form of a layer, whether thick or thin, but generally in large irregular-shaped masses; and no other kind of rock, except in equally rare and peculiar circumstances, is ever found beneath it.

At other places the earth's immediate surface is found composed of some one of certain kinds of rock not less hard in texture than granite, and also of a crystalline consistence, but always found *in layers or beds*, generally of great thickness.

At other places we find, near the surface of the earth, rocks of a comparatively soft, and not of a crystalline consistence, forming also layers or beds, of greater or less thickness.

In some places, rock of a very hard kind is found, not exactly like any of the above, deposited in irregular forms, and often with the appearance of having penetrated through gaps forcibly made in other rocks.

Finally, throughout the first three classes of rocks, but particularly the first two, there are thin *veins* of diverse substances, including minerals.

Rocks of the first class are denominated Plutonic (from Pluto, the god of the infernal regions amongst the ancients), as supposed to have been formed at great depths in the earth, the matter having been originally in a hot and soft state, and afterwards cooled and crystallized slowly, under such enormous pressure as prevented the contained gases from expanding. The term *unstratified* is also applied to this class of rocks.

Rocks of the second and third classes are called Aqueous, as composed of matter deposited by water. Those of the second class are more specially named *Metamorphoric* (from the Greek, *metamorphosis*, a transformation), as supposed to have undergone a remarkable change in the course of their formation. It is supposed that the matter of these rocks, derived from rocks of the granitic kind, and suspended in vast oceans, was, when deposited, subjected to a great heat from below, which gave it in its reconsolidation much of that crystalline texture which it had in its plutonic form.

Rocks of the fourth class are denominated Volcanic, as being evidently composed of lavas, or masses of fire-melted rocky matter, which have been sent upwards by volcanoes.

Rocks of the second and third classes are likewise called *Stratified Rocks*, as being invariably found in strata or layers. Rocks of the first and fourth classes, as wanting this peculiarity, are distinguished as *Unstratified Rocks*.

The plutonic, and some of the lower metamorphoric rocks, have been also called *Primary*, or *Primitive Rocks*, as either the first formed of all, or formed very early. The upper metamorphoric rocks have in like manner been called the *Transition Series*, as forming a kind of link between the primary and those which follow, and partaking of the characters of both. Of the remainder of the aqueous rocks, a considerable number, being the lower portion, are sometimes called the *Secondary Rocks*, while the upper are named *Tertiary*. *Igneous Rock* is also a various name for the volcanic kind.

When rocks of various classes are seen at or near the same place, it is found that those of the second (except in the extraordinary circumstances alluded to) lie above those of the first; and those of the third above those of the second and first classes. Special kinds of aqueous rock are also found in a certain order above one another —much in the same way as if we were to place a book of many volumes on its side, having previously arranged the volumes according to their numbers, in which case the second would be above the first, the third above the second, and so on. Rocks are thus said to observe an *order of superposition*—the volcanic kind alone observing no order.

In some of the upper metamorphoric rocks, and in all those of the secondary and tertiary series, remains of plants and animals are found, showing that when these rocks were formed, the earth had become a scene of vegetable and animal life. The rocks containing these *organic remains*, or *fossils*, are called Fossiliferous; and the remaining rocks, from their containing no such relics, are called Non-fossiliferous.

Above the harder rocks, there are generally layers of clayey and earthy matter, topped by what is called the vegetable soil.

The principal rocks, exclusive of the volcanic, are ranged in the order indicated in the table at the end of this section, descending from the highest to the lowest.

Whatever rock, then, appears on or near the surface, if it be not of the volcanic kind, we may form from it some notion of what rocks are, and are not, below. If, for instance, we anywhere find one of the rocks of the tertiary series, we may deem it almost certain that rocks of the secondary, transition, and primary series, would be found in succession downwards, if we could dig to the proper depth. If we find rocks of the secondary series, it is equally likely that transition and primary rocks are below, and so on. The same conclusions may be formed respecting special kinds of rock of the various classes: if, for instance, we find at the surface a particular member of the secondary series, we may know that certain others of the same series are below. What alone prevents this rule from being of constant application, is the fact, that in no place does every member of the whole

* The g is pronounced hard, and the e as in gem.

series of known rocks exist. Everywhere some are wanting, in France, for example, transition rocks are in many places wanting. The rule, nevertheless, is certain with respect to the rocks which do exist at any place.

The order of supraposition enables us to conclude with greater certainty as to the absence of all rocks higher in the list than that which we find at the surface. If we find secondary rocks at the surface, we may be certain that none of the tertiary are there; if transition, none of the secondary or tertiary; if primary, none of the transition, secondary, or tertiary.

Fossiliferous.	Aqueous.	SUPERFICIAL
		Vegetable Soil.
		Peat.
		Gravel Beds.
		Blue Clay Beds.
		TERTIARY.
		Marl Beds.
		Shelly Millstone.
		Gypsum.
		Coarse Limestone.
		Plastic Clay.
		SECONDARY.
		(Chalk Group.)
		Chalk.
		Greensand.
		Weald Clays.
		(Oolitic Group.)
		Oolite.
		Sandstones.
		Lias.
		(New Red Sandstone Group.)
		Variegated Marls.
		Muschelkalk.
		Variegated Sandstones.
		Zechstein.
		Red Conglomerate.
		Rock Salt.
		(Carboniferous Group.)
		Coal.
		Sandstone.
		Shale.
		Mountain Limestone.
		Old Red Sandstone.
		TRANSITION.
		(Grauwacke Group.)
		Grauwacke.
		Clayey and Sandy Slates, or Lowest Fossiliferous.
		PRIMARY.
Non-fossiliferous.	*Metamorphic.*	*(Inferior Stratified Series.)*
		Clay Slate.
		Mica Slate.
		Primitive Limestone.
		Protogine.
		Gneiss.
		(Granites.)
	Plutonic. . . .	Granite, in varieties.

SECTION II.—CAUSES OF ARRANGEMENT.

The whole science of geology rests on certain natural laws, which are supposed, or have been ascertained, to be in constant operation, though not always, perhaps, with equally powerful effects. They chiefly resolve themselves into what have been called *Degrading and Elevating Causes.*

DEGRADING CAUSES.

The degrading causes are those which refer to the dissolving and wearing away of the elevated parts of the earth's surface, and the carrying of these parts down into lower levels. The *dissolving* is brought about by certain chemical and mechanical laws, and the *carrying down into low levels* is, in the main, a result of the law of gravitation. Considering that the solid parts of the earth are in their very nature liable to the operation of these laws, it appears quite unavoidable that land should be degraded. It is only, however, of late years that the degradation of land has attracted any attention. The immense scale on which it is constantly taking place was first explained in a satisfactory manner by Mr. Charles Lyell, in his "Principles of Geology," published in 1830.

The causes of the degradation of elevated land may be considered under three heads—*meteoric*, or those connected with the atmosphere; *fluviatile*, or those depending on rivers; and *oceanic*, or those in which the sea is the immediate agent.

The operation of the atmosphere and its vapoury contents upon the land proceeds in two ways, chemical and mechanical. There is a tendency in the hardest rock to absorb oxygen and carbonic acid from the atmosphere, and to be by that union dissolved. And this is a union which is always taking place, though in some places with more conspicuous effects than elsewhere. If the soil on any hill of volcanic rock be examined, we shall first find a fine powdery earth, then a mixture of earth and splinters of rock; next splinters alone, graduating into the hard rock below: such may be considered as an exhibition of the gradual process by which a hard rock is dissolved into powder or earth under the action of the atmosphere. In Jamaica, this dissolution of volcanic rock has taken place to a great depth. In granite, which is considered the hardest of all rocks, one of the component substances (felspar) has a great tendency to be decomposed, and hence even this rock is sometimes found to have been reduced to gravel or powder to a considerable depth. A hollow way, blasted through granite, was found by a geologist to have been in six years pulverized to the depth of three inches. These are solely *chemical* phenomena. Again, water perforates into minute fissures in rocks. When a frost arrives, the water swells, and dislodges parts of the rock, which are precipitated into the lower level. Or it may meet some clayey veins or strata, hitherto sufficient to keep various masses together. These veins or strata, being gradually softened by the water, lose their power of cementing the masses. The upper then fall away or slide into a lower level. A *slide* of rock from the Ruffiberg, in Switzerland, in 1806, filled the bottom of the vale below, destroying many villages, and causing the loss of 800 lives. The impulse of wind and rain on the surface of rock is also of great efficacy in pulverizing and wearing it down, sharp parts being rounded, and soft parts hollowed. In Sweden there are some large detached masses of granite, containing perforations produced by this cause, some so very large as to admit of a horse and cart passing through them. These effects may be considered as chiefly *mechanical.* As surely, then, as any part of the earth's crust is elevated into the atmosphere, just as certainly is it liable to be worn down and carried into a lower level.

When water collects into channels and follows its well-known tendency to find the lowest level to which it has access, it becomes a mechanical instrument of still greater force for wearing down the land. In its smallest rills, as it descends the mountain side, it cuts into the soil, and carries off whatever particles it can disengage. When gathered into brooks, its operations are still more powerful. When one of these is placed amongst mountains, every heavy shower swells it into an impetuous river, by which large quantities of detached rock and soil are brought down. In the upper parts of the courses of almost all rivers, the greater speed of descent makes up for the smaller volume of water, as far as the power of bringing down stones and soil is concerned. Again in the lower part of the course, the smaller speed is sometimes compensated by the unevenness of the course; in which case, the water is incessantly driven from one projection of the banks against another, and by that means wears away a great quantity of solid matter. Many facts have been collected to prove the great efficacy of rivers in wearing down the land. The Nerbuddah, a river of India, has scooped out a channel in basaltic rock, 100 feet deep. The river Moselle has worn a channel in solid rock to the depth of 600 feet. Messrs. Sedgwick and Murchison give an account of gorges scooped out in beds of the rock called conglomerate, in the valleys of the Eastern Alps, 600 or 700 feet deep. A stream of lava, which was vomited from Ætna in 1603, happened to flow across the channel of the river Simeto. Since that time the stream has cut a passage through the compact rock to the depth of between 40 and 50 feet, and to the breadth of between 50 and several hundred feet. The cataract of Niagara, in North America, has receded nearly 50 yards during the last forty years. Below the Falls, the river flows in a channel upwards of 150 feet deep, and 160 yards wide, for a distance of seven miles; and this channel has manifestly been produced by the action of the river.

Sometimes, during floods, rivers produce great changes in very short periods. A flood caused by the bursting of the barrier of a lake in the valley of Bagness, Switzerland, moved at first with the tremendous velocity of 33 feet per second. From the barrier burst by the waters to Lake Geneva, there is a fall of 4187 Paris feet; the distance is 45 miles; and the water flowed over all this space in five hours and a half. It carried along houses, bridges, and trees; and masses of rock equal in size to houses were transported a quarter of a mile down the valley.

The matter carried down by rivers is often deposited at their sides, when it constitutes what is called *alluvial land*. Sometimes it is deposited at the bottom of lakes, when it forms what are termed *lacustrine deposits*. In many instances it has been deposited in large quantities at the mouths of rivers, giving rise to what are denominated *deltas*. Deltas are so called on account of their resembling the fourth letter of the Greek alphabet. The triangular form of a delta is produced by the river, at a certain point inland, dividing itself into two streams which gradually diverge till they reach the ocean, enclosing the space which constitutes the delta. As an instance of the great amount of new land formed at the mouths of rivers, the delta of the Ganges is 220 miles in one direction by 200 in another. The lower part of this delta, a wilderness inhabited by tigers and crocodiles, is as large as the principality of Wales!

The matter carried down by rivers, and thus deposited, is nothing in amount compared to that transported to the ocean. The quantity of sand and mud brought down by the Ganges to the Bay of Bengal, is in the flood season so great that the sea is discoloured with it 60 miles from the river's mouth. According to Mr. Lyell, the quantity of solid matter brought down by this river every day, is equal in bulk to the greatest of the Egyptian pyramids. According to Captain Sabine, the muddy waters of the Amazon river may be distinguished 300 miles from its mouth.

The constant action of the sea upon the land is strikingly apparent to the inhabitants of coasts. Whole islands have been destroyed by the action of tides and oceanic currents, while the remains of others rise above the surface of the water, like the ruins of some desolated city. Many instances of the encroachment of the sea upon the land have been recorded. An inn on the coast of Norfolk, built in 1805, then 70 yards from the sea, was, in 1829, separated from the coast by only a small garden. A church on the coast of Kent, which in the reign of Henry VIII. was a mile inland, is now only about 60 yards from the water's edge. The island of Nordstrand, on the coast of Schleswig, was, in the thirteenth century, 50 miles long and 35 broad. About the end of the sixteenth century, it was reduced to an area of only 20 miles in circumference. The inhabitants erected lofty dykes for the purpose of saving their territories; but in the year 1634 a storm devastated the whole island, by which 1340 human beings, and 50,000 head of cattle perished. Three very small islets are all that now remain to point out the place where once flourished the fertile and populous island of Nordstrand. It is an old notion that Great Britain was once united to the continent of Europe; and the identity in structure of the opposite coasts of the strait of Dover seems to favour the supposition. There is reason to believe that the Island of Ceylon was at one period united to Hindostan. Humboldt is of opinion that the West India islands once constituted a circuit of land which enclosed the Gulf of Mexico.

It thus appears that there are causes in continual operation, for the wearing down of the elevated parts of the earth's crust, and taking the component particles into lower levels. The effects of these causes may be easily traced in the aqueous rocks, many of which are simply deposits of sediment carried by water from high into low places, and subsequently hardened, probably by heat from below and pressure from superincumbent materials. Were such causes not in some way counteracted, dry land could not long exist: all would be taken down and buried in the sea. We find the counteraction in what are termed the *Elevating Causes*.

Elevating Causes.

As Degrading Causes are chiefly owing to water, Elevating Causes are chiefly owing to fire. They are therefore sometimes comprehended under the term *Igneous Agency*.

The manifestations of igneous agency at present observable, may be considered under three heads—namely *volcanoes*, *earthquakes*, and *gradually elevating forces*. These phenomena may be viewed as the effects of subterranean heat, operating under different circumstances. A volcano may be described as an opening in the earth's surface, bearing the general appearance of a vent of subterraneous fire, and through which smoke, cinders and ashes, are almost continually issuing, but which sometimes discharges great fragments of rock, and vast quantities of melted rocky matter. The general effect is a throwing up of earthy material from a low to a high level.

Geographers at present reckon about 200 volcanic vents in activity throughout the earth. The greater number of the whole are in a line along the west coast of South and North America. There are many in the islands of the Pacific and Indian Oceans, and in the centre of Asia. In Europe, there are only three in great activity—Ætna in Sicily, Vesuvius in Italy, and Hecla in Iceland. But a vast number of hills throughout France, Britain, and other countries, bear the appearance of having once been active volcanoes. As volcanic action often takes place in the sea, and as there are probably many on land not yet described by geographers, the number of such vents throughout the earth must be considerably more than 200.

Of the power of volcanoes to throw up large quantities of solid matter, we have many examples. During an eruption of Ætna, a space around the mountain, 150 miles in circumference, was covered with a layer of sand and ashes, generally about twelve feet thick. In the first century, the cities of Herculaneum and Pompeii were buried beneath such a layer of matter by Vesuvius. In 1660, the Philosopher Kircher, after accurately examining Ætna, and the ground adjoining its base, calculated that the whole matter thrown out by it at its various active periods would form a mass twenty times as large as the mountain itself, which is 10,870 feet high, and 30 miles in diameter at the base. From this mountain, in 1775, there issued a stream of lava a mile and a half in breadth, twelve miles long, and 200 feet thick. At an earlier period, there was a stream which covered eighty-four square miles. In 1538, a large hill, since named Monte Nuovo, was thrown up in the neighbourhood of Naples in one night; and in 1759, in a district of Mexico, previously covered by smiling plantations, a sudden outburst of volcanic action, which lasted several months, terminated in leaving six hills, varying from 300 to 1600 feet in height above the old plain.

Of the effect of submarine volcanoes, some interesting observations have been made in recent times. In June 1811, an island was thrown up by volcanic agency, near St. Michael's, in the Azores. Columns of cinders rose 700 or 800 feet above the surface of the sea, with a noise resembling that of distant artillery. In the course of a few days, the island was a mile in circumference, and about 300 feet in height, having a crater in the centre, full of hot water. Some time afterwards, it disappeared. In July 1831, a similar island was thrown up, under precisely similar circumstances, in latitude 37° 11′ N., and longitude 12° 44′ E., off the coast of Sicily. It consisted of stones, mud, and cinders, and was of a circular form, about a mile and a half in circumference, with a crater of hot water in the centre, 400 yards in diameter. This island, named Sciacca, or Graham's island, existed so long above the sea, as to allow of many persons landing upon it. The Bay of Santorin, in the Greek archipelago, which is about six miles long and four broad, contained, a few years ago, three volcanic isles, the first of which rose about the year 200, the second in 1650, and the third in 1709. In a part of the bay, where the water is generally several hundred feet deep, a shoal has for several years been gradually rising: about 1816, there were fifteen fathoms water upon it; in 1830, there were only three or four; the later accounts reduced it to two and a half. This rising mass was ascertained to be of solid rock, about half a mile in length, by one-third of a mile in breadth: the water deepening suddenly all round it. In 1825, a new island was observed to rise in the Pacific Ocean, about 300 miles north of New Zealand. It consisted of solid rock, had a pool in the middle, and sent forth smoke from several chinks.

Many islands which have long been inhabited by man, bear all the appearance of having risen, in like manner, from the bosom of the deep. The islands of St. Helena and Ascension, the Azores, the West India islands, Iceland, and many of the islands in the Pacific are evidently the produce of volcanic action. "Owhyhee," says M. de la Beche, "is a magnificent example of such an island: the whole mass, estimated as exposing a surface of 4000 square miles, is composed of lava, and other volcanic matter, which rises in the peaks of Mouna Roa and Mouna Kaa, to the height of between 15,000 and 16,000 feet above the level of the sea."

The causes of Earthquakes have not as yet been satisfactorily explained, but they are now generally allowed to be connected with volcanic agency. They occur less frequently, and generally with less tremendous effect, in Europe, than in some other parts of the world, those parts where volcanic agency is most active being also the parts where earthquakes are most frequent and most dreadful. Though their effect is sometimes to cause a sinking of the ground, they may, upon the whole, be considered as among elevating causes. It is conceived that they are produced by gases confined in the molten interior of the earth, similar to those which find vent by volcanoes. Such gases, prevented by local circumstances from escaping, may, it is thought, thus shake the solid ground over a large tract, and even cause it to rise to a certain extent above its former level. The most striking proof which has been adduced in support of this doctrine, is the effect of the earthquake which took place in Chili in 1822. This is part of that continent in which volcanoes are most numerous and active. On the occasion referred to, a shock was felt along the coast for more than 1000 miles. The land for 100 miles along the coast, and backward to the line of the Andes, was raised above its former level. At the shore, and for some distance along the bottom of the sea, the rise was three or four feet, so that rocks formerly submerged, and covered with shell-fish, were now exposed above the sea. Old beaches, similar to that now raised, were also observed in parallel lines along the land, the highest being about fifty feet above the ocean.

It has since been observed that old beaches, similar to those in Chili, exist in the neighbourhood of many seas. Along the Frith of Forth, in Scotland, there is one about forty feet above the present level of the sea, and which generally appears as a kind of bank a few hundred yards back from the present shore. In the firths of Clyde and Cromarty, similar beaches are traced. They may always be detected by their terrace-like level, and the presence of sea-shells, rounded pebbles, gravel, and sand, such as usually compose beaches at the present day. In some places, old beaches have been conspicuous enough to become objects of popular wonder. In the vale of Glenroy, in Inverness-shire, as also in some neighbouring vales connected with Glenroy, there are three terraces along the sides of the hills, at various heights, which the ignorant people of the district firmly believe to have been roads formed by the hero Fingal for hunting, but which are now shown pretty clearly to have been the shores of quiet estuaries or arms of the sea, similar to many which still exist in the Scottish Highlands—three successive elevations, probably the effect of earthquakes, having elevated the land above the water, so as to leave as many terraces. Among the Alps, and in South America, there are vales marked in exactly the same way as Glenroy.

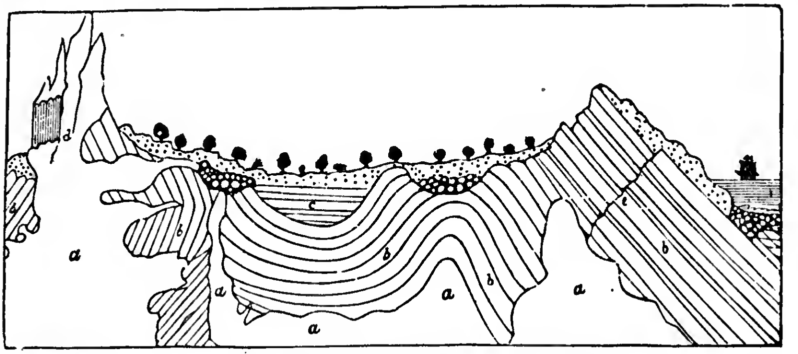
The existence of a force which *gradually elevates* the land in many places out of the water, was discovered by Mr. Lyell. His chief observations were made upon the shores of the Gulf of Bothnia, which he ascertained to have risen several feet in the course of the last century, and a few inches even since 1820.

Besides the greater elevating causes arising from subterranean fires, there are some lesser ones of less mysterious origin. The sands deposited on beaches are sometimes blown by winds in upon the land, covering the vegetable soil throughout a large space, and in some instances forming hills of considerable height and magnitude. Some parts of the coast of Holland are thus fenced with ranges of sand-hills, the whole mass of which has been blown back from the sea. On some parts of the French coast, large tracts, once smiling with cultivation, are thus buried under a sterile layer of sand, which is continually advancing, notwithstanding every effort of man. On the coast of Moray, in the north of Scotland, a tract once forming the barony of Culbleen, has been transformed into a sandy tract since the fifteenth century. Such sand-beds readily become converted into strata of sandstone, if saturated with water containing a limy infusion.

In various parts of the world, land is raised out of the sea by the efforts of coral insects. The works of these creatures are seen upon a vast scale in the Pacific, where whole ranges of islands are formed by them. On the coast of New Holland, there is a coral reef which stretches out to a thousand miles in length. The insects do not commence their laborious operations at a great depth below water; from 60 to 100 feet is considered the utmost extent to which the islands extend downwards. They are generally of a circular or oval shape; and Mr. Lyell is of opinion that corals build upon the rims and in the craters of submarine volcanoes. The outer wall of the building emerges first above the waves, enclosing a pool of tranquil water. The seeds of vegetables are either brought there by sea-birds, or wafted by the ocean, and the islands soon become clothed with a mantle of green. The substance of which these islands and reefs are composed, is lime, which the insects secrete from the sea-water, and cement together with a glutinous matter contained in their bodies. Mr. Lyell, while surveying the Isthmus of Panama, detached a quantity of these animals, and placed them on some rocks in a shallow pool of water. On returning to remove them a few days afterwards, he found they had secreted stony matter, and had firmly glued themselves to the bottom.

If we consider the operation of the elevating causes, we can be at no loss to understand how we should now see, as composing dry land, and sometimes in very lofty situations, strata which were once at the bottoms of seas; neither will it be surprising, if the irregular nature of volcanic forces is considered, that the strata, so elevated, rarely are found in their originally level position, but in all degrees of inclination, sometimes quite on edge, and even in certain rare instances folded backwards, so as to be upside down.

The changes produced by the united operations of aqueous and igneous agency are in part represented in the subjoined engraving of a supposed section of part of the earth's crust.



a Primary Rock, which has been thrown up, so as to disturb and mix itself with the Secondary Rocks.
b Secondary Rocks, thrown into inclinations and curves by the rising of the Primary Rock
c Tertiary Formation, deposited in a hollow formed by the disturbance of the Secondary Rocks.
d Basaltic Columns. *e* A fault or hitch in the strata.
The Circles are Boulders or detached stones, rounded by travelling in water, and deposited in hollows formed by water.
The dots indicate beds of gravel, immediately beneath the soil.

SECTION III.—DESCRIPTION OF ROCKS AND ORGANIC REMAINS.

PRIMARY.

Granite.

Geologists have been accustomed to describe this as the lowest and oldest of all rocks. Certainly, no other rock is ever found beneath it, except in peculiar circumstances afterwards to be described: if the mass of the earth, therefore, were to be judged of from the small superficial crust with which we are acquainted, granite might appear to constitute the bulk of our planet—a vast nucleus on which all the stratified rocks rested. Geologists are now disposed, under a sense of their limited knowledge, to speak of granite, not as the lowest and oldest of all rocks, but as the lowest as yet discovered, and as one which, though in most of its forms old, is yet sometimes found of recent formation. Granite, in fact, often appears as a volcanic rock, which has been thrown up in a state of fusion through superincumbent strata of all kinds, penetrating into their chinks, and spreading over them on the surface. Even tertiary rocks are found permeated and covered by it—a proof that it has been formed since the deposition of those rocks, which is one of the most recent events in geological chronology. These are the peculiar circumstances in which it may be said that other rocks sometimes lie beneath granite.

Granite, then, may be described as generally forming a basis or bed for all the other rocks—as rising in some places from its unmeasured depths into chains of lofty hills—and as in other places penetrating in veins through superincumbent rocks, and partially covering them at the top. It composes some part of the mountain ranges of Cornwall, Cumberland, and the Scottish Highlands, and veins of it are found upon or near the surface in many other parts of England and Scotland.

Three substances usually enter into the composition of granite; namely, (1) *quartz*, a gray glassy substance, composed of the oxygen of the atmosphere in union with one of the newly discovered metallic bases (silicium); (2) *felspar*, also a crystalline substance, but usually opaque and coloured pink or yellow, composed of sandy and clayey matter, with a small mixture of lime and potash; (3) *mica*, a silvery glittering substance, which divides readily into thin leaves or flakes, and consisting principally of flint and clay, with a little magnesia and oxide of iron. In some granites, instead of mica, we find *hornblende*, a dark crystalline substance, composed of alumina, silex or flint, and magnesia, with a considerable portion of the black oxide of iron. Such granites are called *Syenite*, from having been first found in the island of Syene. Other varieties are—*Serpentine*, in which there are dark spots like those on the skin of the snake (hence the name), and *Porphyry*, of which the distinguishing peculiarity is its containing little angular pieces of felspar enclosed in the mass.

In man's economy, granite is a rock of great importance. Its uncommon hardness makes it very suitable for the erection of buildings where great durability is desired. Hence, the docks of Liverpool, Waterloo Bridge in London, and many other buildings of a similar nature in England, have been composed of it, notwithstanding that it had to be brought from a great distance. Nearly the whole city of Aberdeen is built of the granite found in the neighbourhood; and the houses have consequently a glittering appearance when the sun is shining upon them. This stone is also the component material of Memnon's Head and Pompey's Pillar, two ancient structures in Egypt.

Inferior Stratified Series.

Above the granite, in its ordinary position, lies the inferior stratified series, consisting mainly of two kinds of rock, gneiss and mica-slate, with alternating strata of hornblende rock, quartz rock, eurite, talcose slates, chlorite slates, and argillaceous slates; of all of which it may be said that they follow no determinate order. These rocks are of the same materials as granite, in a very slightly modified form, and they are nearly as crystalline in their texture. Geologists also find in many places that the granite *passes* into them—a term expressing a blending of the characters of rocks at the line of their juncture. These two facts have led to the supposition that the inferior stratified rocks were formed from the materials of the granite, disintegrated by mechanical or chemical means, and washed into the beds of vast oceans, where, on their deposition, they were reached by the high temperature of the interior, and thereby reconsolidated in a crystalline form. To account for the rocks composed exclusively of one of the materials of the granite, we may suppose a chemical separation of those materials.

The most prevalent rock of the series is *gneiss*, a compound, like granite, of quartz, felspar, mica, and hornblende, and so highly crystalline as to be sometimes scarcely distinguishable from granite. A great portion of the Highlands of Scotland is composed of strata of gneiss, of vast thickness. It is remarkable for its richness in veins of the metals. *Mica-slate*, or *schist*, the next most prevalent rock of the series, is composed of mica and quartz. It is the surface rock of many extensive tracts of country. *Quartz rock*, which we may suppose to have been formed by a chemical separation of that component of granite, is also a prevalent rock. Humboldt takes notice of a mass of it in South America, more than 9500 feet in thickness. The round white pebbles, or candy stones, so often found on sea-beaches, and in the beds of rivers, are pieces of quartz rock. *Eurite*, of which felspar is the main ingredient, and *hornblende rock*, the chief element of which is signified by its name, may also be accounted for by a chemical origin.

Clay-slate is the geological term for the well-known stone with which houses are roofed. It is, as its name imports, composed mainly of clay—a substance too liberally diffused amongst the ingredients of granite, to admit of any wonder as to its being found in a nearly distinct state in this rock. Mica-slate and clay-slate are *fissile* in their structure—that is, capable of being split into very thin plates: hence the utility of slate, as a material for covering houses. But a curious diversity exists in this respect between mica-slate and roofing slate. In the former, the *cleavage*, or direction in which it splits, is in the same line as the stratification; but in roofing slate, the cleavage is always more or less transverse. What makes the latter circumstance the more remarkable—when strata of roofing slate are found, as often happens, contorted or wavy, the direction of the cleavage is in one straight line through them all, indicating that the influence which produced the cleavage in that rock took effect after the whole had been laid down, and after, by some subsequent accident of pressure, they had been forced into a wavy direction. Probably this phenomenon is of an electric nature. Clay-slates are found in great abundance in Cornwall and in the Scottish Highlands. A fine kind makes the slates used at school, and from a kind still finer are cut the pens used for writing on school-slates.

In the inferior stratified series, there occur a few small beds of limestone, sometimes called *Saccharine Limestone*, from its resemblance to refined sugar, and sometimes *Primitive Limestone*, from the period of its occurrence in the series. In Greece and Italy this rock has been subservient to the development of national talents, the highest that have ever been known of their class, for it is the marble from which the works of the Greek and Italian sculptors have been formed. In the geological history of our globe, its first appearance in the ascending series of rocks is an event of no small consequence, for limestone strata form a large proportion of the superior formations, and the manner in which they have been formed has engaged much attention. Limestone is the *carbonate of lime*, that is, a combination of the earth lime (itself a union of the metal calcium and oxygen) with carbonic acid (this being, again, a union of oxygen with the elementary substance carbon). Carbon is the largest element in the composition of vegetable and animal substances, and this its first appearance in the structure of rocks is of course a point of much interest, more especially as it is generally concluded that many of the superior limestone strata have been entirely formed of animal remains. We are thus tempted to surmise that the formation of the limestone beds of the inferior stratified series marks some early and obscure stage of organic existence on the surface of our planet. No distinct remains of plants or animals have, indeed, been found in this series; and it is customary to point to the next upper series, in which both do occur, as the era of organic life. Yet many geologists are of opinion that the inferior stratified rocks might have contained such remains, though the heat under which the rocks seem to have been formed may have obliterated all trace of such substances.

TRANSITION.

Grauwacke Group.

All the rocks hitherto described are of crystalline texture, and, apparently, chemical phenomena have attended their formation. In the group we have now arrived at traces of mechanical origin and deposition become apparent; but still a few strata resembling the preceding occur throughout the lower parts of this series, as if the circumstances under which the earlier rocks were formed had not entirely ceased. Hence the term *transition* for the series, as implying a passing from one state of things to another.

The rocks forming the lower part of this group, and which are sometimes separately classed as the *Lowest Fossiliferous Group*, are an alternation of beds of chlorite, talcose, and other slates, resembling those of the inferior stratified series, with beds of clayey and sandy slate, of apparently mechanical origin, and in which a few fossils are found. It thus appears that the cessation of the chemical origin of rocks, and the commencement of organic life, are events nearly connected; and it has thence been surmised that the temperature of the earth's surface was now for the first time suitable to the production and maintenance of organic things. At the same time, the alternation of the rocks teaches us the instructive fact that the change was not direct or uniform, but that, for some time, the two conditions of the surface superseded each other. This is conformable with a general observation, which has been made by an eminent geologist,* namely, that, however sudden changes may have taken place in particular situations, a general change of circumstances attending rock formations is usually seen to have been more or less gradual. The few fossils found in this part of the series are, as far as ascertained, the same as those of the next higher rocks.

These are a series of arenaceous and slaty rocks, of evidently mechanical origin, intermixed with small beds of limestone, in which that peculiarity is less distinct, the whole being termed more particularly the *Grauwacke* group. The general composition of the grauwacke indicates its having been formed of a fine *detritus* (matter washed from other rocks), and its having been deposited slowly; but it sometimes has fragments of rock, of various sizes under that of a man's head, imbedded in it, and is occasionally *passes into* conglomerates. The limestones

* M. de la Beche—Manual, 474

mixed with the grauwacke beds are larger and more numerous than in the preceding group, indicating an increase of the causes which produced carbonic acid. Fossils are also more numerous in them than in some of the other beds.

The grauwacke forms the immediate surface in many large districts in Scotland, England, France, Germany, and North America, showing that, at the time of its formation, "some general causes were in operation over a large portion of the northern hemisphere, and that the result was the production of a thick and extensive deposit enveloping animals of similar organic structure over a considerable surface."*

Fossils of the Grauwacke Group.

The fossils of the grauwacke (a few of which extend to the clayey and sandy slates immediately below) are of both plants and animals. Amongst the plants are algæ, or sea-weeds, showing that seas like the present now existed. Some land plants are also found, but of the simpler structures; as *filices*, or ferns; *equisetaceæ*, a class of plants of the character of the mare's tail† of our common marshes; and *lycopodiaceæ*, a class of the character of our club mosses.‡ All of these land plants are *monocotyledons*, that is, produced from seeds of a single lobe, and therefore *endogenous*, that is, growing from within—timber plants being, on the contrary, the produce of two-lobed seeds, and growing by exterior layers. The *flora* of this era thus appears of a very simple kind, indicating the existence only of marshy and damp grounds.

The animals are also, in general, of an humble and simple kind. There is abundance of those creatures (*Polypi*) resembling plants, which fix themselves on the bottom of the sea by stalks, and send forth branch-like arms for the purpose of catching prey, which they convey into an internal sac, and digest. At present these creatures abound in the bottoms of tropical seas, where they live by devouring minute impurities which have escaped other marine tribes, and thus perform a service analogous to that of earth-worms and other land tribes, the business of which is to clear off all decaying animal and vegetable matter. But the class of creatures found in greatest numbers in the grauwacke series of rocks are *shell-fish*, possibly because the remains of these creatures are peculiarly well calculated for preservation. All over the earth, wherever grauwacke rocks are found, shell-fish are found imbedded in vast quantities, proving that shell-fish were universal at the time when that class of rocks were formed. In a work entitled "Remarks on the Geology and Mineralogy of Nova Scotia," by Abraham Gesner,§ it is stated that they abound to a surprising degree in the valuable iron ores which in that province accompany or form part of the grauwacke rocks. In reference to the beds at Nictau, the author says, "The impressions made by marine organic remains in the ore and slate are extremely beautiful and distinct. Millions of shell-fish, of the molluscous and crustaceous tribes, which once enjoyed a perfect animal existence, have been swallowed up by this ore, where their remains and perfect likenesses are yet to be seen in the same natural and symmetrical beauty they possessed when alive."‖ At New Canaan, another of the places where these rocks are dug, the *lily encrinite*, a remarkable example of the radiated tribes, is found. It is so called from its resemblance to a lily resting on its stalk; "it is supposed," says Mr. Gesner, "that the animal resided in the bottom of the flower; and those portions of it which were movable, stood stretched out like arms to seize its prey. In the grauwacke at New Canaan, this animal appears like the lily with its capsule and petals closed. It is often of large dimensions; some were procured during our last visit to their stony graves, as large as water-melons, although in general they are much compressed, and have been flattened by the weight of the rock resting above them when in a soft state. This species of radiated animals is now altogether extinct, and many ages have passed since a living species could be produced. It has never been discovered in any of the strata placed above the new red sandstone; and as it does not appear but in a few of the older strata, the whole race must have enjoyed but a short existence."

Among the shell-fish of the early seas, a few of the most remarkable kinds are described by geologists as *ammonites* and *nautili*. These fishes have been found in great varieties of size; but one peculiarity pervades them all, that the greater part of the shell is a curve containing air-cells, while the animal itself resided in the outer portion, as if a human being were to have a house consisting of a long row of chambers, and live only in the front room. The ammonite receives its name from its resemblance to the curved horn on the head of the statue of Jupiter Ammon. It has been an animal of wonderful character and habits. Some of them have been of a minuteness scarcely visible, and others four feet wide. They are found over the whole surface of the earth. The economy of this animal destined it to live in general at the bottoms of deep seas, but to be able to rise occasionally to the surface. While it lived in the outer part of its wreathed shell, the interior curls were hollow, containing air, so as to make it of nearly the same weight with the element in which it lived. As the pressure of the water at the bottom of a deep sea would break in the plates of any ordinary shell, as it does a bottle when one is lowered to a considerable depth, the shell of the ammonite has been strengthened by a curious kind of internal arch-work, so as to be able to resist the weight of the incumbent fluid. This arch-work so completely meets all human ideas of ingenious contrivance for the purpose which it was destined to serve, as to form one of the most striking examples of that adaptation of means to ends which is universal in the works of nature, and which is so well fitted to impress the conviction of a great designing First Cause. The weight of the ammonite was so nicely adjusted to an equality with the water, that its filling with air or water a small central pipe which runs through the whole extent of the curve, was sufficient to make it rise as high or sink as low as might suit its inclination.

The *Trilobites* are another of the early species which deserve particular notice. Their remains, like those of the ammonites, are universal over the earth. It is curious that, while they have long ceased to live, other genera or kinds of the same class of creatures (*Crustacea*) still exist, and serve to afford some knowledge of their habits. The trilobite had a head and eyes, below which there was a body of no great length, covered with shelly plates in the manner of a lobster's tail, and terminating in a narrow rounded point. It is supposed that it had soft paddles to make way through the water, which have not of course been preserved. But the most interesting feature in the trilobite was its eyes, of which several specimens have been obtained in a nearly entire state. The eye of the trilobite has been formed with 400 spherical lenses in separate compartments on the surface of a cornea projecting conically upwards, so that the animal, in its usual place at the bottoms of waters, could see every thing around

* De la Beche.

† The mare's tail is an elegant plant, having a succulent erect jointed stem, with attenuated foliage growing in whorls round the joints, the latter being protected by a distinct striated sheath; the parts of fructification constitute a scaly catkin at the apex of the stem.—*Mantell.*

‡ Herbaceous prostrate plants found in damp woods and bogs, having their leaves simple and imbricated, that is, lying over each other.

§ Halifax, Nova Scotia. Gossip and Coade. 1836.

‖ "They are almost all bivalves," he adds, "of the genus *anomia*, although some were obtained resembling the *nautilus disens* and *planorbis equalis*." He elsewhere mentions that the encrinite and trilobite, which in Germany are said not to have been found in rocks earlier than the mountain limestone, are found in the iron ore and clay-slate of Nova Scotia.

As there are two eyes, one of the sides of each would have been useless, as it could only look across to meet the vision of the other; but on the inner sides there are no lenses, that nothing may, in accordance with a principle observable throughout nature, be thrown away. It is found that in the serolis, a surviving kindred genus, the eyes are constructed on exactly the same principle, except that they are not so high, which seems a proper difference, as the back of the serolis is lower, and presents less obstruction to the creature's vision. It is also found that in all the trilobites of the later rocks, the eyes are the same.

This little organ of a trivial little animal carries to living man the certain knowledge, that, millions of years before his race existed, the air he breathes, and the light by which he sees, were the same as at this hour, and that the sea must have been in general as pure as it is now. If the water had been constantly turbid or chaotic, a creature destined to live at the bottom of the sea would have had no use for such delicate visual organs. "With regard to the atmosphere," says Dr. Buckland, "we infer that, had it differed materially from its actual condition, it might have so far affected the rays of light, that a corresponding difference from the eyes of existing crustaceans would have been found in the organs on which the impressions of such rays were then received. Regarding Light itself, also, we learn, from the resemblance of these most ancient organizations to existing eyes, that the mutual relations of Light to the Eye, and of the Eye to Light, were the same at the time when crustaceans endowed with the faculty of vision were placed at the bottom of the primeval seas, as at the present moment."

A few bones of fishes have been found in the grauwacke; but some obscurity rests on the point. If such really have been the case, the remains of this era may be said to include specimens of all the four divisions of the animal kingdom—radiated, jointed, pulpy, and vertebrated animals, or radiata, articulata, mollusca, and vertebrata

SECONDARY.

Carboniferous Group.

This is a very comprehensive group, embracing not only the coal strata, and the beds of sandstone, limestone, and others alternating with these, but two great formations on which the proper coal group may be said to rest (though in a state of intimate connection), named the Mountain Limestone, and the Old Red Sandstone.

The *Old Red Sandstone* is a rock composed of grains of sand, cemented by the oxide of iron (the same substance as common iron rust), which gives it its red colour. Its strata are sometimes thin, and sometimes of the thickness of several thousand feet.

Mountain Limestone is an abundant rock. It forms the surface of a vast portion of the central counties of Ireland. Quick-lime, for the improvement of soil, and the preparation of the mortar used in building, is made from mountain limestone. It is also used in many countries as a building stone. Great caverns often occur in this rock, being probably owing to some chemical phenomenon in its formation. One of these at Mitchelston, in Ireland, comprehends passages several miles in extent. Mountain limestone is frequently traversed by beautiful veins of calcareous spar, at times appearing to be principally composed of organic remains, while at others not a trace of these can be detected. This rock is of various colours, but mostly gray, varying in intensity of shade. In some situations it affords good marble, which is susceptible of a considerable degree of polish. From its durable nature, it is likewise used in building. That stupendous work, the breakwater at Plymouth, is composed of it. Many valuable veins of lead ore occur in this rock.

The superior group more particularly called *Carboniferous*, and variously termed the *Coal Measures*, is composed of beds of that mineral, often very numerous, alternating with beds of sandstone, shale, limestone, ironstone, and some other substances. As many as forty beds of coal exist in the neighbourhood of the town of Newcastle. The great utility of this mineral as a domestic fuel, and in the arts, gives it a high importance, and happy is the country in which it exists in any considerable quantity. In a merely geological point of view, it is equally important. This rock is entirely a mass of vegetable matter, which has accumulated in certain situations, and afterwards been covered over and pressed into a hard consistence under other strata.

Two suppositions have been formed respecting the circumstances under which coal was formed. According to one, the vegetable matter must have grown in a dense forest for many years; then the land must have sunk, and become the basin of a lake or estuary, in which situation rivers would wash into it mud and sand, which would cover over the vegetable mass, and form superincumbent beds of shale and sandstone respectively. Then, the ground would be once more elevated, or sufficiently shoaled up, to become again a scene of luxuriant vegetation. When the vegetation had again become accumulated, the land would be again sunk, and become once more the basin of a lake, in which case the beds of mud and sand might again be formed by rivers. And this alternating process is supposed to have taken place as often as there are beds of coal to be accounted for. The other theory is, that, into some great estuary or lake, rivers coming from different quarters would bring the various matters forming the strata of the carboniferous group, a river from one direction bringing the mud which would form shale, another from another direction the vegetable matter which would form coal, and so on, each deposit perhaps taking place through the efficacy of some local circumstances, while the causes for the other deposits were temporarily suspended. At present great difficulties beset both theories.

Fossils of the Carboniferous Group.

In this group of rocks, about 300 species of plants have been discovered, all of them now extinct. About two-thirds of them are ferns; the others consist of large *coniferæ* (allied to the pine), of gigantic *lycopodiaceæ*, of species allied to the *cacteæ* and *euphorbiaceæ*, and of palms. Most of these plants probably exist in the coal beds, forming in fact their sole composition; but the peculiar nature of this mineral renders it difficult to detect them by examination.* Thin slices, however, have been examined by the microscope, and the vegetable structure has then been detected, where no external trace of it was visible. In cannel coal, a kind peculiarly hard, the vegetable structure is observed throughout the whole mass, while the fine coal retains it only in small patches, which appear as it were mechanically entangled. Slate and cannel coal often bear distinct impressions of plants. The plants are such as grow in hot moist situations; and it is therefore presumed, that a climate of that nature existed at an early period where coal is now found, even in Melville's Island, which is within the polar circle. Dr. Hutton thought that the vegetables must have been carbonized (or charred) by heat; but Dr. Macculloch contends, on good grounds, that the change has been effected solely by water and pressure, and that by these agents peat is capable of being converted into coal.

Large fragments of trees are often found in the shale and sandstone beds of the carboniferous group, more frequently in the former than in the latter. As usual with fossil substances, they are converted into the material in which they are imbedded, but preserve all their original lineaments, except that they are generally changed from their original round to a flattened form, the result of the

* Maclaren's Geology of Fife and the Lothians.

pressure they have sustained. In most instances, these fragments of trees appear to have been transported from a distance, and laid down horizontally in their present situation; but some have been found with their roots still planted in their native soil of mud, and the stems shooting upwards through several superior beds of various substances. Even in some coal beds, there are found stems of trees in their original vertical position; the roots being imbedded in shale beneath. In these instances, we must suppose the fossil to be on the spot where the living tree was planted, grew, and died. In the Bensham coal seam, in the Jarrow coal-field, a few years ago, there was found an upright tree of the kind called lepidodendra, thirteen and a half feet wide at the base, and thirty-nine feet high, the branches at the top being also entire; the lepidodendron, a common plant in this group, is so called from the scaly appearance of its stem, the scales being the roots of the leaf stalks. Various fossil trees have been discovered in the sandstone beds of the carboniferous group, at Craigleith and Granton, in the county of Edinburgh. One found in Craigleith quarry was twenty feet long, three feet in diameter, with scars where the branches had been torn off, and was ascertained, by microscopic inspection of slices of the trunk, to have been a conifera of the genus *Araucaria*, of which living species exist in New Holland.

The animal remains of the carboniferous group are much the same as those of the grauwacke—zoophytes, mollusca, crustacea, and a few fishes.

NEW RED SANDSTONE GROUP.

This group of strata, lying above the carboniferous group, comprehends rocks called—

The *Red Conglomerate*, formed of pieces of earlier rocks, some rough, some smoothed by rolling, all caked together;

Zechstein, a kind of limestone, abounding in Germany;

Red or *Variegated Sandstones*, a group of many varieties of colour, and principally of argillaceous and siliceous consistence, much used for building in England and other countries;

Muschelkalk, a limestone varying in texture, but most frequently gray and compact; not found in Britain or France, but occurring in Germany and Poland;

Variegated Marls—beds of rock of different colours, red, blue, and gray, composed of the remains of shell-fish.

To this group also belong beds of *rock salt*, of which many exist in England, particularly in the county of Chester. Rock salt is a crystalline mass, forming regular strata, sometimes of the thickness of many feet. The substance is rarely pure, but generally contains some portion of oxide of iron, which gives it a red colour. It is dug like coal and other minerals, and when melted and subjected to proper purification, is sold for domestic purposes.

FOSSILS OF THE NEW RED SANDSTONE GROUP.

The vegetable remains of this group are much the same as those of the preceding; but in the department of animal life, when we arrive at the Muschelkalk, or Shell Limestone, we find a great difference, leading to a supposition that, at this era of geological chronology, "circumstances had arisen changing the character of marine life over certain portions of Europe; that certain animals abounding previously, and for a great length of time, disappeared never to reappear, at least as far as we can judge from our knowledge of organic remains;"* and that certain new forms of a very remarkable kind were added.

The new creatures were of such a class as we might expect to be the first added to the few specimens of fish which had hitherto existed: they were of the class of Reptiles, creatures whose organization places them next in the scale of creation to fish, but yet below the higher class of animals which bring forth their young alive and nourish them by suck (mammalia). The earth was as yet only fit to be a partial habitation to creatures breathing its atmosphere and living upon its productions. It is supposed to have been under so high a temperature as to be unsuitable for mammalia: the lands which existed were probably low and marshy, with a hot, moist atmosphere, so as to present an appropriate field of existence only for lizards, crocodiles, and creatures of similar character. It is also to be supposed that the land was at this period undergoing frequent changes and convulsions, so that only a class of creatures to which submersions and deluges were matters of indifference, could reside upon it without a greater waste of life than was part of the Great General Design. The Reptiles, which first begin to appear in the Muschelkalk, continued to flourish while a great succession of other rocks was forming: throughout the whole of the Secondary Formation, there were few other land animals. In fact, the world must have been in the possession of reptiles for a many thousand times longer period than it appears to have yet been in the possession of man. "When we see," says Dr. Buckland, "that so large and important a range has been assigned to reptiles among the former population of our planet, we cannot but regard with feelings of new and unusual interest, the comparatively diminutive existing orders of that most ancient family of quadrupeds, with the very name of which we usually associate a sentiment of disgust. We shall view them with less contempt, when we learn, from the records of geological history, that there was a time when reptiles not only constituted the chief tenants and most powerful possessors of the earth, but extended their dominion also over the waters of the seas; and that the annals of their history may be traced back through thousands of years antecedent to that latest point in the progressive stages of animal creation, when the first parents of the human race were called into existence."*

The Reptiles of this early age were peculiar both in size and in structure. Some, which inhabited the seas, resembled lizards, but were of gigantic size; others, designed for land as well as sea, resembled the crocodiles which still exist in warm climates.

One of the most remarkable kind (genera) has received the name of *Icthyosaurus* (Fish Lizard), of which seven species or varieties have been discovered. The head is like that of the crocodile, composed of two long slender jaws, provided with a great number of teeth (in some cases 180), and eyes of great size (in one instance, the cavity for the eye has been found to measure fourteen inches), while the nostril, instead of being near the snout, as in the crocodile, was near the anterior angle of the eye. The body was fish-like, arranged upon a long spinal column, which consisted of more than a hundred joints, and to which a series of slender ribs was attached and terminating in a long and broad tail, which must have possessed great strength. The whole length of some specimens of the Icthyosaurus was about thirty feet. Instead of the feet, with which the lizard and crocodile are furnished, the Icthyosaurus had four paddles like those of the whale tribes, fitting it to move through the waters in the manner of those animals. It had also a construction of the sternum or breast-arch, and of the fore paddles, similar to that found in the Ornithorynchus, an aquatic quadruped of New Holland, and evidently designed, as in the case of that animal, to enable it to descend to the bottoms of waters in search of food. While the Icthyosaurus, then, is mainly allied to the lizard tribes, it combined in itself the additional characters of the fish, the whale, and the Ornithorynchus. "As the form of the vertebræ by which it is associated

* De la Beche's Manual. 404

* Bridgewater Treatise, .. 167.

with the class of fishes seems to have been introduced for the purpose of giving rapid motion in the water to a lizard inhabiting the element of fishes, so the further adoption of a structure in the legs, resembling the paddles of a whale, was superadded, in order to convert these extremities into powerful fins. The still farther addition of a furcula and clavicles, like those of the Ornithorynchus, offers a third and not less striking example of selection of contrivances, to enable animals of one class to live in the element of another class."* Such deviations cannot be considered as monstrosities; they are perfect adaptations of a creature to its purposes in the theatre of being. Only the spine of the Icthyosaurus as yet existed in other animals. Its head, its paddles, and its breast-arch, were all detached parts of future animals. How strange to reflect, that some of these contrivances were allowed to become extinct, and, as it were, lost to nature, and ultimately, after a long interval, were revived in connection with new creatures!

The internal structure and the modes of living of the Icthyosaurus, have been in a most unexpected manner made clear by the discovery of the half-digested remains of animals found within them or in their neighbourhood. It appears that the creature possessed a large stomach, extending throughout nearly its whole body, and that it lived upon fish and other reptiles, including its own kind. It must have occasionally devoured creatures several feet in length. Masses of the refuse of the Icthyosaurus, petrified as hard as the finest marble, and well known to geologists under the name of *coprolites*, are found to be marked spirally, like the refuse of certain species of sharks and dog-fish, the intestinal gut of which winds greatly, in order that it may take up the least possible room. We thus obtain a distinct idea of the nature of a very important part of the bodily economy of this long extinct race of animals. The stomach occupied so large a space in their bodies, for the reception of large quantities of food, and it was at the same time so necessary that the speed of the animal in pursuit of prey should not be clogged by a very large or long body, that the smaller intestines had been, by a wise arrangement of nature, reduced nearly to the state of a flattened tube, coiled like a cork-screw around itself; "their bulk being thus diminished," says Buckland, "while the amount of absorbing surface remained nearly the same as if they had been circular."

The name *Plesiosaurus* is applied to another highly remarkable reptile of gigantic size, which inhabited the world before the days of mammalia. A particular species has been described as having a body and paddles which bore some resemblance to those of the Icthyosaurus, the former being more bulky, and the latter longer and more powerful. At the end of a long neck, like the body of a serpent, was a head resembling that of a lizard, but also partaking of the characters of the head of the crocodile and Icthyosaurus. The tail was short. The backbone of this creature, and the neck and tail continuing it, contained in all about ninety vertebral pieces, thirty-three of which composed the neck; and the vertebræ are found to be of a less fish-like structure than those of the Icthyosaurus, and not nearly so well calculated for rapid motion. The ribs describe a large circle, and, being formed in four parts, seem to have been designed to contain a capacious set of lungs, and to rise and fall as the lungs were inflated or emptied: in this respect they resemble the ribs of the chamelion, whose changes of colour are now known to be occasioned by the varied depth of its inspirations. It is therefore surmised, though with little confidence, that the Plesiosaurus was also capable of changing its colour—a power which must have been highly necessary to a creature of its unwieldy character, both to enable it to elude the quicker and equally voracious Icthyosauri, and that it might more readily ensnare and seize the creatures designed to be its prey. The Plesiosaurus probably lived chiefly on or near the surface of the water, breathing the air, and dabbling for prey like a duck or swan, but might also be able to descend to the bottom, and even to move, though awkwardly, upon land. One part of its organization is peculiarly striking, as foreshadowing a structure of a more important kind. The paddles, which may be considered an advance or improvement upon the fins of fishes, are at the same time the type of the legs of quadrupeds and of the arms and limbs of man. The fore paddle consists of scapula (shoulder blade), humerus (shoulder), ulna (upper bone), and radius (lower bone), succeeded by the bones of the carpus and metacarpus, and the phalanges, equivalent to those which compose the palm and fingers of a human being. The hind-paddle presents femur, tibia, and fibula, succeeded by the bones of the tarsus and metatarsus, and five toes. Thus "even our own bodies, and some of their most important organs, are brought into close and direct comparison with those of reptiles, which at first sight appear the most monstrous productions of creation; and in the very hands and fingers with which we write their history, we recognise the type of the paddles in the Icthyosaurus and Plesiosaurus."*

Of the Crocodile family found in abundance in this class of rocks, the *Iguanodon*, of which remains have been found in the fresh-water formation at Welden in England, may be cited as a specimen. It was a huge animal, resembling the present Iguana of South America, which chiefly lives upon plants and seeds. The smallest part of the thigh-bone of an Iguanodon was found to be twenty-two inches in circumference, and much larger than that of any existing elephant. Species resembling the present Gavial of the Ganges have also been found. It may fairly be inferred from the present habits of the Gavial and other kinds of Crocodilea, that at the time when the extinct species flourished, the world must have contained many low shores and savannahs, fitted for the residence of such creatures. Some parts of England are thus proved to have had at one time shores of lakes and estuaries resembling those of the Ganges, the Nile, and other waters in hot countries, and consequently a much higher temperature than at present.

But perhaps the greatest wonder of the Reptile Age, was the creature called the *Pterodactyle.* Mainly a reptile of the lizard kind, its body possessed some of the characteristics of the mammalia; it had the wings of a bat, the neck of a bird, and a head furnished with long jaws full of teeth, so that in this last part of its organization it bore some resemblance to the crocodile. Eight species of the Pterodactyle which have been found, vary from the size of a snipe to that of a cormorant. The eyes were of enormous size, apparently enabling it to fly by night. From the wings projected fingers terminated by long hooks, like the curved claw on the thumb of the bat. These must have formed a powerful paw, wherewith the animal was enabled to creep or climb, or suspend itself from trees. It has been conjectured that the Pterodactyle would chiefly live on flying insects, of which, it is important to notice, several varieties existed at the same time, their remains being found in the same rocks. And it is likely, from the size of the eyes, that it searched for prey by night as well as by day. But it has also been argued, from the great length and strength of the jaws, and the length of the neck, that the Pterodactyle did not live solely upon flies, but likewise sought for fish in the manner of our own present sea-birds.

Tortoises also existed during this age, as is proved by the marks of their feet on sheets of sandstone, and by their remains. But as yet no animals of a higher class

* Bridgewater Treatise, i. 185.

* Buckland's Treatise, i. 213

had appeared upon earth for the remains of certain creatures of the Opossum family, found in the oolite at Stonesfield, near Oxford, stand as yet so solitary, that we cannot consider them as proving that mammalia were added to reptiles. With, then, flocks of Pterodactyles flying in the air in pursuit of huge dragon-flies; gigantic crocodiles and tortoises crawling amidst the jungles of low, moist, and warm shores, and such monsters as the Ichthyosaurus and Plesiosaurus swarming on the surface of the sea, while its depths were peopled by infinite varieties of fish, shelled and vertebrated; we can form some faint idea of what sort of world it was while the strata between the coal and the chalk were in the course of being deposited.

Olitic Group.

Next in order is a group which derives its name from a kind of limestone conspicuous in it, called oolite. Oolite, again, is named from its resembling the eggs or roe of fish. The oolite group comprehends, besides oolite itself, various alternating clays, sandstones, marls, and limestones.

Oolite is a carbonate of lime, intermixed with other ingredients. The oolites found at Bath, Portland, and Purbeck, are much esteemed in building. In the *oolite* which occurs over a considerable part of western Europe, there is a general uniformity of structure. In other parts of the world it differs very considerably, especially in its mineralogical character; and when this is the case, in order to determine whether certain rocks belong to the group or not, recourse has been had to the organic remains contained in them. In some parts of Europe these are very abundant, and in other places the reverse. To account for this difference, it has been supposed that in those parts of western Europe where they are abundant, shallow seas existed; while in those places, such as Italy and Greece, where few remains are found in the formation, the waters were deep.

With respect to the deposition of the oolitic group, nothing very satisfactory can be said. Whence came the immense quantity of carbonate of lime, is a question not easily answered. To account for it by springs, similar in size and saline contents to these we now see, appears to be unphilosophical. Many limestones are nearly altogether composed of organic remains; and this has led to a theory, that these animals extracted lime from the water, leaving their shells, produced through millions of generations, to be gradually converted into limestone. Notwithstanding all that we can suppose was deposited from springs and organic bodies, "there remains," says De la Beche, "a mass of limestone to be accounted for, distributed generally over a very large surface, which requires a very general production, or rather deposit, of carbonate of lime contemporaneously, or nearly so, over a great area."

In the oolitic group is comprehended by some geologists an important subordinate group, named the *lias*, which may be generally described as an argillaceous and calcareous deposit, sometimes the clayey material predominating, and sometimes the limey.

Fossils of the Oolitic Group.

In this group are found, as in some of the preceding, *algæ* (sea-weeds), *equisetaceæ* (mares' tails), *filices* (ferns), and *coniferæ* (allied to the pine). The animal remains are nearly the same as in the preceding group, but of a greater variety of species.

Cretaceous or Chalk Group.

This group, the uppermost of the secondary series of rocks, is so named from the beds of chalk of which it is mainly formed. Chalk is a carbonate of lime. It is very plentiful in England; and at Dover and other places it runs along the coast in cliffs and mountains of considerable size. Nodules or small masses of flint, sometimes containing remains of shells and animals, are abundant in chalk, and it is extremely difficult to account for their presence there. In the lower parts of the English chalk deposits, the flints disappear, becoming gradually more rare in the passage downwards. From this circumstance, the group has been sometimes divided into *upper*, or *chalk with flints*, and *lower*, or *chalk without flints*. But this characteristic does not universally prevail. Beneath the chalk there is a rock called *greensand*, which in Normandy is used as a building stone. An argillaceous deposit called *gault* also occurs; it is of a bluish-gray colour, and is frequently composed of clay in the upper, and marls in the lower part.

The cretaceous group, taken as a mass, may, in England, and over a considerable portion of France and Germany, be considered as cretaceous in its upper part, and sandy and clayey in its lower part. The group is extensively distributed over Europe; and M. de la Beche makes the following observations upon its mineralogical character in general:—"Throughout the British islands, a large part of France, many parts of Germany, in Poland, Sweden, and in various parts of Russia, there would appear to have been certain causes in operation, at a given period, which produced nearly, or very nearly, the same effects. The variation in the lower portion of the deposit seems merely to consist in the absence or presence of a greater or less abundance of clays or sands, substances which we may consider as produced by the destruction of previously existing land, and as deposited from waters which held such detritus in mechanical suspension. The unequal deposit of the two kinds of matter in different situations would be in accordance with such a supposition. But when we turn to the higher part of the group, into which the lower portion graduates, the theory of mere transport appears opposed to the phenomena observed, which seem rather to have been produced by deposition, from a chemical solution of carbonate of lime and silex, covering a considerable area.' M. de la Beche goes on to state, that no springs, or set of springs, could have produced the great deposits of chalk which cover immense surfaces. "But," says he, "although springs, in our acceptation of the term, could scarcely have caused the effects required, we may perhaps look to a greater exertion of the power which now produces thermal waters for a possible explanation of the observed phenomena." Mr. Lyell states, that chalk must have originated in the sea, in the form of sediment, from tranquil water; and that, before the existence of the rocks above it, must have been raised in large portions above the water, and exposed to the destroying power of the elements.

Fossils of the Cretaceous Group.

In this group, *confervæ* and *naides* were added to the vegetables; to the animal remains some fishes are added, but the number of the saurian reptiles is diminished.

A species of rocks, called the *Wealden rocks*, occur beneath the lower green sand of the English series, and are characterized by the presence of terrestrial and fresh-water remains in abundance.

TERTIARY.

The cretaceous group was at one time thought to be the uppermost; but it was in time discovered that, in several places, and particularly under the sites of the cities of London and Paris, there existed a still higher group or series, to which the name supra-cretaceous was therefore at first given, afterwards changed to the Tertiary Formation or Tertiary Series.

The tertiary rocks appear as if they had been formed in great hollows or basins in the former surface: hence it is customary to speak of the *London Basin*, the *Paris Basin*, &c. The Paris basin has been well explored and is supposed to present a good example of the Tertiary Formation. It consists of five subordinate groups or series, whereof the first, third, and fifth, appear, from the organic remains found in them, to have been formed in fresh water, and the second and fourth in sea water. They have been thus arranged in an ascending order:—

1. Fresh-water formation,	Plastic clay. Lignite. First sandstone.
2. Marine formation,	Calcaire grossier.
3. Second fresh-water formation,	Siliceous limestone. Gypsum, with bones of animals. Fresh-water marls.
4. Second marine formation,	Gypseous marine marls. Upper marine sands and sandstone. Upper marine marls and limestone.
5. Third fresh-water formation,	Millstone without shells. Shelly millstone. Upper fresh-water marls.

Plastic Clay.—This substance has been so named from its easily receiving and preserving the forms given to it, and, from possessing this property, it is used in the potteries. It rests upon a surface of chalk, which is very irregular, and furrowed out so as to present an alternation of hills and valleys. This clay is of various colours; and above it, and separated by a layer of sand, there frequently occurs another bed of clay, which scarcely can be called plastic. It is black, sandy, and sometimes contains organic remains. In this deposit, considered as a mass, it is stated that organic remains do not occur in the lower parts. In the central portion, fresh-water animals commonly occur, and in the upper part there is a mixture, sometimes an alternation, of marine and fresh-water remains.

Calcaire Grossier, as its name implies, is composed of a coarse limestone, which is employed for architectural purposes. It is frequently separated from the plastic clay beneath by a bed of sand, and it alternates with argillaceous or clayey beds. The animal and vegetable remains enclosed in it are numerous, and generally the same in corresponding beds, presenting considerable differences when the beds are not identical.

Siliceous Limestone is sometimes white and soft, sometimes gray and compact, and penetrated by silex. It is often full of cells, which are occasionally large, and communicate with each other in all directions.

Gypsum and Marls.—Gypsum is a crystalline substance composed of lime, in union with sulphuric acid and water. Its colours are gray, white, and yellow; but different varieties of it have different hues. It was used in ancient times for window glass. The gypseous rocks consist of an alternation of gypsum and limey and clayey marls; these marls are also found in thick beds above this alternation. These beds are considered as having been deposited in fresh water, and above them are others, which, from their organic remains, are believed to have been deposited in the sea.

Upper Marine Sands and Sandstones.—These consist of irregular beds of siliceous sandstone and sand. The animal remains in the lower portion of these beds are broken and very rare. In some situations, however, millions of small bodies have been found. These beds are occasionally covered with a species of rock which is filled with marine shells.

Upper Fresh-Water Formation.—This rock sometimes consists of white calcareous marls, at others of different siliceous compounds; from one of these, millstones of a celebrated kind are formed. They are sometimes charged with shells and petrified wood.

The supra-cretaceous rocks of England are commonly known by the names of plastic clay, London clay, Bagshot sands, the fresh-water formations of the Isle of Wight, and the crag of Norfolk.

Plastic Clay.—This deposit, though it occasionally contains an abundance of clay, employed for various useful purposes, is also mixed with beds of pebble, irregularly alternating with sands and clay. It thus differs from that of Paris, but it agrees with it so far as it reposes upon an uneven surface of chalk. The organic remains are principally marine, but those of fresh-water and terrestrial animals are intermingled with them.

London Clay.—The great argillaceous deposit which underlies the London district, has [illegible] this name. It is of a bluish or blackish colour, and contains a portion of calcareous matter; beds of [illegible]stone are also said to be occasionally present in it. This clay varies considerably in thickness, sometimes from seventy-seven to seven hundred feet. Besides the remains of a great variety of shell-fish, those of a crocodile and turtle have been found; masses of wood have also occurred in this stratum.

Bagshot Sands.—These rest upon the London clay, and consist of layers of various kinds of sands and marls containing fossil shells.

The Isle of Wight and London formations, although differing considerably in the nature of their deposits from those of Paris, present such an analogy in the organic remains of some parts of the group, that we are justified in referring the deposit to the same epoch, local circumstances and accidents having determined their characters.

It may be observed, that volcanic agency has been very active during the formation of this group. Ætna, it would appear, has for a long series of ages given forth its igneous products, and a considerable portion of these rest upon supra-cretaceous rocks. In central France, where extinct volcanoes are numerous, this is still more evident; a volcanic mass, called the Plomb du Cantal, appears to have burst through and fractured the fresh-water limestones of the Cantal, which, according to Mr. Lyell, are equivalent to the fresh-water deposits of Paris, and some of those in England.

Fossils of the Tertiary Series.

As yet, no distinct traces of the higher forms of organization have appeared. No vestige of the mammiferous or sucking animals, either terrestrial or aquatic, which form so large a portion of the existing animal kingdom—no marks of the bird class, now so extensive and important—and scarcely any token of such marine and fresh-water shells and other productions as abound in the present time—have been discovered either in the earlier or later secondary strata of the globe. The rare and indeed almost unique, cases of supposed exception to this statement, have all been found capable of such explanations as leave the general truth unshaken.

In the Tertiary Formation we find a striking and wonderful change of appearances. These strata are rich beyond all that go before them in animal remains. At the time of their formation, the aptitude of the earth for the maintenance of organic life has vastly increased, and was continually increasing, as the period approached when man himself and the higher orders of being were to become its inhabitants. The way was paved, it will be seen, for this consummation, by the same regular and progressive steps which characterized the organic changes of the geological eras already described.

From their relative position, and from the organic remains contained in them, geologists have been enabled to distinguish, in the tertiary series of strata, four great eras of formation. One of the most striking and novel features of these formations consists, as already mentioned, in the repeated alternations of *fresh-water* deposits with marine ones; a circumstance established beyond question by the character of the fossil shells and bones found respectively in these deposits. To the oldest of the tertiary eras, the term Eocene is applied; the second is called the Miocene period; the third the Older Pliocene; and the fourth and latest, the Newer Pliocene; names founded on the respective proportions which they fossil shells bear to shells of existing species. In each of these periods is included a great fresh-water, as well as a marine, formation or deposit. Of the living beings which flourished in each of these periods, we shall endeavour to give some account, commencing with the most ancient, the Eocene.

After the chalky formation, a period of considerable repose seems to have ensued, during which a large portion of the existing continents, and in especial the hollows and basins on their surface, appear to have been the site of vast lakes, rivers and estuaries. From these was deposited the first great fresh-water formation of the Eocene period. While this deposit was going on, the globe, no longer an entire stagnant marsh, but as yet incapable of affording much support to terrestrial animals, was tenanted only by such quadrupeds as live beside rivers and lakes. Nearly fifty extinct species of mammalia, chiefly of this character, were discovered by Cuvier in the first Eocene fresh-water formation. The most of these belonged to the class Pachydermata (*thick-skinned* animals), of which the elephant, the rhinoceros, the hog, the tapir, and the horse, are remarkable existing examples. This class of Pachydermatous animals, it may be observed, only includes such thick-skinned creatures as have no more prominent mark to distinguish them than their *skins*. The seal and the river-horse, for example, are thick-skinned, but then they are *amphibious*, and that is a more prominent distinction. The extinct animals to which we now refer resemble the tapir more than any of the other Pachydermata. Among these extinct creatures, the most worthy of notice are the Palæotherium, the Anoplotherium, the Lophiodon, Anthracotherium, Cherapotamus, and one or two other families, including, some of them, not less than eleven or twelve distinct species. These mammiferous families had some general traits of resemblance, and the description of the great *Palæotherium* may afford an idea of the main features of all. This animal was of the size of the horse, or about four feet and a half in height to the wither. It was more squat and clumsy in its proportions than the horse; the head was more massive, and the extremities thicker and shorter. On each foot were three large toes, rounded, and unprovided with claws; the upper jaw was much longer than the under. The tapir, and partly, also, the hog, if large enough, would closely resemble the great Palæotherium. "The Palæotheria (says Buckland) probably lived and died upon the margins of the then existing lakes and rivers, and their dead carcases may have been drifted to the bottom in seasons of flood." The other mammiferous families of the first Eocene formation, were all, like the Palæotheria, herbivorous, and had, it is probable, similar habits.

The number of animals, aquatic and terrestrial, whose remains are found in the other deposits of the Eocene period, is immense. In some gypsum (sulphate of lime) quarries of that era, scarcely a block can be opened which does not disclose some fragment of a fossil skeleton. The following list of the animals found in the gypsum quarries of Paris will show sufficiently how very different from the gigantic reptiles of the secondary eras were the creatures that tenanted, and found fitting sustenance on, the earth during the Eocene period. Besides various extinct Pachydermatous families, there were found extinct species of the wolf and fox, of the raccoon and genette, among the Carnivorous tribes; of the opossum; of the dormouse and squirrel; nine or ten species of birds, of the buzzard, owl, quail, wood-cock, sea-lark, curlew, and pelican families; fresh-water tortoises, crocodiles, and other creatures of the Reptile class; and several species of Fishes:—all of these animals, be it remembered, being *extinct species* of existing families, exclusive of the Pachydermatous animals, and the Fishes, which were extinct species of *extinct families*. The occurrence of the birds mentioned in the preceding list of the Eocene animals, forms (says Dr. Buckland) "a remarkable phenomenon in the history of organic remains." The number of fossil shells found in the Eocene formations is estimated by Mr. Lyell at 1238. As in the case of the terrestrial creatures, few of these shell-fish are of recent or existing species, not more, at the utmost, than 3½ in every hundred. We do not, moreover, recognise in the strata now under consideration, those prodigious accumulations of *microscopic* shells, as they are called from their extreme minuteness, that distinguish the formations of the secondary or preceding ages. One small piece of rock, of the ages in question, has been found to contain above ten thousand chambered shells, though the whole weighed only an ounce and a half. In fact, great beds of secondary limestone seem to be almost wholly composed of microscopic shells. Such phenomena are not presented in the Eocene or subsequent tertiary formations. The shells of these periods, as has been already observed, approximate more to the character of recent or existing species.

In the Eocene period, then—the earliest of the Tertiary eras—we perceive, for the first time, the existence in the animal kingdom of a similar order to that which now prevails, indicating that the earth and its atmosphere were in a certain degree assimilated to their present condition. It seems impossible, however, to agree with Mr. Lyell in the subjoined remark on the Eocene era:—"When we reflect (says that writer) on the tranquil state of the earth, implied by some of the lake-formed and sea-formed deposits of this age, and consider the fulness of all the different classes of the animal kingdom, as deduced from the study of the fossil remains, we are naturally led to conclude that the earth was at that period in a perfectly settled state, and already fitted for the habitation of man." Several strong arguments might be adduced against this conclusion, but we shall only refer to one objection—the temperature. From the frequency of the remains of crocodiles and other tropical reptiles in the Eocene formations, and from the frequency of palm-leaves and trunks, as well as from other evidences, the atmosphere may be regarded as having been still at too high a temperature for human comfort. Volcanic action, moreover, appears to have been of very common occurrence.

The second, or Miocene period, however, of the Tertiary ages, brings us a step nearer to the existing condition of things. A strong proof of this is derived from the shells alone of the strata of this period. Whereas only three in the hundred Eocene fossils were of recent species, of the Miocene shells we find eighteen in the hundred to have existing representatives. Along with the mammalia, also, of the Eocene period, we find that the Miocene deposits present us with the earliest forms of animals existing at the present time. In Dr. Buckland's Bridgewater Treatise, a table is given, exhibiting the animals found at Darmstadt, in a bed of sand referable to the Miocene period. In this list are mentioned two skeletons of the Dinotherium, a large herbivorous animal, called by Cuvier the Gigantic Tapir; two large Tapirs; Calicotherium—two large Tapir-like animals of this name; two Rhinoceroses; Hippotherium, an animal allied to the horse; three Hogs; four large Cats, some as large as a lion; the creature called the Glutton; Agnotherium, allied to the dog; and Machairodus, an animal allied to the bear. From this list the reader will perceive the gradual approach in the Miocene animals to existing species. The largest of the terrestrial mammalia yet discovered belongs to the period now under notice; it is the Dinotherium, or Gigantic Tapir, already mentioned. No complete skeleton has yet been discovered; but from the bones found, Cuvier and others imagine the animal to have reached the extraordinary length of eighteen feet. The most remarkable peculiarities of its structure consists in two enormous tusks at the end of its lower jaw, and the shoulder-blade, which resembles that of a mole, and is calculated to have given the power of digging, or other free movement, to the fore-foot. It seems probable that this stupendous creature lived in fresh water lakes, and had the half-terrestrial, half-aquatic habits of the walrus or river-horse. The tusks might be used in digging up roots and plants, and also in sustaining the head on banks during sleep, or in pulling the body out of the water, as the walrus uses a similar pair of tusks. "In these characters (says Buckland) of this gigantic, herbivorous, aquatic quadruped, we recognise adaptations to the lacustrine (lake-covered) condition of the earth, during that portion of the tertiary periods, to which the existence of these seemingly anomalous creatures seems to have been limited."

In the Miocene period, the seas became the habitation of numbers of marine mammalia, consisting of Dolphins, Whales, Seals, Walrus, and the Lamantin, or Manati. Few of these animals were of the same species as those which exist at present, but the differences were far from being great or remarkable. This circumstance, as well as the considerable number of fossil shells identical with existing ones, exhibits an approach in the character and tenantry of the Miocene seas to the present state of things in these respects. The discovery, also, of true terrestrial mammalia, as the Rhinoceros and Hog, in the Miocene formations, shows, that since the era of the gigantic reptiles, no slight portion of the earth's surface had assumed the condition of dry land, fit for the support of the common herbivorous creatures. At the same time, the occurrence of such animals as the Dinotherium in the Miocene strata, proves, as Dr. Buckland remarks, that many regions were still covered with great lakes and estuaries.

It now remains to inquire into the nature and peculiarities of the animals characterizing the Pliocene age, which, for convenience, has been arranged into two periods, the Older and Newer Pliocene, the latter of which immediately preceded the formation of the Diluvial layer constituting the present superficial matter of the globe.

Proceeding from the deepest seated portions of the terrestrial crust upwards, we find a progressive approach, as has already been stated, in the character of the animal remains to the existing varieties of animal life. A remarkable proof of this is presented by the shells of the Pliocene periods. Whereas only eighteen in the hundred of the Miocene shells were of recent species, in the Older Pliocene from thirty-five to fifty, and in the Newer Pliocene not less than from ninety to ninety-five in the hundred, are identical with shells of existing species. This great change is accompanied by the disappearance of the Palæotherian family and others, which formed the most striking animal remains of the periods immediately preceding. In place of these extinct species of *extinct* Pachydermatous or thick-skinned families, we observe in the strata of the Pliocene periods a vast number of remains of *existing* Pachydermatous families, such as the elephant, the rhinoceros, and the hippopotamus, though these remains belong to varieties that are now extinct. The first traces also now appear of Ruminant animals—of oxen, deer, camels, and other creatures of the same class. But though it is of importance to notice the existence of such remains in the Pliocene ages, in order to exhibit the progressive approach to the present state of things in the animal kingdom, it is in the huge and extraordinary creatures, now no longer to be seen on the face of the earth, that the interest of such an investigation as the present chiefly lies. The Pliocene ages are not less rich in these wonders than the periods already described, and to this portion of the subject we shall now turn our attention.

The enormous creature called the *Great Mas'odon*, belongs to the Pliocene era. Of all the fossil animals whose skeletons have been found *complete*, or nearly so, the Mastodon is the largest. Much confusion has existed relative to this animal's true character, many naturalists regarding it as an extinct species of the elephant and others holding that it approached nearer to the hippopotamus. Cuvier, however, determined it to be the head of a distinct family, comprehending several other species. It is about one hundred and twenty years since remains of the Mastodon were first discovered in America, and vast quantities of them have been since found in the same region, buried chiefly in marshy grounds. One skeleton nearly complete was dug up on the banks of the Hudson in 1801, and it is from this that a correct knowledge of the animal has been principally derived. In height, the Mastodon seems to have been about twelve feet, a stature which the Indian elephant occasionally attains. But the body of the Mastodon was greatly elongated in comparison with the elephant's, and its limbs were thicker. The whole arrangement of the bony structure resembled that of the elephant, excepting in one point, which Cuvier regarded as of sufficient consequence to constitute the Mastodon a different genus This was the cheek-teeth, which are divided, on their upper surface, into a number of rounded, obtuse prominences, arranged not like the elephant's, but like those of the wild boar and hippopotamus; whence it is concluded, that, like the latter animals, the Mastodon must have lived on tender vegetables, roots, and aquatic plants, and could not have been carnivorous. The lower jaw of the skeleton found on the Hudson is two feet ten inches in length, and weighs *sixty-three pounds*. Like the elephant, the Mastodon had two tusks, curving upwards, and formed of ivory, and, in the opinion of Cuvier, it had also a trunk of the same kind with the former animal's.

Altogether, making an allowance for several additional feet of length, the larger specimens of the elephant must be considered as varying little from the Great Mastodon. Though not an aquatic animal, the Mastodon, as has been mentioned, appears to have lived, like the hippopotamus, on aquatic vegetables, and this is corroborated by the marshy situations in which its remains are generally found in the greatest profusion. The Indians of Canada had observed these bones, and believed them to belong to a peculiar animal which they called the *father of oxen*. There have been found many bones, belonging, it is conceived from the teeth and other peculiarities, to smaller varieties of the Mastodon. No complete skeletons, however, having been yet dug up, it is unnecessary to attempt any detailed description of what these minor Mastodons must have been. From the immense number of Mastodon bones which have been dug up in various parts of the earth, and particularly in the New World, we must conclude, that at no distant period of time the terrestrial surface was extensively peopled by these enormous creatures. How strange would the spectacle have been, could a human being have been set down in the midst of the great marshes of the ancient world, and beheld these animals browsing in hundreds, all like moving mountains of living matter!

Another creature, belonging to the later Pliocene ages, if not indeed to the era of the Diluvial formation, has been discovered in America, both north and south. This is the *Megatherium*, an animal more widely removed in character from any existing creature, than any of the other fossil remains that have been yet observed. The Megatherium was discovered towards the end of the last century. A skeleton, almost entire, was found nearly at one hundred feet of depth, in excavations made on the banks of the river Luxan, several leagues to the south-west of Buenos Ayres. The Megatherium was a tardigrade (slow-moving) animal, like the sloth, and was at least the size of a common ox. Its limbs were terminated by five thick toes, attached to a series of huge, flat, metatarsal bones, or those bones with which the toes are continuous, as in the human foot. "Some of the toes (says Buckland, in his notice of this creature) are terminated by large and powerful claws of great length; the bones supporting these claws are composed partly of an axis, or pointed core, which filled the internal cavity of the horny claw; and partly of a bony sheath, that formed a strong case to receive and support its base." These claws, from their position, were admirably calculated for the purpose of digging. The legs of this creature were of enormous thickness, its thigh bone being nearly three times the thickness of the same bone in the elephant. The other bones of the Megatherium were almost proportionably heavy. A still more remarkable feature, however, in the animal's structure, was the coat of armour, of solid bone, varying from three-fourths of an inch to an inch and a half in thickness, which covered its hide, in the same manner as the armadillo's is encased by the same substance.

The habits and peculiarities of this stupendous sloth, for so the Megatherium may be termed, are well described and explained in Dr. Buckland's Bridgewater Treatise. After stating that with the head and shoulders of a sloth, it combined, in its legs and feet, an admixture of the characters of the ant-eater and the armadillo, and resembled them still more in being cased in a coat of armour, he continues, "Its haunches were more than five feet wide, and its body twelve feet long and eight feet high; its feet were a *yard in length*, and terminated by most gigantic claws; its tail was probably clad in armour, and much larger than the tail of any other beast among living or extinct terrestrial mammalia. Thus heavily constructed, and ponderously accoutred, it could neither run, nor leap, nor climb, nor burrow under the ground, and in all its movements must have been necessarily slow; but what need of rapid locomotion to an animal, whose occupation of digging roots for food was almost stationary? and what need of speed for flight from foes, to a creature whose giant carcass was encased in an impenetrable cuirass, and who by a single pat of his paw, or lash of his tail, could in an instant have demolished the cougar or the crocodile? Secure within the panoply of his bony armour, where was the enemy that would dare encounter this behemoth of the Pampas (the South American region where it existed), or in what more powerful creature can we find the cause that has effected the extirpation of his race?

"His entire frame was an apparatus of colossal mechanism, adapted exactly to the work it had to do; strong and ponderous, in proportion as this work was heavy, and calculated to be the vehicle of life and enjoyment to a gigantic race of quadrupeds; which, though they have ceased to be counted among the living inhabitants of our planet, have, in their fossil bones, left behind them imperishable monuments of the consummate skill with which they were constructed."

Another extinct tardigrade creature, presenting many of the characters of the Megatherium, was discovered in a calcareous cavern in Virginia, and received from President Jefferson, who first described some of its bones, the name of the *Megalonyx*. Jefferson conceived the claw to be that of an extinct feline animal of vast size (that is to say, an animal of the same description as the tiger, lion, cat, and lynx, all of which are beasts of prey); but the French naturalists declared the possessor of the claw to have been herbivorous, or calculated to live on herbs; and this was triumphantly proved by the discovery of others of its bones. The Megalonyx appears (for a complete skeleton has not yet been found) to have been a little smaller in size than the Megatherium. But the Megalonyx, according to Cuvier, was herbivorous after the manner of the sloth, since its teeth were conformed precisely like that animal's. From the resemblance of their feet, also, he concludes that their gait was similar, and all their movements alike. The difference in volume of body, however, must have prevented the habits of the Megalonyx from being perfectly analogous to those of the sloth. The Megalonyx could but seldom have climbed up trees, because it must rarely have found any sufficiently strong to support its weight. But its height would enable it to browse, like the sloth, among the leaves of trees, without its being under the necessity of climbing any but such tall and strong ones as could bear its weight. It is even possible that the weight of the creature may have been serviceable in bending down, and perhaps in breaking, the elevated branches which contained its food.

The next fossil animal to which we shall refer, is that long called the *Mammoth*, under the impression that it was a distinct genus, but which is now universally denominated the *Fossil Elephant*, as being an extinct species of that existing family. The Mammoth (which name we shall retain for the sake of distinction) is rather to be regarded as a creature of the Diluvial than of the Pliocene period (that is to say, belonging to the age, when, by means of floods, the present beds of gravel and hard clay so often found between the rocks and vegetable soil were laid down upon the earth), as some specimens have been discovered in Siberia, with portions of the flesh and hair actually preserved along with the bones among the ice. It was at first thought, when numbers of Mammoth bones were discovered in Italy, and other southern countries of Europe, that they were the remains of elephants brought by the Romans and others from Asia and Africa; but the incalculable quantities of them ultimately detected in Russia and other districts, where elephants were never brought in the shape of oriental tribute, as they were to Rome, showed that their presence was to be attributed to natural causes, and not to the casual agency of man. In truth, the beds of the Volga, Don, and other northern rivers, are filled with them, and this can be accounted for only on the hypothesis, either of an alteration in the habits of the elephant, or of a great change of climate in these parts, or of some immense moving force on the face of the earth, which has carried them thither. The instance in which part of the flesh was found along with the bones, will supply us with a general description of the Mammoth. When the animal, on this occasion, was first seen through the mass of ice in which it lay, the soft parts were nearly entire. After the natives had fed their dogs for a long time with the mountainous bulk of flesh, Mr. Adams of St. Petersburgh heard of it, and set out to see it. When he reached the spot, the skeleton was entire, with the exception of a fore leg. The spine of the back, a shoulder-blade, the pelvis, and the rest of the extremities, were still united by ligaments and a portion of the skin. The other shoulder-blade was found at some distance. The head was covered with a dry skin. One of the ears, in high preservation, was furnished with a tuft of hair, and the pupil of the eye was still discernable. The brain was found in the skull, but in a dry state. The neck was furnished with *a long mane*, and the skin, generally, was covered with black hairs and a reddish sort of wool. Of the quantity of hair and bristles that had been on the body, some idea may be formed from the fact that thirty pounds of them were gathered from the ground, where the dogs, in eating the flesh, had dropt them. The tusks were more than nine feet long, and the head, without the tusks, weighed more than four hundred pounds. Altogether, the skeleton of this Mammoth was about the size of a large elephant's.

Skeletons similar to this have been found in abundance in the islands of the Arctic sea. They differ in several minute points of structure from the common elephant, and on this circumstance the most rational explanation of their being found in such cold climates is founded. This explanation is, that the Mammoth Elephant was of a species fitted to be a native of cold countries; and of this reasoning, the different structure and the long thick hair, are held to be proofs. Whether this may be the case or not, it seems certain that the Mammoth's existence must have been very recent, and must have approached closely to if not encroached on, the era of man.

SUPERFICIAL.

Diluvium, Alluvium, Peat, and Vegetable Soil.

In many parts of the earth's surface, a thick bed of compact clay, containing stones of various sizes, and sometimes of a red, sometimes of a blue colour, is found above the hard rocks: it is called *Diluvium*, as supposed to have been deposited by a deluge which had swept over the earth after the most of the present rocks had been formed, and placed in their present arrangement. Some of the stones contained in the diluvium are rounded as by the act of rolling; others contain seams or grooves, which are supposed to have been occasioned either by their rubbing on some hard substance in passing, or having been rubbed against by smaller stones passing them. All over the earth large blocks of stone are found on or near the surface, which it is certain have been carried from great distances, as rocks of the same kind in their original position are not to be found near. There are blocks of this kind in Cumberland, which appear to have originally belonged to hills in the south of Scotland; and some have been found in the district between the Trent and Thames, which geologists suppose to have been brought hither from Norway.

The *Alluvium* is the matter carried down by rivers, and deposited in large level spaces beside their banks, or in islands at their mouths.

Peat is an accumulation of decayed vegetable matter mixed with water. It is well known for its properties as fuel.

The *Vegetable Soil* is generally composed of the inferior substances in a pulverized state, or of detritus carried from a distance, mingled with decayed vegetable and animal matters.

Remains in the Diluvium, &c.

The period when the diluvium was deposited, being that immediately preceding the existing order of things on the earth's surface, is marked by the remains of animals, many of which still exist, while others are extinct. The chief evidence on this point is derived from bones, and fragments of bones, found in caves which are supposed to have served, about the time of the diluvial action, as retreats for Hyænas and other beasts of prey. That of Kirkdale, in Yorkshire, discovered a few years ago, was found to contain remains of twenty-three species; namely, Hyæna, Tiger, Bear, Wolf, Fox, Weasel, Elephant, Rhinoceros, Hippopotamus, Horse, Ox, three species of Deer, Hare, Rabbit, Water-rat, Mouse, Pigeon, Raven, Lark, a species of Duck and Partridge. The bones, in all these cases, were broken into angular fragments or chips, and were all more or less decayed, though the gelatinous matter yet remained in some of them. They were covered by a layer of mud about a foot deep, the nature of which led to the supposition that it must have been deposited during the action of the diluvium.

Till a recent period, no trace of any animal of a higher order was discovered in rocks. Some remains of a human skeleton had been found in a cave in Guadaloupe, imbedded in stony matter; but it was concluded, in that case, that the enclosing matter was of recent formation, and that the human being whose relics were discovered in it, might have been alive at no distant era. Latterly, however, fossil zoology has made one step in advance. In 1838, a fossil jaw-bone of one of the *quadrumana* (four-handed or monkey tribes) was discovered in the tertiary formation at the northern foot of the Pyrenees, in the department of Gers, in France. Two deposits there are very rich in fossils, affording remains of no fewer than thirty mammiferous animals. In the second and newer of these, which is lacustrine, or a deposit from a fresh-water lake, the jaw-bone of the monkey was found, containing, four incisor teeth, two canini, four false grinders, and six true grinders in a continued series. The monkey is supposed to have been about three feet in height. The bone occurred in a stratum of marl, covered by compact limestone. Another jaw-bone of a monkey was discovered with other remains, in August, 1839, in a brick-field at Kingston, near Woodbridge, in the county of Suffolk: the particular bed in which it was found has not been stated. The bone indicates a species of the quadrumana not now existing.

These must be considered as very interesting discoveries. The earliest animals and plants are of the simplest kind. Gradually, as we advance through the higher strata, or, in other words, as we proceed through this record of progressive creation, we find animals and plants of higher and higher structure, till at last we come to the superficial strata, where there are remains of kinds approximating to the highest of all the animated tribes, namely, man himself. But, before the above discoveries, there remained one remarkable gap in the series. The quadrumana, or monkeys, who form an order above common mammalia, but below the bimana, or human tribes, were wanting. Now this deficiency is supplied; and it is shown that every one of the present forms of animated existence, *excepting the human*, existed at the time when the superficial strata were formed. The only zoological event of an important nature subsequent to that period is the creation of man; for we may consider of a lesser importance the extinction of many of the specific varieties which flourished in the geological ages, and the creation of new.

VOLCANIC.

Rock of this kind owes its origin to internal fire, which seems to have sent it up in a state of fusion. It is spread over large parts of the surface of the earth, particularly in France, where there are many extinct volcanoes. The apertures through which it has forced its way from below, and the chinks and rents formed at the time of its eruption in adjacent rocks, are often found filled with it. Large mountains are also composed of volcanic rock. It is remarkable for the fine soil formed out of it.

The chief varieties of volcanic rock are:—

Trap, a term from the Swedish, expressive of the appearance of stairs which a hill of this rock often presents —a bare precipice alternating with a grassy platform or terrace. In trap rocks, nodules are often found; that is, little isolated masses of a different consistence from the including matter: the rock is then said to be of *amigdaloidal structure*, from the Greek word for an almond. This peculiarity is owing to the porousness of the original matter: it contained many small air-cells, which, being afterwards filled up with silex, carbonate of lime, zeolite, and other ingredients, became nodules of those substances.* In Plutonic rocks, no such peculiarity is ever found.

Basalt, a dark gray rock, of crystallized form, masses of which resemble groups of pillars, the various pillars generally having regular sides and angles, and the whole joined compactly together. The Giant's Causeway, in Ireland, and the Island of Staffa, in the Hebrides, are notable examples of basalt. The structure of basalt is found to have originated in the manner in which refrigeration, or cooling, took place at its formation. The process has been imitated on a small scale by the fusing of a few hundred-weights of basalt, and allowing the mass to cool in the furnace: as the cooling gradually proceeded,

* Lyell's Geology, iv. 272.

globules appeared; these enlarged till they pressed laterally [sideways] against each other, and became converted into polygonal [many-cornered] prisms. Thus the rock was replaced in something like its original form, in a common furnace.

Greenstone, a compact, hard, tenacious rock, of dark grayish colour, slightly tinged with green.

Lava (a term from the Gothic, signifying *to run*), the product of modern volcanic mountains.

Section IV.—MINERAL VEINS.

Throughout the primary, transition, secondary, and tertiary rocks, but particularly the two first kinds, there occur what are called *veins*, containing divers substances, most commonly metals, quartz, and calcareous spar, the last being a hard and shining substance deposited from lime. The form and direction of veins may be best understood from the way in which they mostly seem to have originated, namely, by chinks or cracks formed in all directions throughout the rocks, and which have subsequently been filled with various substances.

Those filled with metals penetrate downwards so far, that their lower ends are rarely found, and miners have an idea that they reach quite through the earth. Near the surface of the earth, they are generally found poorest in the metal they contain, richer at a certain distance down, and then poor again. They also often change their metal at different depths. In France there are veins which contain iron above, then silver, and next copper. One of the Cornwall mines have zinc above, and copper in great quantity below. These veins also change their width at different depths: thus, the Dalcoath mine in Cornwall varies from forty feet to six inches in width.* What at first appears extremely strange, a vein will sometimes be rich, or contain abundance of the metal at the place where it passes through one kind of rock, and poor where it passes through another. Thus, for instance, a copper vein will be productive as long as it is dug through slate, and become poor when it passes into granite. Such a vein, it may also be remarked, is generally found richest in the slate when it approaches the granite.

Till a recent time, two theories as to the formation of metallic veins were predominant—one representing them as the result of a forcing of fused matter from below into the chinks, the other accounting for them by supposing an infiltration of the matter in water from above. These theories, respectively termed Huttonian and Wernerian, are now given up: "many veins are fissures of mechanical origin, into which metalliferous matter has been sublimed from the effects of high temperature; but others have resulted from an electro-chemical 'separation or segregation of certain mineral and metallic particles from the mass of enveloping rock, while it was in a soft or fluid state, and their determination to particular centres.'"† Within the last few years, much light has been thrown on the subject by electro-chemical experiments, whereby the workings of nature, in this department of her economy, were imitated on a small scale. Becquerell and Mitcherlich, foreign mineralogists, have succeeded in forming crystals by electricity. Our own countryman, Mr. Andrew Crosse, of Somersetshire, has in like manner formed calcareous spar out of water which had percolated through a limestone rock, and which was forming crystals naturally at the place where the experimentalist obtained it. The same gentleman produced quartz crystals, and thus made the formation of what are called precious stones no longer a mystery. The electric apparatus used by Mr. Crosse was of small power, but kept long in operation, such being the way in which nature works the same ends.

In Mr. Crosse's experiments, the same solution produces different substances at different ends of the electric pole. For example, a battery operating for six months on fluat of silver, produced at the negative pole six-sided cubes of silver, and at the positive, crystals of silica and chalcedony. This opens up a most interesting field of speculation. The difference of substances found in certain veins, their comparative richness and poorness, may have been the consequence of different electric states in the rocks in which they were deposited.

[WORKS ON GEOLOGY.

Geology, like all other branches of natural history, is best studied in the fields. Accurate and extensive observations are absolutely necessary to the acquisition of any considerable knowledge of this vast and important science. Books are useful chiefly in directing attention to the things which are necessary to be *observed*. A comparison of the various theories of different philosophers, respecting the structure of the earth, with the phenomena upon which those theories are founded, will enable the careful and judicious observer to form and modify his own theory in conformity with his own observations. Theories are chiefly valuable for the assistance which they afford us in classifying facts, and every one who proposes to take up any subject of natural science in earnest, will read the most noted general works on that subject. Cuvier's Theory of the Earth is important as the production of the greatest naturalist since Linnæus. Lyell's *Principles of Geology* should be read for general information on this subject, and his Travels in the United States, as well as Featherstonhaugh's Excursions in the Slave States, and Jameson's Discovery and Adventure in Africa, are important for those who are desirous of learning the geology of this country and Africa. Brande's *Dictionary of Science, Literature, and Art* is a useful book of reference with respect to the meaning of terms used in this as well as the other sciences.

Buckland's *Reliquiæ Diluvianæ*, the Transactions of Geological Society of London, and Leonhard's *Characteristics of Rocks*, are also valuable. Mineralogy, which is a subordinate branch of Geology, is extremely interesting, and throws light on all the kindred branches of science. On this subject Cleaveland's Treatise is one of the best that has been written. The Transactions of the American Philosophical Society, and the Academy of Natural Sciences of Philadelphia, contain many interesting tracts on Geology and Mineralogy.—*Am Ed.*]

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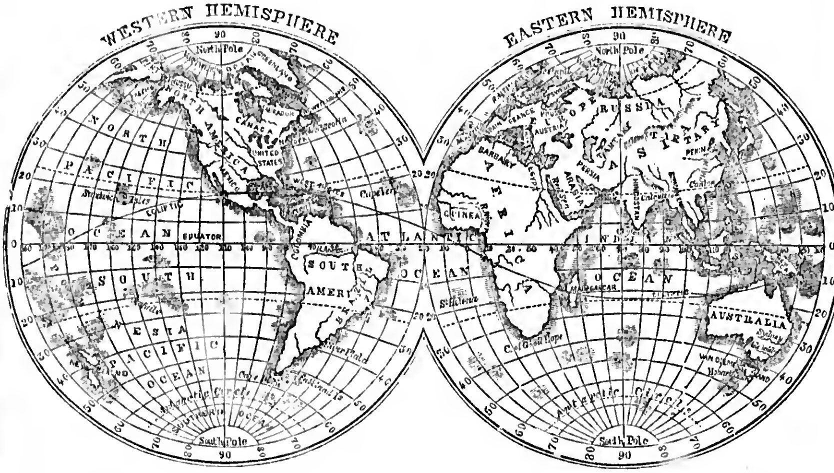
* Comstock's Geology, New York, 1836.
† Mantell's Wonders of Geology, 651

GEOGRAPHY.



INTRODUCTORY.

The Earth which we inhabit, as has been explained in the article Astronomy, is a nearly round globe or mass of matter, forming one of eleven primary planets, which at various distances revolve round the sun as a centre, and receive from that splendid luminary the blessings of light and heat. The earth is one of the smaller sized of the planets, being only about a fourth of the diameter of Uranus, and an eleventh of the diameter of Jupiter, and forms, therefore, a comparatively small portion of the planetary system, and, with reference to the stars, only a speck in the vast extent of creation.

According to the calculations of astronomers, the earth is 7902 miles in mean diameter, and measures about 25,000 miles in circumference. But the diameter or thickness is greater at the middle, or equinoctial line, than in the contrary direction. The cause of this has been explained in Astronomy, but may here be briefly adverted to. The diurnal motion of the earth on its axis, or imaginary poles, causes a greater whirl at the middle than the extremities of the mass, and the earth, originally in a soft state, has been there bulged out all round. The extent of this bulging is twenty-six miles on the whole thickness, or thirteen miles from the surface to the centre of the earth. Thus, the form of the globe is that of an orange, or flattened sphere, and its diameter is twenty-six miles greater from one side to another, at the equinoctial line, than betwixt the poles. Such is the nice adjustment of the daily motion of the earth on its axis, that if it were only a little greater, the sea would rise and fly off, and if the velocity were still more increased, the whole mass of earth and water would be dispersed in fragments, or, in other words, be destroyed. The earth, as far as can be ascertained, is a solid body, well balanced in all its parts, and consists of two kinds of matter, land and water—the land being composed of rocks, metallic ores, soils, and a variety of other substances (see Geology); while the water, as is well known, is of two qualities, fresh and salt—the former in lakes and rivers, and the latter in the sea or ocean. The greater part of the earth consists of solid land or rocky matter, but a large proportion of it is covered by the waters of the ocean; and therefore, to appearance, the ocean forms the principal portion of the globe. It is so, however, only in appearance, notwithstanding its imposing extent, the water being merely a superficial covering to the land.

The manner in which the land is mixed with the ocean is quite irregular, and the relative situation and dimensions of each are constantly shifting. From causes which have been explained in the article Geology, the sea is daily making encroachments on the land, while the land at other places is in the course of being left dry by the sea. Thus, in point of fact, the external features of the globe are ever changing; and it may be safely averred, that in the course of ages there has been a thorough alteration over the whole surface of the globe—that not one part now resembles that form which it originally possessed.

In order to facilitate the operations of the navigator and traveller, and with the view to mark the relative situation of every spot on the earth's surface, the globe has been subjected to divers measurements, by means of ideal lines drawn from north to south, and east to west, as represented in the figure which forms the frontispiece. In the first place, the whole surface is represented as spread out in the form of two hemispheres—the Eastern Hemisphere containing the continents of Europe, Asia, and Africa, and the Western Hemisphere North and South America. The line which appears to cut across the hemispheres at the middle is the *equator* or equinoctial line, and from this are measurements in degrees of latitude.

The earth's surface has been calculated to contain 198,943,750 square miles, of which scarcely a third part is dry land; the remaining two-thirds are water. The land is composed principally of two large masses or tracts, one of which comprehends the continents of Europe, Asia, and Africa; the other comprehends the continent of America. Australia, which lies in the ocean in a southerly direction from Asia, is so extensive as to be entitled to the name and character of a fifth division. All the detached and smaller masses of land, called islands, when taken together, are computed to contain as much land as the continent of Europe. In reference to maps of the earth, Europe, Asia, Africa, and Australia, with their islands, are distinguished as lying in the eastern hemisphere; while America, with the West Indian and other islands, are comprehended in the western hemisphere. The seas which encompass these extensive tracts of land have locally various names; but the two principal expanses of water are the Atlantic and Pacific Oceans—the former separating Europe, Asia, and Africa, from America, on the west, and the latter lying betwixt the western shores of America and the eastern shores of Asia. The extensive oceans surrounding the north and south poles are called the Polar Seas, which have not been explored sufficiently for us to be able to say whether any large tracts of land lie in these remote quarters of the globe. Great diversity of opinion prevails with respect to the depth of the ocean. By numerous investigations, it does not appear that the depth is anywhere much more than two or three miles, generally it is a great deal less; and it might be argued, that notwithstanding the large surface of the ocean, the body of its waters can only be considered as lying like lakes in the hollows of the land; for the earth, as already noticed, is eight thousand miles in diameter, and to that huge mass of dense matter the sea bears no proportion in its depth. While the surface of the land exhibits a variety of mountain ranges, hills, vales, and plains, so also is the bottom of the sea varied in its configuration, abounding in sandbanks, hills, rocks, and reefs, dangerous to the mariner; and the islands which rear their heads above the surface are only the tops of the highest hills and mountains in the sea.

The waters of the ocean, as every one knows, are salt to a greater or lesser degree—a quality which is considered necessary to preserve them from putridity. How they should possess this saline property, no one has yet been able to explain satisfactorily. Some have imagined that the saltness is caused by rocks of salt at the bottom of the sea, but this is obviously incorrect, for rocks of salt do not abound to such an extent as would be required for performing this important office. It is more probable that the saltness is an inherent property in the water itself; there is at any rate nothing more strange in this than in the circumstance of the atmosphere being in *its* nature composed of divers kinds of air or gases. For an examination of this point, however, and for a regular account of the ocean and its tides, we refer to the article THE OCEAN.

According to the beautiful harmony of design manifested in all departments of creation, the earth, with its ocean, its atmosphere, its rivers, and its varying climates, forms an appropriate field for animal and vegetable existence. The manner in which animals and plants are thus distributed in situations and circumstances exactly suited to their character, is a matter of deeply interesting observation. Nature—by which, as a phrase of convenience, we denote the great Creating and Disposing Power—has appointed very few forms of animal or vegetable life to be localized in any portion of the globe approaching to its entire terrestrial surface. Most of them are calculated for certain degrees of heat and cold, dryness, and moisture; and, accordingly, are to be found distributed in rings or zones around the globe, or at certain elevations, with a direct reference, in all cases, to the temperature and other conditions of the situation.

It appears, from the researches of geologists, that the distribution of animal and vegetable forms has, in the course of ages, undergone variations conformable to alterations of condition in soil, climate, and other circumstances. Races of animals have thus entirely disappeared from the surface of the earth, while insular tracts of land, which have risen from the bosom of the deep, have become clothed with vegetation, and are now the appropriate theatre of existence of various kinds of animals. The dispersing power of winds and currents, not to speak of the active interference of man, is supposed to be capable of accounting for the distribution of many plants; but it is clear, that without the ever-vigilant superintendence of an all-wise Providence, the earth, taken in its whole extent, could not exhibit those remarkable forms of animal and vegetable life which are so nicely suited to the localities in which they are placed. In Europe, and nearly all other temperate regions, we find the horse, the cow the dog, the cat, the crow, the sparrow, the house-fly, and other creatures with which we are familiar, because the nature of these animals is suited to climates of moderate heat and cold. In the warm and dry regions of Asia and Africa, other forms of animal life prevail—as the lion, tiger, and camel; the latter being suited to traverse wide sandy deserts, and to endure privations of drought for a greater length of time than any other beasts of burden. America has the condor, the Washington eagle, the llama, and other great birds and beasts of prey peculiar to itself. A remarkable distinction in animal forms is that found in Australia. There, as will be afterwards mentioned, the quadruped races are furnished with pouches for their young, and move forwards by leaping, peculiarities conformable to the locality in which they happen to be placed.

EUROPE.

Europe is the smallest of the great divisions of our globe, but distinguished above the rest by the character of its population, the superior cultivation of the soil, and the flourishing condition of arts, sciences, industry, and commerce, the multitude of large and well-built cities, and its power and influence over the other parts of the world.

It is washed on three sides by the sea, which is called by different names, and belongs either to the Northern Arctic or the Atlantic Ocean. A narrow strait of the Mediterranean separates it from Africa. On the east alone it joins the mainland, being there separated from Asia by an imaginary line. Europe is situated in the northern frozen and the northern temperate zones, between 10° and 73° east longitude, and 36° and 71° north latitude. Including the islands, which contain about 317,000 square miles, the whole extent of Europe amounts to about 3,250,000 square miles, of which Russia comprises nearly one-half. The greatest length, from Cape St. Vincent, in Portugal, to the northern extremity of the eastern boundary, at Waygatt's, is about 3500 miles. The greatest breadth, from Cape Matapan in the Morea, to the North Cape in Norway, is about 2500 miles.

Europe is remarkably well watered, although its rivers have not so long a course nor such large cataracts as those in other parts of the globe, particularly in America. The principal rivers are the Ebro, the Rhone, and the Po, running into the Mediterranean; the Danube, the Dneiper, and the Dneister, into the Black Sea; the Don, into the Sea of Azoph; the Wolga, into the Caspian; the Dwina, into the Arctic Ocean; another Dwina or Duna, the Vistula, and the Oder, into the Baltic; the Elbe, Weser, and Rhine, into the North Sea; the Seine into the English Channel; the Thames into the German Ocean; the Loire and Garonne, the Douro and Tagus, the Gaudiani and Gaudalquiver, into the Atlantic. The Wolga and Danube are the longest. By the Danube, which penetrates the continent on its southern, and the Rhine which penetrates it on its north-western side, Europe is almost cut in two by water-courses. The Rhine is celebrated for the romantic beauty of its banks, on the middle and higher part of its course. At the distance of 200 miles from the sea, it is as broad as the Thames at Westminster, and suitable for navigation with steamboats and small vessels.

Europe possesses numerous large lakes, but none so extensive as those in North America. The largest is

Lake Ladoga in Russia. The lakes celebrated for their beauty and extent are Lake Constance and Lake Leman in Switzerland, or on the borders of that country.

A great part of Europe is mountainous; the southern more so than the northern. The most elevated region is Switzerland, from which there is a descent, which terminates on the side of the North Sea and the Baltic, in low plains. The lowest and most level parts are Holland and Northern Germany, Denmark, Russia, and Prussia. The highest mountains are the Alps, in Switzerland and Italy, which spread from those countries in various directions, extend westwardly into France, and are connected by the Cevennes with the Pyrenees, which separate France from Spain. One chain of the Alps stretches south towards the Mediterranean; then, taking an easterly course, runs through Italy, under the name of the Apennines. Several branches run eastward from the Alps, through the south of Germany, as far as the Turkish provinces. Another chain, the Jura, runs to the north, and separates Switzerland from France. In the east of Europe are the Carpathian mountains, which on one side meet the Sudetic range, and on the other the mountains of Turkey in Europe. The highest mountain in Europe is Mont Blanc, in Savoy, one of the Alps, which is said to be 15,766 feet above the level of the sea.

Several of the European mountains are volcanoes; as Ætna, Vesuvius, and Hecla. It is a fact worthy of notice, that none of the volcanoes of Europe are to be found in any of the great chains of mountains which have just been enumerated. The only one on the continent is Vesuvius, and this is too much detached to be considered as properly forming one of the Apennines. Ætna, in the Island of Sicily, rising to the height of ten or eleven thousand feet above the level of the sea, is the largest European volcano. The Lapari Islands, anciently called the *Æolian*, a few miles to the north of Sicily, bear evident marks of a volcanic origin; and in several of them, subterranean fires are still in operation. Iceland, too, presents the most abundant tokens of the presence of volcanic fire, and has often suffered under its devastations; Mount Hecla is the most noted, although not the only source of the eruptions on this island. To the possession of many inland seas, and, consequently, of a line of coast very extensive in proportion to its area, Europe is greatly indebted for the great advancement of its inhabitants in civilization; these circumstances being favourable to that intercourse without which nations never make great advances.

The chief islands belonging to Europe are—Iceland, in the north sea, lying in the 65th degree of north latitude; Great Britain, Ireland, and other British Islands, in the Atlantic and German Oceans; Majorca, Minorca, Sardinia, Sicily, Corsica, Elba, the Ionian Isles, Malta, Candia, and Cyprus, in the Mediterranean Sea. The European peninsulas are six in number: Scandinavia, Jutland, Crimea, Italy, Spain, and Greece. The soil of Europe, though not equal in luxuriance to that of the tropics, is almost throughout fit for cultivation. The tracts in the northern zone are almost the only exception.

With respect to climate, Europe may be divided into three parts—the warm region, where the lemon-trees grow wild, as far as 48° north lat., having a pleasant spring, a hot summer, and a short winter; the temperate, as far as 65° N., in which grain ripens; and the cold region, to the extreme north, where nothing will grow but reindeer moss, and no domestic animal can live except the reindeer. The products are not so various as in other parts of the world, and many of them were originally brought from foreign countries and naturalized; but, on the other hand, Europe can boast of a more perfect cultivation. Among the animals are horses, some of which are of the nobler breeds; horned cattle; sheep in Spain, Saxony, and England, of the finest wool; asses, goats, swine, dogs; reindeer; wild beasts of different kinds valuable for their flesh or fur; whales; sea-cows, sea-dogs; abundance of wild and tame fowl; large quantities of fish in the seas, lakes, and rivers, among which the herring, in particular, affords sustenance to many of the inhabitants; useful insects, such as bees, silkworms, kermes, gall-flies, and Spanish-flies. Oysters and pearl mussels also abound. It produces all kinds of grain, and sufficient for its consumption; beautiful garden plants; abundance of fruits, including those of southern climates, such as figs, almonds, chestnuts, lemons, oranges, olives, pomegranates, dates; also flax, hemp, cotton, madder, tobacco: the best kinds of wine; and a great variety of wood for fuel, and for house and ship building. The birch and the willow best endure the cold of the northern polar circle. Europe produces all the varieties of metals and minerals in great excellence and abundance. In gold and silver, Hungary and Transylvania are the richest; in iron, the northern countries, Sweden, Norway, and Russia. Salt of all kinds, rock, sea, and spring salt, is also abundant in Europe.

The inhabitants, estimated by Malte-Brun at 200 millions at least, are unequally distributed; in Russia and Sweden there are from fifteen to eighteen to a square mile; in the Netherlands, where the population is most dense, Italy, France, Great Britain, and Germany, the same extent supports from one hundred and fifty to two hundred and fifty persons. The inhabitants consist of several different races, speaking distinct languages. The stocks to which the principal languages belong, are—the Teutonic, which is the mother of the German, Dutch, English, Swedish, and Danish; the Latin, or Roman, now spoken only by the learned, but the mother of the Italian, French, Spanish, Portuguese, and Wallachian; the Slavonic, to which belong the Russian, Polish, Bohemian, Bulgarian, Vandal, and the Servian, or Illyrian. Besides these, there are the modern Greek; the Turco-Tartaric; the Finnish and Hungarian; the Celtic in Wales and the north-west part of France (Bretagne); the Highlands of Scotland and Ireland; the Basque, among the Pyrenees. The most widely spoken is the German, with its kindred languages, formed by a union of the Roman with the Teutonic.

The prevailing religion is the Christian, which includes several churches, viz., the Roman Catholic, which is the most numerous; the Protestant (Lutheran, Calvinistic, and Anglician), consisting of numerous sects—Anabaptists, Mennonites, Quakers, Unitarians, Methodists, Moravians, and the Greek church. A part of the inhabitants profess the Jewish, a part the Mohammedan religion. Among the Laplanders and Samoeides, there are also some heathens, but their number is small.

Agriculture has made great advances in Europe, and is daily improving. In this respect, those countries are particularly distinguished where the Teutonic languages are spoken, as also are France and a part of Italy. In no part of the world are manufactures carried to such perfection as in several of the European countries, especially in Great Britain, France, the Netherlands, and Germany. The inhabitants work up not only native European, but also foreign products, and supply all the wants and luxuries of life. Commerce is not less active, and is promoted by well-constructed roads and canals, by well-organized posts, banks, insurance companies, commercial companies and fairs. The commerce of Europe extends to all quarters of the world, and every sea is filled with European ships. In this respect, Great Britain is most distinguished. Europe is the seat of art and science; to her belongs the honour of discovering the most important truths, of giving birth to the most useful inventions and the finest productions of genius, and the improvement of all the sciences. In intellectual progress, the Teutonic races, and those who speak the languages derived from the Latin, have surpassed the Slavonic nations. The

Turks have remained strangers, in many respects, to the literary and scientific improvement which has marked the other European nations. Eighty-five universities provide for the higher branches of education; numerous gymnasia and academies for the preparatory studies, and a great number of lower schools, particularly in Germany, are employed in educating the common people. In many places there are academies of science, and societies of all kinds, for the cultivation of the arts and sciences.

By its physical situation, Europe is divided into East and West Europe. West Europe comprises the Pyrenean peninsula (Spain and Portugal), the country west of the Alps (France), the countries north of the Alps (Switzerland, Germany, and the Netherlands), the country south of the Alps (Italy), the Islands of the North Sea (Great Britain, Ireland, and Iceland), and the countries on the Baltic (Denmark, Norway, Sweden, and Prussia). East Europe contains the countries north of the Carpathian mountains (Russia and Gallicia), and the countries south of the Carpathian mountains (Hungary, in its more comprehensive sense, and Turkey).

The following are the political states of Europe:—The three empires of Austria, Russia, and Turkey; seventeen kingdoms, viz., Portugal, Spain, France, Great Britain, Holland, Belgium, Denmark, Sweden, (including Norway), Sardinia, the Two Sicilies, Greece, Prussia, Bavaria, Saxony, Hanover, and Würtemberg; one ecclesiastical state, the papal dominions; eight republics, namely, Switzerland, the Ionian Islands, San Marino, Hamburg, Lubeck, Bremen, Cracow, and Frankfort; one electorate, Hesse; six grand-duchies, Baden, Hesse-Darmstadt, Saxe-Weimar, Mecklenburg-Schwerin, Mecklenburg-Strelitz, and Tuscany; twelve duchies, viz., Oldenburg, Gotha, Meiningen, Altenburg, Brunswick, Nassau, Dessau, Bernburg, Cöthen, Modena, Parma, and Lucca; one landgraviate, viz., Hesse-Homburg; twelve principalities, viz., Hohenzollern-Hechingen, Hohenzollern-Zigmaringen, Schwarzburg-Rudolstadt, Schwarzburg Sondershausen, Waldeck, Lippe-Detmold, Schaumburg-Lippe, Lichtenstein, Reuss-Greiz, Reuss-Schleiz, Reuss-Lobenstein, and Reuss-Ebersdorf.

Austria, Prussia, Bavaria, Saxony, Hanover, Würtemberg, Hamburg, Lubeck, Bremen, Frankfort, Hesse, and the above grand-duchies and duchies, compose the region which we call Germany, but the proper name of which, as given by the natives, is Deutschland—the land of the Teutones, an ancient people of central Europe.

THE BRITISH ISLANDS.

These islands, the most important belonging to Europe, lie at a short distance from the north-west coast of France, betwixt the Atlantic Ocean on the west and the German Ocean on the east. From their southernmost boundary upon the British Channel to the most northerly of the Shetland group, is a distance of very nearly eleven degrees, measuring from the 50th to the 61st degree of north latitude. The main island, which since the Union has been called Great Britain, is composed of two portions, with considerably distinctive features, under the names of England and Scotland. England forms the larger, the most southerly, and much the finest portion of the island, and lies betwixt the 50th and 55th degree. Scotland lies on the north of this division, and reaches the 58th degree. Ireland is a large and beautiful island lying to the west of England, from which it is separated only by a channel half a day's sail in breadth, and extends in length from 51° 10′ to 55° 20′ north latitude. Its greatest length, measuring from N E. to S W., is about 300 miles; the greatest breadth about 60 miles. The chief of the minor islands are the Isle of Man, lying in the Irish Channel; Anglesea, on the coast of Wales; the Hebrides, a series of large and small isles on the west coast of Scotland; the Orkney Islands, separated from the north point of Scotland by the Pentland Frith; and the Shetland Islands, lying considerably north of the Orkneys. Besides these, there are some Islands in the British Channel, near the coast of France, called Guernsey, Jersey, Alderney, &c. Reckoning large and small, the British islands amount to some hundreds in number but many of the smallest are not inhabited.

In 1831, the population of England and Wales was 13,894,569, of Scotland 2,365,807, and of Ireland 7,734,365; adding the number of individuals in the army and navy, 277,017, the total population amounted to 24,271,758. Reckoning the inhabitants of foreign countries subject to Great Britain, the entire population of the British empire amounts to about 118,000,000.

[It is considered unnecessary here to say any thing further of the British Islands, as they form the subject of various other articles, entitled HISTORY OF GREAT BRITAIN, DESCRIPTION OF ENGLAND, DESCRIPTION OF SCOTLAND, DESCRIPTION OF IRELAND, CONSTITUTION AND RESOURCES OF THE BRITISH EMPIRE, not to speak of the accounts of Canada, West Indies, East Indies, and other foreign possessions, each forming distinct numbers of the present work.]

FRANCE.

After Great Britain, France is usually reckoned the most powerful and influential country in Europe. In point of territorial extent and amount of population, it stands much higher than Great Britain, which is but a small country, and it likewise possesses a finer climate; nevertheless, such have been its unfortunate political and religious dissensions and misarrangements, that it has permitted itself to be outstripped in the race of improvement by England. Yet under all its backwardness, in many points France forms a great nation, well deserving of the sympathy and respect of its neighbours; and it is greatly to be desired that in future a good understanding should subsist between it and Great Britain.

France is situated between latitude 42° 20′ and 51° 5 N., and longitude 3° 51′ E. and 9° 27′ W., comprising an extent of 213,800 square miles, with a population, according to official returns, in 1827, of 31,851,545. It is bordered on the north-east by the Low Countries, the Prussian province of the Lower Rhine, and Rhenish Bavaria; on the east, it is separated from Baden by the Rhine, and touches Switzerland and Sardinia; on the south, its boundaries are the Mediterranean, the Pyrenees, and the Bidassoa; the ocean bounds the rest. The island of Corsica, and the Hières, in the Mediterranean, and the Isles of Oleron, Ré Noirmoutier, Belle-Isle, Dieu, and Ushant in the Atlantic, belong to France. The foreign possessions are of little value. They are in Asia, Pondicherry and Karical on the Coromandel coast, Yanaon in the Northern Circars, Chandernagore in Bengal, Mahe on the Malabar coast, a factory at Surat, and some factories in Arabia, containing in all 179,000 inhabitants, in Africa, Senegal, Goree, the Isle of Bourbon, and some factories, containing 93,000 inhabitants; in America, Martinique, and Gaudaloupe with its dependencies, Guiana, and the small islands of St. Pierre and Miquelon, near Newfoundland, containing 225,000 inhabitants. The territory is divided into 86 departments, which generally derive their names from the rivers. They are subdivided into 363 arrondissements, 2844 cantons, and 38,339 communes. Each department is governed by a prefect and each arrondissement by a subprefect. The cantons have no administrative powers. The communes are under a mayor. The provincial officers generally are appointed by the home minister, only those of towns under 5000 inhabitants being appointed by the prefect.

The principal mountains of France are—1. The Vosges on the north-east. They are of a rounded outline, with gentle slopes, and afford much open pasturage. The highest summit is not more than 4500 feet high. 2. The Jura mountains lie to the south of these, and their summus rise to the height of 6000 feet. 3. Many Alpine branches intersect Dauphiny and Provence. In the centre of the kingdom are—4. The mountains of Auvergne, of volcanic origin, of which the Puy de Dome, the Monts d'Or, and the Cantal, are the most conspicuous. 5. The Cevennes lie to the south-east of the range last mentioned. Their highest summit is Mont Lozère (about 6510 feet). 6. The Pyrenees form the principal part of the boundary between France and Spain. These mountains divide the country into four great basins, the form and exposure of which necessarily have a great influence on their climate and productions. The narrow valley of the Rhone runs from north to south, while the open basins of the Seine, the Loire, and the Garonne, stretch in a north-western direction. The Adour rises in the Pyrenees, and washes the walls of Bayonne. The other rivers are principally tributaries. The Marne and the Oise fall into the Seine; the Allier, the Loire, the Sarthe, and the Mayenne, into the Loire; the Rhone receives the Saône, the Isère, the Durance, the Ain, and the Sorgue; the Tarn and the Dordogne join the Garonne. The numerous branches of these rivers are joined by canals, which form an extensive internal water communication.

In respect to soil, the richest part of France is the northern division, comprehending the provinces of Flanders, Artois, Picardy, Normandy, and the Isle of France, where there is a deep rich loam; about 18,179,590 acres in extent. The valley of the Garonne is composed of a friable sandy loam, with a calcareous mixture, and moisture sufficient for every purpose. This district contains 7,654,561 acres. The great valley of Languedoc is extremely prolific, though the soil is not so fine as that of the preceding districts. The Limagne, a valley of Auvergne, is considered to have one of the finest soils in the world. It consists of beds of earth, said to be twenty feet deep, formed from the decomposition of soft basalt. The calcareous and chalk formations are extensive. The chalk provinces are unfruitful in grain, but the genial influence of the sun allows them other riches. The calcareous loam on the borders of the chalk formation is more productive. The Bretagne, Anjou, and Maine, are immense heaths. The *landes* are extensive tracts of sandy deserts, producing nothing but broom, heath, and juniper. The most extensive are the landes of Bordeaux, twenty leagues in length by twelve in breadth. In the remaining provinces, gravel, or a gravelly sand, is the predominating soil. The woods and forests are estimated to cover a space of 18,795,000 acres. The principal are those of Ardennes, Orleans and Fontainebleau. The northern and western coasts are formed in a great proportion by immense downs and sandbanks; and where the shores are formed by cliffs, they are seldom bold enough to be approached with safety. The harbours are therefore few. On the Mediterranean, the coast of Languedoc is very dangerous, but Provence abounds in good harbours. The culture throughout the northern half of the kingdom, consists of wheat, barley, oats, pulse, and, of late much more than formerly, of potatoes; in the southern half, corn (particularly maize), vines, mulberries, and olives. The eastern parts, being more elevated than the western, have more rigorous winters and more ardent summers. Coal and iron are found in abundance. The most common fuel is wood.

The superficial extent of France has been recently estimated by Baron Dupin at 53,533,426 hectares, or 132,694,000 English acres. The amount of capital invested in agricultural pursuits is estimated at 37,522,061,476 francs; the gross annual produce at 4,678,708,885 francs; the expenses of cultivation at 3,334,005,515; leaving a profit of 3½ per cent. on the capital. The produce of wheat in the best cultivated districts, and on the best soil, hardly exceeds eighteen bushels per acre: an English farmer expects twenty-five on the same extent. In 1812, the number of horses in France was 2,176,000; but in 1819, the horses and mules together amounted only to 1,657,671; at present the number is estimated at 2,500,000. The number of horned cattle is 6,973,000; of sheep, about 45,000,000. The total number of all kinds of poultry is about 51,600,000. The French are the best wine-makers in the world. The Champagne, Burgundy, Claret, Hermitage, are universally celebrated. For a long time, the choicest growths were in the hands of the church; and in the frequent changes of property which have taken place since the Revolution, many vineyards have deteriorated in consequence of bad management. The brandies of France are believed to be unrivalled. The value of the whole produce of wine and brandy is about 800,000,000 francs. The culture of the vine is supposed to have increased nearly one-fourth since the Revolution, owing principally to the small proprietors, each of whom endeavours to supply his own consumption by a little patch of vineyard. M. Dupin says that many hectares of French territory are yet uncultivated, merely for want of cattle to stock and manure them; that two-thirds of the inhabitants are without animal food; that more than one-third subsist entirely on oats, buckwheat, rye, chestnuts, or potatoes, and that the agricultural population is too great for the prosperity of France. Two-thirds of the population is agricultural.

France possesses a soil and climate capable of furnishing her with all the raw materials of manufacture except cotton. The manufacture of fine woollen cloths at Sedan was introduced under the auspices of Colbert. The machinery used was very defective until M. Chaptal engaged an English machinist to instruct the French artisans. Steam-engines are rare; the spinning-mills being worked chiefly by water or by horses. The quantity of native wool manufactured in 1819 was 38,000,000 kilogrammes (of about 2⅕ lbs. each), and, in 1826 42,000,000, with 8,000,000 of imported wool; the value of the manufactured articles was 265,000,000 francs; of the raw wool, 105,000,000: the quantity exported was about one-thirteenth of the whole quantity manufactured. By the exertions of Henry IV., the mulberry-tree was cultivated in all the southern provinces. At Tours, silk stuffs for furniture are chiefly manufactured; at Ganges, and other places in the Cevennes, silk stockings. Lyons is the principal place for silk manufactures of all kinds. Paris ranks next after Lyons. In 1812, the value of the raw material amounted to 45,560,000 francs, of which 22,000,000 were the price of imported silk. The value of manufactured goods, at the same period, was 107,560,000 francs, of which less than one-third was exported. Forty years ago, the spinning of cotton by machinery was hardly practised in France. Cotton mills have been established within that period, and the manufactures of Alsace are now superior to those of England in the brilliancy of their colours. In 1812, 10,362,000 kilogrammes of cotton were spun by machinery; and in 1825, 28,000,000 of greater fineness. The cambrics, gauze, and lawn of St. Quentin, Valenciennes, and Cambray are among the most valuable products of French industry. Lace is made in great quantities.

The whole produce of the linen and hemp manufactures is estimated at 200,000,000 francs. In 1814, 100,000,000 kilogrammes of cast-iron were produced; in 1825, 160,000,000. Gilding and watch-making are carried on, chiefly in Paris, to the annual value of about 38,000,000 francs each. Printing also employs a great number of persons at Paris. In 1814, the number of printed sheets was 45,675,039; in 1820, 80,921,302; and in 1826, 144,561,094. Notwithstanding the low price of labour in France, the industry of that country cannot enter into competition with that of England. One of the circumstances which depress it is the want of internal communication by roads and canals. The practicable roads of France are not more than one-third of the extent of those of England. The cross-roads are few, and the great roads are seldom kept in good order. The length of the canals in France is not more than one-eleventh of those of England. Another point in which France is inferior is in the use of steam-engines, attributable in part to the deficiency of coal, or the difficulty of transporting it. The total force of steam-engines in France is reckoned to be equal to that of 500,000 men; that of England is equal to a power of 8,000,000 men. All the power derived from machinery of every sort, or from constructive ingenuity, and applied to purposes of industry in France, is only one-fourth of the similar power employed in England.

The commerce of France has been very much diminished by the loss of her colonies. The value of the colonial imports, in 1788, was 227,000,000 francs; in 1824, it was only 50,000,000. The exports for 1788 amounted to 119,000,000; in 1824, to 44,000,000. The total value of exports from France in 1824 was 440,542,000 francs; of which 163,056,000 were productions of the country, and 277,486,000 manufactured articles. The amount exported to the United States was 55,000,000, being more than that to any other country. The imports for the same year were of the value of 454,861,000 francs; of which 272,873,000 francs were raw materials for manufacture, 121,957,000 natural productions for consumption, and 60,030,000 manufactured articles.

The French are descendants of the Roman provincials and ancient Gauls, and hence their language is a mixture of modified Latin and the tongue of the original inhabitants, but much altered in orthography and in tone of speech in modern times. The kingdom was for many centuries governed in a despotic manner by a line of sovereigns of different dynasties, from Clovis, in the year 481, to that of the Bourbons in the person of Louis XVI., 1793. One of these monarchs, Louis XIV., who reigned during the latter half of the seventeenth century, exhausted the resources of the nation in foreign wars and personal extravagance, and, besides, greatly corrupted the manners of the people. This laid the foundation of a course of events which terminated in the national ruin and fearful outbreak of the Revolution in 1789. This revolution deluged the country in blood, and ended with the establishment of a republic; but this was speedily succeeded by the elevation of Napoleon Bonaparte, first as consul, and next as emperor. The career of Napoleon closed in 1815, with the battle of Waterloo, and the Bourbons were restored by the arms of Britain and other nations. The Bourbons were expelled in 1830, since which period the reigning monarch has been Louis Philippe, a descendant of the brother of Louis XIV., and in whose male descendants the monarchy is hereditary.

On the establishment of the present limited monarchy in 1830, the national constitution was reorganized on the following footing:—The king is the supreme head of the state; he commands the land and sea forces, declares war, makes treaties of peace, alliance, and commerce; appoints to all offices of the public administration, and makes all the regulations and ordinances necessary for the execution of the laws under the responsible advice of his ministers. Any of the three branches of the legislature can propose laws; the Chamber of Peers may sit without that of the Deputies only as a court of justice; peers may speak in the house at the age of twenty-five years; princes of the blood may sit in the House of Peers without a special summons from the king; the deliberations of the peers are public; the renewal of one-fifth of the deputies every year is abolished; persons are eligible as deputies at the age of twenty-five years; the deputies elect their president without the concurrence of the king; and the electors choose the officers of the electoral colleges without the interference of the king; articles 46 and 47 of the old charter, respecting amendments, and the adoption of the tax acts by the deputies, previously to being sent to the peers, are repealed; as is also article 56, exempting the ministers from impeachment, except for treason or extortion; the *prevôtal* courts are abolished; the king takes the constitutional oath, not at the time of the coronation, but on his accession, as in England. Besides this, provision is to be made, by separate laws, for—1. The trial of offences of the press by a jury; 2. The responsibility of ministers, and other agents of power; 3. For the re-election of deputies promoted to offices with salaries; 4. The annual vote of supplies for the army; 5. The organization of the national guard; 6. The settling the rank of all naval and military officers; 7. Departmental and municipal governments founded on the elective system; 8. Public instruction provided for; liberty of teaching allowed to all; 9. The abolition of the double vote, and of the electoral candidates and their eligibility. The charter is intrusted to the protection of the national guard, and the patriotism of the nation. The charter, with the "changes and modifications expressed in the declaration of the Chamber of Deputies," was presented to Louis Philippe, who, on the 9th of August, 1830, took the constitutional oath; and thus the *constitution octroyée* was changed into a real contract between the ruler and the people.

By the letter of these provisions, France possesses a free constitutional government; but such is the influence of the executive, that, practically, the people enjoy much less liberty than the British. So unsettled, likewise, is the system of things, that a large standing army and militia force (National Guard) has to be maintained, at a heavy expense and inconvenience to the nation. In 1837, the army amounted to 300,000 men. The national expenditure in 1838 was about £44,000,000, to which the revenue was inadequate: the national debt at the same time amounted to 254,566,496 francs. The French navy, in 1836, consisted of 49 ships of the line, 62 frigates, 31 corvettes, 49 brigs, and with other vessels amounted to a total of 321.

Previously to the revolution of 1789, the Roman Catholic was the established religion, and the country contained a vast number of monasteries and convents. Latterly, since 1830, there has been no established church, but the Roman Catholic worship predominates, and is adhered to by the reigning family. In 1836 there were 14 archbishops, 66 bishops, 174 vicars-general, 660 canons, 3401 curés, 27,776 desservans, and 6184 vicaries—total of clergy, 37,275. The bishops have each about £600 a year of salary, and the working clergy from £20 to £60 each. There are about 1,000,000 of Protestants in France. The entire cost to the state of religious establishments, Roman Catholic, Protestant, and Jewish, amounted in 1838 to 35,443,500 francs. With respect to education, France at present possesses 26 universities, 363 high-schools, or academies, in the large towns and districts, 73 normal schools for training teachers, 873 boarding-schools, 36,000 elementary schools for boys, and 11,000 elementary schools for girls. The whole are under the supreme direction of the minister of public instruction; and the total cost in 1838 was, 19,005,673 francs, or nearly £800,000.

France possesses a considerable number of towns, with populations of from five to thirty thousand, and more particularly about twelve thousand, but not many of any consequence with a larger amount of inhabitants. Paris, the capital, in 1827, had a population of 890,531, which is about half the amount of the population of London. The other chief towns are Lisle, with a population of 69,860; Rouen, 90,000; Strasburg, 49,708; Nantes, 71,739; Boulogne, 19,314; Havre, 21,049; Rheims 34,862; Brest, 26,655; Cambray, 17,031; Lyons, with suburbs, 170,875; Marseilles, 115,943; Toulon, 30,171 Aix, 23,132; Grenoble, 22,149; Clermont, 30,010; Besançon, 28,795; St. Etienne, 30,615; Dunkirk, 24,517;

Amiens, 42,032; and Orleans, 40,340. The chief port in the north of France is Havre, on the English Channel, and Marseilles and Toulon are the principal outlets on the south. In point of capability for maritime trade, France is far inferior to Great Britain, from its want of good harbours, though perhaps that circumstance is of less consequence than the peculiar genius of the people, which is adverse to naval adventure.

Paris, the capital, is a beautiful city, built of white sandstone, situated on a flat ground, on both banks of the river Seine. Here reside the most learned and accomplished men in France, and also the court of the king in the palace of the Tuileries. At a few miles' distance is Versailles, a royal residence of extraordinary extent, built by Louis XIV., and since considerably improved. Paris has been long distinguished as a place of residence of literary and scientific characters, and in the present day is the place of publication of an immense quantity of books in all departments of literature; it is likewise celebrated as a depôt for works in the fine arts, as painting, engraving, and sculpture, in which it is superior in many respects to London. The character of the French people has usually been represented as exceedingly frivolous, but in this there has been much exaggeration; and it is certain that in recent times they have demonstrated an anxious desire for improvement in the useful arts, and for a settled form of government.

SPAIN AND PORTUGAL.

Spain, or the Peninsula, as it is frequently called, is an extensive country, occupying the south-western extremity of Europe between latitude 36° and 44° N., and is surrounded by the Atlantic Ocean and the Mediterranean Sea, except on the north-east, where part of the Pyrenean chain of mountains form its boundary with France. In its dimensions, this country extends 700 miles in length by 500 in breadth, forming an area of 350,000 square miles. Portugal, afterwards to be mentioned, lies like a patch on the side of the Peninsula, facing the Atlantic. Spain, proper, is divided naturally into two unequal compartments, one of which includes the central region, and the other that of the coast. Spain is essentially mountainous. It consists chiefly of extensive plains traversed by lofty ridges, towering to a height of from eighteen hundred to two thousand feet. There are comparatively few trees in the country, and the air being dry, the number of rivers is not great. The principal are the Ebro, Douro, Tagus, Gaudiana, and Guadalquiver; but from the bad system of things, they are not put to their full uses for navigation and trade. On the lower parts of Spain, particularly on the east, the climate is delightful, but in the high central plains the heat is as intense in summer as the cold is piercing in winter. The productions of Spain are rich and various. Iron, tin, copper, quicksilver, and indeed every valuable mineral, abound in the Peninsula. There are also a number of coal and salt mines. Wheat of the finest quality is produced in most of the provinces. The other principal productions of the soil are oats, barley, maize, rice, oil, honey, sugar, hemp, flax, cork, cotton, silk, and barilla; the wool, as is well known, is of a very superior quality. There are many fine fruits grown, as figs, oranges, pomegranates, lemons, &c. Among the animal productions, the horse of Andalusia, a province on the Mediterranean, opposite Africa, is esteemed among the finest in the world. The sheep are millions in number; and the sea-coast supplies abundance of fish.

The country is divided into 14 provinces or districts, as follows:—Navarre; Biscay; the Austurias; Galicia; Arragon; Catalonia; Leon; Old Castile; New Castile; Estremadura; Valencia; Andalusia, including Cordova, Seville, and Granada; Murcia; and the Balearic Isles in the Mediterranean. The capital, and seat of the cortes or parliament, is Madrid, in the province of New Castile, at the centre of the kingdom. Population in 1825, 201,344. The principal seaport is Cadiz.

About the beginning of the present century, the population of Spain amounted to 10,409,079 individuals, among whom were the following classes:—Beginning with the religious bodies, there were 148,242 clergy and monks, and 32,000 nuns, exclusive of about a fourth of the population living on their property without doing any thing; there were 100,000 individuals existing as smugglers, robbers, pirates, and assassins, escaped from prisons and garrisons; about 40,000 officials appointed to capture these, and having an understanding with them; nearly 300,000 servants, of whom more than 100,000 were unemployed and left to their shifts; 60,000 students, most of whom begged, or rather extorted, charity at night; and if to this melancholy list we add 100,000 beggars, fed at the doors of monasteries and convents, we shall find that there existed in Spain nearly 600,000 persons who were of no use in agriculture or the mechanical arts, and who were only calculated to prove dangerous to society. Having made these, we find there then remained 964,571 day-labourers, 917,197 peasants, 310,739 artisans and manufacturers, and 34,339 merchants, to sustain by their exertions upwards of ten millions of inhabitants. These results, which are as applicable at the present day, when the population has increased to about 14,000,000, as at the time when they were deduced, exhibit a state of society so radically corrupt and debased, as to render all hopes for its regeneration very nearly desperate. Lately, on the death of Ferdinand, the reigning monarch, the queen, in the capacity of regent, made a powerful attempt to establish constitutional government, which was the first step towards practical reform of abuses. Her daughter Isabella, according to the will of Ferdinand, was proclaimed queen whereupon ensued a civil war betwixt her forces and those of her uncle Don Carlos, who wished to assume the sovereignty. This war has greatly injured Spain and what its results may be no one can foretell.

Portugal, which lies on the western frontier of Spain, facing the Atlantic, and measures 41,500 square miles in extent, is an ancient small kingdom, intimately resembling Spain in almost every particular, and at present in much the same unsettled condition. The country possesses two fine rivers, the Douro, which forms the great maritime emporium of Oporto, and the Tagus, which is that of Lisbon, the capital. Portugal is rich in natural productions, but wants the cultivation of industrious hands. The rich mines of precious metals are now neglected, on account of want of hands and fuel. The chief source of profit is in the fruits, which are exported in abundance, particularly the orange and grape. Wines of several sorts, port and sherry in particular, are produced, and exported chiefly to England. Agriculture, commerce, the arts, every thing in short, is neglected in Portugal, which in the present day is a miserable poverty-struck country. Like Spain, it is eaten up by clergy, secular and regular; and these classes have moreover rendered at least a third part of the year holidays, greatly to the loss of the nation. The late Don Pedro, father of the present queen Maria, had the address to abolish the monastic institutions, and to sequestrate the property to the state, which was an important measure of national regeneration.

The assumption of sovereignty by Maria led to a civil war or contest betwixt her forces and those of her uncle Don Miguel, which was most injurious to the country Miguel was ultimately defeated and expelled. The population of Portugal was stated in 1826, at 3,214,000.

ITALY.

Italy, once the seat of the Roman empire, but which, since the overthrow of that power, has never formed an independent whole, is a narrow peninsula, extending from the Alps (46° to 38° N. lat.) into the Mediterranean Sea, which on the east side of Italy is called the Adriatic, on the west, the Tuscan Sea. The Apennines, rising near the maritime Alps, are the principal chain of mountains, and stretch through the country, dividing Lombardy from the Genoese territories and Tuscany, and Tuscany from Romagna, intersecting the states of the Church, and running through the kingdom of Naples to the Strait of Messina. Upper Italy (Lombardy) is remarkably well watered. The Po, which receives a great number of rivers from the large lakes at the foot of the Alps (Lago Maggiore, di Lugano, di Como, d'Iseo, and di Garda), and the Adige, are the principal rivers. They both rise in the Alps, and flow into the Adriatic Sea. In Middle Italy (Tuscany and the states of the Church) are the Arno and the Tiber, which rise in the Apennines, and flow into the Tuscan Sea. In Lower Italy (Naples) there are no large rivers, on account of the shortness of the course of the streams from the mountains to the sea: the Garigliano is the principal. The climate is warm, without excessive heat, and generally salubrious. The winter, even in Upper Italy, is very mild: in Naples it hardly ever snows. The abundance and excellence of the productions of the soil correspond with the beauty of the climate. In many places both of the north and south there are two, and even three, crops a year. The volcanic character of the coasts of Lower Italy is particularly remarkable in a geological point of view, especially in the region of Puzzuoli and Vesuvius. The neighbouring islands of the Mediterranean are distinguished by the same character. The present number of inhabitants is much inferior to the former population of this delightful country, the total amount being 21,.97,500.

The national character of the Italians, naturally cheerful, but always marked by strong passions, has been rendered, by continued oppression, dissembling and selfish. The Italian, moreover, possesses a certain acuteness and versatility, as well as a love of money, which stamp him for a merchant. In the middle ages, Venice, Genoa, Florence, and Pisa, were the chief marts of the European commerce with the East Indies; and Italians (then called Lombards, without distinction, in Germany, France, and England) were scattered all over Europe for the purposes of trade. The discovery of a passage by sea deprived them of the India trade, and the prosperity of those republics declined. The Italian, restricted almost solely to traffic in the productions of his own country, has nevertheless always remained an able and active merchant. Before Rome had (2100 years ago) absorbed all the vital power of Italy, this country was thickly inhabited, and for the most part by civilized nations. In the north of Italy alone, which offered the longest resistance to the Romans, dwelt a barbarous people, the Gauls. Farther south, on the Arno and the Tiber, a number of small tribes, such as the Etrusci, the Samnites, and Latins, endeavoured to find safety by forming confederacies. Less closely united, and often hostile to each other, were the Greek colonies of Lower Italy, called Magna Grecia. The story of the subjection of these nations to the Roman ambition, belongs to the history of Rome. Italy, in the middle ages, was divided into Upper, Middle, and Lower Italy. The first division comprehended all the states situated in the basin of the Po; the second extended between the former and the kingdom of Naples, which formed the third.

Italy is in modern times cut up into a number of distinct states, partly independent, with native princes, partly under the rule of Austria, and a portion under the civil sway of the head of the Romish church. Throughout the greater part of this fine country the system of police is wretched, and robbery is exceedingly common; commerce, agriculture, and the useful arts, are in a low condition; bigotry prevails, and the national character is reduced to the lowest moral standard. The most civilized and best governed part of Italy is Tuscany which differs very materially from the adjacent states. In the present day, Italy is only celebrated for its music, and its collections of works in the fine arts. The following sketch gives a view of the amount of population in the five great divisions into which Italy is partitioned:—

The population of the states of the Church is about 2,600,000. The capital is Rome, the seat of empire of the ancient Romans, but now greatly altered in figure and appearance, and completely changed in character; this venerable city possesses a population of 150,000 The other chief towns are—Bologna, with a population of 65,000; Ancona, 30,000; Perugia, 30,000; Ferrara, 24,000; and Ravenna, 24,000. There are other eight towns, with a population of from 7000 to 14,000.

The duchy of Tuscany, in 1826, had a population of 1,275,000 inhabitants. The capital of this state is Florence, the population of which amounts to 80,000. The other chief towns are—Leghorn, 66,000; Pisa, 20,000; Sienna, 18,000; Prato, 10,000; Pistira, 9600; Avezzo, 7000; and Crotona, 5000.

Austrian Italy, or the Lombardo-Venetian kingdom, which consists of the great plain of the Po, is subdivided into the governments of Milan, Venice, Parma, and Modena. The chief towns of the state of Milan are—Milan, 151,000; Brescie, 31,000; Cremona, 26,000; Mantua, 25,000; Pavia, 21,000; Lodi, 18,000; and Como, 7600. The chief towns in the state of Venice are—Venice, 101,000; Verona, 48,000; Padua, 35,000; Vicenza, 19,000; Udina, 18,000; Treviso, 15,000; Belluno, 8000, and Rovigo, 7000. The state of Parma has the town of Parma, 30,000; Placentia, 28,000; and Guastalla, 5000. The state of Modena possesses the town of Modena, 27,000; Reggio, 18,000; and Mirandola, 6000.

The Sardinian States are composed of Piedmont, Genoa, Savoy, and the Island of Sardinia, the whole of these divisions having a population of 3,831,350. The principal town and sea-port in this district is Genoa, which possesses a population of 80,000 inhabitants.

The fifth division of Italy is composed of the states now included in the kingdom of the Two Sicilies. This forms the southern, and perhaps the finest portion of the Italian peninsula, and branches out into the two smaller peninsulas of Otranto and Calabria. Naples is the chief town, with a population of 354,000 inhabitants, being thus the largest city in Italy. Naples is famed for the beauty of its environs, particularly the bay on which it is situated, and for the exceeding fineness of its climate. Sicily, an island belonging to the kingdom of Naples, measures 180 miles long by 150 in breadth, and is one of the most beautiful islands of Europe. It is chiefly distinguished for its celebrated volcano, Mount Etna. Malta, an islet in the Mediterranean, about fifty-four miles to the south of Sicily, now belongs to the British government.

RUSSIA.

The Russian empire stretches over the half of Europe, and the whole of Northern Asia, from the Baltic to the Pacific, and includes vast territories on the north-western coast of North America. It lies between lat. 38° and 79° N. It is bounded on the north by the Northern or Icy Ocean, west by Norway, Sweden, the Baltic Sea, Austria, and Prussia, and south by Turkey, the Black Sea, Persia, the Caspian Sea, Independent Tartary, and China. The total superficial area is estimated at 8,000,000 square miles, of which about 1,500,000 are situated in Europe, and 5,600,000 in Asia. The Russian dominions compose about one-seventh of the habitable globe. The surface of Russia is generally level, and some tracts of land of this flat nature, frequently bleak and barren, are called steppes. The country also possesses chains of lofty mountains in different quarters. Russia raises vast quantities of corn, which it exports; and it produces fruits and wine in abundance. The forest also yields important articles of export. Cattle of all kinds, horses, and sheep, are likewise bred in immense numbers, chiefly for the exportation of their skins. The mines of the country are productive of platina, zinc, copper, quicksilver, alum, and salt, all of which are continual sources of revenue. Russia possesses various rivers of the first magnitude, and canals are in the course of establishment on a considerable scale.

The population of Russia, including Poland and Finland, is 57,000,000, of nine different races:—1. Slavonians 44,000,000, including the Russians (42,000,000, among whom are the Cossacks, about 600,000 capable of bearing arms) and the Poles; 2. Finns, who are scattered over the country, from Tornia and the Niemen to the Obi (3,000,000); 3. Tartars, from the Dniester to the Caucasus (2,000,000), mostly under their own government, without agriculture or fire-arms; 4. Georgians or Circassians (2,000,000); 5. Samoiedes; 6. Mantchoos; 7. Mongols, to whom belong the Calmucks; 8. Eastern tribes (including Tchutsches, Kuriles, and Aleutians); 9. Jews, particularly in the Polish provinces. Besides these races, there are natives of almost all countries of Europe and Asia, as Greeks, Arabs, Hindoos, Gipsies, French, English, and Danes. There are among these Russian subjects eighty tribes, differing in language, religion, and manners from the rudest state of barbarism to the highest degree of European civilization. The population is divided into four classes, the nobility, clergy, common people or freemen, and peasants or serfs. In 1811, the number of persons subject to do military duty was as follows:—643,135 persons engaged in trade; 6,389,269 crown peasants; 10,113,177 peasants belonging to individuals; 1,077,636 appanage peasants; 112,453 freemen; in all, 18,335,730 men. We find manufacturers of leather, tallow, candles, soap, felt, coarse linen, mats of the bark of the linden tree, hardware and the art of dyeing, among the Russians, before the time of Peter the Great; but since his reign these have been carried to much greater perfection, and many now manufactures have been introduced. In 1815, Russia contained 3253 manufacturing establishments; twenty-three of these deliver to the government annually cloth of 700,000 roubles in value, and there are, besides, one hundred and eighty-one private establishments. Drugs are prepared in forty-tivo laboratories; and there are distilleries of brandy, of which 120,000,000 gallons are consumed in the country. Ship-building is carried on in the large villages on the Wolga and in the sea-ports.

The government is an unlimited monarchy; the emperor is autocrat of all the Russians; the state is indivisible; the ruler cannot be, at the same time, ruler of any other country (since 1815, however, he has been king of Poland), and must be of the Greek religion. In 1797, the succession was settled in the male line, by the rules of primogeniture, and, in failure of males, in the female line. All the princes of the blood are called grand-princes. By the ukase of March 20, 1820, it was declared that only the children of a marriage acknowledged by the emperor are capable of succeeding to the throne. The highest councils are, 1, the imperial council, under the presidency of the emperor, erected January 1, 1810, with four departments—that of legislation (the supreme tribunal in civil and ecclesiastical suits), that of war, that of civil and ecclesiastical affairs, and that of finance; 2, the senate, for home affairs (a deliberative body, consisting of eight departments, three of which have their seat in Moscow); 3, the holy synod; 4, the ministry of state. The ministers have a seat and voice in the imperial council and in the senate. The ministry is divided into three sections—that of foreign affairs, war, the marine, the home department, ecclesiastical affairs, education, and finance; that of the imperial treasury; and that of the public accounts, roads and canals, and justice. The whole state is divided into fifty-one governments and several provinces; of these forty are in Europe, exclusive of the Cossacks of the Don, the Cossacks of the Black Sea, and the kingdom of Poland. The military force of Russia is exceedingly great, yet nothing to excite any dread. By some accounts it is stated as having totally amounted to 870,000 men; but a vast proportion of this force is composed of irregular militia, or armed slaves. It is considered by recent writers on the subject, that the utmost amount of regular force which Russia can bring into the field is 150,000 men, infantry, cavalry, and artillery. It is indisputable that Russia has no pecuniary resources to support a large army long in the field, and therefore any fear expressed by European powers on this score is ridiculous. The principal dependence of Russia is upon England, and a quarrel with the British government would most likely lead to a serious commotion in the state. The prevailing religion is that of the Greek church, with a full toleration of all religions. The state of society is a strange mixture of refinement and barbarism. The population is composed of four different classes, as has already been mentioned. The boors or peasants are the property of the crown or of individuals; they amount to about 35,000,000, and are in a state of great poverty. They are sometimes emancipated by their owners, and are sometimes permitted to purchase their freedom. The noble families are about 150,000, comprising 750,000 individuals, and enjoy some privileges and exemptions. The freemen, not nobles or clergymen, are divided into six classes—the inhabitants of cities, the three guilds (capitalists, according to their income tax), the trades, foreigners or strangers, the notable citizens (*savans*, artists, bankers), and the colonists. In regard to rank, these classes form fourteen gradations; and all who can claim either of the eight highest are considered as noble. Distinction of any kind, however, is only gained by the possession of a superior military rank.

Debased as Russia is, it has recently made great advances in civilized usages. Science, literature, and the arts, are highly cultivated, and liberally endowed. The Russians, it seems, have not much original genius, but they are the best imitators in the world, and quickly adopt foreign manners, language, and improvements. The wretched system of territorial slavery is gradually disappearing, and the peasants are now more protected by the laws than formerly. The punishment of criminals is also becoming more lenient. Russia possesses a number of towns of from 10,000 to 30,000 inhabitants. Petersburg, the capital, has a population of 425,000, and Moscow 240,000. Petersburg, which is built upon the flat banks of the Neva, is considered to be in appearance the most splendid city in the world.

GERMANY.

Germany as it is called by the English, l'Allemagne by the French, and Deutschland by the natives themselves, is a large territory extending from the Baltic Sea on the north to the Gulf of Venice on the south, having Hungary and Russia on the east, and France and the Netherlands on the west. At its south-west corner it is touched by Switzerland. This immensely large territory occupies the bulk of the centre of Europe, and consists of an area of 250,000 square miles. The most remarkable circumstance about Germany is its being composed of a considerable number of states, each less or more independent within its own bounds, but externally dependent on the other states of the confederation, as is mentioned already under the head Constitutional Governments. Altogether, there are thirty-four monarchical states, and four free cities, which enter into a confederation as equal sovereigns. For mutual safety they compose a diet or congress, at which each state has a certain number of votes. The principal states of Germany are Prussia and Austria; Saxony, Bavaria, and Hanover, are of lesser dimensions and importance. The others do not require any notice.

In the days of Roman greatness, Germany, or Germania, as it was then called, was inhabited by a barbarous but powerful people, reckless of control, and ambitious of securing the spoils of richer nations. They broke loose at different periods, overrunning Italy and other fair portions of Europe, and, under the general appellation of Goths, finally prostrated the empire of Rome. The term Goth is now used in a contemptuous sense, but it has to be remarked that modern Europe stands indebted for its liberties to the Goths. The free institutions of Germany were carried into England and other countries, where they have since grown and flourished; and in later times the world has received various useful arts from the same source, in particular the art of printing, which transcends all other inventions. In the eighth century, Charlemagne united the Roman imperial crown (a thing merely so in name) with the German empire, and the great territory we are speaking of was thenceforward called the Holy Roman empire of Germany. This empire lasted till its dissolution in 1806; but long before that era Germany had been broken up into states, by the enterprise of its native dukes and princes, and the name empire was little else than nominal. In 1815, the states entered into the confederation which now binds them.

This large confederated country is watered by 500 rivers, of which the principal are the Rhine, the Danube, the Weser, the Elbe, and the Oder. The most southern chain of German mountains is formed by the Tyrolese Alps, the Alps of Algau, and the Carnian and Julian Alps, running from east to west. To the south-east are the Carpathian mountains, to the north-west the Bohemian forest. There are also alpine regions on the Upper Rhine. In Northern Germany there are sandy heaths and moors, and many districts contain fertile strips only along the large rivers. On the whole, the soil is fertile, and the climate in general is temperate and healthy. The number of inhabitants is estimated at nearly 40,000,000, in 2390 towns, of which 100 have over 8000 inhabitants; 2340 market villages; 104,000 villages, and numerous small settlements. Of the inhabitants, there were in 1825, Germans, 27,705,855; persons of Slavonic origin, 5,325,000; Walloons and French, 309,000; Jews, 292,500; Italians, 188,000; Gipsies, 900; and Armenians and Greeks, 900. In the same year, the number of persons of different religious persuasions was as follows: — Roman Catholics, 18,376,300; Protestants, 15,150,500; Jews, 292,500; Greeks and Arminians, 900. It should, however, be stated, that in this enumeration there are in all likelihood many religionists who are altogether unsettled in belief, although ostensibly belonging to some communion; for in no country in the world is there such latitude in thinking upon points of faith. Germany contains 24 universities, which are attended by about 30,000 students—a class of wild young men, having habits and an appearance very different from what usually characterize attendants at colleges in Great Britain. The publishing and reading of books prevail to a great extent in Germany, which is essentially literary in its tastes. There are public libraries in 150 places, with about six millions of volumes. Ten thousand authors produce annually from about 330 to 5000 new books. There are about one hundred political journals, two hundred and twenty other journals, and at least one hundred and fifty periodical publications. Most of the best English productions are regularly translated and printed in Germany. It is curious that, with all this abundance of literature, and the prevalence of education, with also freedom of religious opinion, Germany is far from being a free country It is despotically ruled by great or petty sovereigns, has only here and there the mockery of representative government, and the people in the mass are destitute of the power to better their condition. Germany, from which all our freedom sprang, is itself ranked among the least free of the nations of Christendom.

One of the chief of the small German kingdoms is Saxony, lying in the centre of Europe, and consisting principally of the plain of the river Elbe, in its upper part, with a population of 1,700,000 inhabitants. It is rich in agricultural produce, and feeds about a million and a half of sheep, the wool of which is remarkably fine and valuable. Saxony has various flourishing manufactures, linen and woollen goods being the staple. It also carries on a brisk trade with various parts of the world. The grand centre of its commerce, and indeed that of all Germany, is at Leipsic, one of its chief towns. Here a great fair is annually held, which is attended by merchants from all parts of Europe, and at which, in particular, the sale of books is very great. The most elegant town in Saxony is Dresden, situated upon the banks of the Elbe.

Germany possesses four free cities, acting as independent states within their own bounds, and individually entitled to vote in the Germanic diet; namely, Hamburg, Lubeck, Bremen, and Frankfort-on-the-Maine. The independence of these towns is a remnant of a confederacy of cities, which was established in the thirteenth century, under the name of the Hanseatic League. Besides these four free cities in Germany, the Polish city of Cracow was declared a free city by the general act of the Congress of Vienna, and is under the protection of Russia, Austria, and Prussia. Hamburg, situated upon the Elbe, which flows into the North Sea, is one of the chief commercial and maritime cities of Europe. It possesses a population within its territory of 150,000 inhabitants.

AUSTRIA.

Austria is a monarchy now forming one of the leading powers of Europe, and is usually esteemed the principal of the German states. Only a portion of the territory, however, belongs to Germany. As a government, it includes a number of ancient states, which have been acquired and added in the course of time by a series of ambitious sovereigns. These are (in addition to Austria Proper, composed of Upper and Lower Austria), Bohemia, Moravia, with the alpine regions of Styria, Carinthia, and the Tyrol; several of the Polish provinces, now called Gallicia; the kingdom of Hungary, and the Lombardo-Venetian kingdom in Italy. This great country is governed by an absolute prince, who takes the title of emperor. It comprises more than 256,399 square miles, and upwards of thirty-two millions of inhabitants. Of these it is reckoned that there are twenty-two millions of Roman Catholics, three millions of the Greek church, two millions of Protestants, and half a million of Jews. The military force of the monarchy in 1819 amounted to 270,000 men, independent of militia. Austria numbers 777 cities, 2224 market towns, and 69,105 villages. The most populous cities are Vienna, Milan, Venice, Lemberg, and Padua. The principal sea-ports are Trieste, Venice, and Fiume; other places of trade are Vienna, Prague, Pesth, Lemberg, Brody, and Gratz.

The capital of Austria is Vienna, which is a city of great extent, situated on the Danube, and greatly improved in modern times. Latterly, much has been done in Austria to establish schools and educate the people, by which they may ultimately be prepared for the enjoyment of political freedom. Meanwhile great improvements are taking place in the condition of the nation by the extension of trade and commerce, steam-navigation, roads, &c.

PRUSSIA.

Prussia is one of the most remarkable kingdoms in Europe. It has risen from nothing at the beginning of last century to be one of the principal continental nations. The increase of its size from its original dimensions, as the Duchy of Brandenburg, to the condition of a first-rate kingdom, has been effected by the intrepidity of its people and the military character of its sovereigns, particularly of Frederick II., or the Great. Prussia, as now constituted, lies in the northern quarter of Europe, with the Baltic Sea on the north, and Russia on the east. It comprises the districts or provinces of East and West Prussia, Posen, Pomerania, Brandenburg, Silesia, Westphalia, and the Rhenish provinces; which divisions include the portion of Poland which was taken by Prussia at the partition of that unfortunate kingdom. The aggregate extent of these territories amounts to 106,852 square miles, with a population of 14,000,000, upwards of eleven millions of which are Germans. Prussia is considered to be greatly weakened as a power by its large scattered extent of territory. The kingdom has three vulnerable parts, towards Russia, Austria, and France; hence its situation is dependent. It is compelled to keep up a large military force, consisting of 180,000 regular troops, with so large an addition of irregulars, as make up in all nearly half a million of soldiers. The king of Prussia is an absolute monarch, yet he is surrounded by a spirit of freedom which necessarily influences his actions. One of the most striking features of this monarchy is the care which it bestows on science and education. The sciences are nowhere fostered with more care, and there are few countries in which common schools are more widely diffused. (See our article EDUCATION.) Prussia carries on some maritime trade by means of the Baltic, and its inland trade is promoted by the rivers Oder, Vistula, Elbe, and Saale, the Rhine, Memel, Pregel, Warta, Netze, Hanel, Spree, Weser, Moselle, &c., which either flow through Prussia, or belong to it. Nine and a half millions of the inhabitants of Prussia are of the Reformed Church, and four and a half millions are Catholics.

SWITZERLAND.

Switzerland is a mountainous territory, occupying the alpine regions betwixt France and Germany, and having Italy on the south. This beautiful and romantic country has, from time immemorial, been occupied by a hardy and independent race of inhabitants, mostly attached to republican forms of government, and always ready to defend their rights and their country from the aggression of the great powers in the neighbourhood. Switzerland measures about 300 miles in length by 140 in breadth, and is supposed to contain 19,000 square miles. Politically, the country is divided into twenty-two small states or cantons, generally independent of each other, but confederated for purposes of mutual protection. Some states are more free in their forms of government than others. The total population amounts to two and a half millions, of which upwards of one-half are Protestantr, and the remainder chiefly Roman Catholics and Jews. The German language is used in most cantons.

Geneva is the smallest but most populous state in proportion to its size, and in this canton is situated the town of Geneva, upon a beautiful lake of about fifty miles in length and eight or ten in breadth. The highest mountains of Switzerland are found in the cantons of Uri, Berne, Underwalden, and Grisons. Of about sixty Swiss mountains which have been measured the highest is Monte Rosa, 15,535 feet high; the lowest, Chalet, is 3000 feet high. Mont Blanc, within the limits of Savoy, is the highest mountain in Europe, being 15,668 feet high. The mountains of Switzerland are pastoral in their lower parts, and in many instances covered at top with perpetual ice, the icy coverings being here characteristically named *glaciers*. The continual alternation of hill and dale affords the most striking natural scenes in every part of Switzerland. In some places, within a short distance, one may see at the same time all the seasons of the year; and it is often possible to stand between spring and summer, so as to collect snow with one hand, and to pluck flowers from the soil with the other. Every mountain has its waterfalls; and as their sources are sometimes lost in the clouds, the cataracts seem to descend from the skies. Switzerland abounds in lakes and rivers, the fisheries of which are valuable, and which serve to embellish the landscape, but none of the rivers are navigable. Small steam-vessels now ply on the lakes of Geneva, Zurich, Constance, and Neufchatel, and are a great convenience to travellers. The chief rivers are the Rhine, the Reuss, the Rhone, and the Tessino. The cultivation of the vine is carried on to a considerable extent in Switzerland; the breeding of cattle is, however, the chief employment of the inhabitants. Swiss cheeses are imported in great numbers into Germany, France, and Italy.

Manufactures of silk, cotton, and linen, have of late years greatly increased in Switzerland, which is rivalling England in some kinds of goods, particularly printed calicoes. Recently great improvements have been made upon the roads through this attractive territory, and travellers are now well accommodated on all the main routes.

The people of Switzerland form one of the best educated, most industrious, and best behaved nations in the world; and consequently they are generally happy and in good circumstances. Although the country does not anywhere touch the sea, and all goods have to be carried many miles by land journey through other states, the Swiss possess a thriving system of trade and commerce, and are rapidly advancing in a career of national prosperity, thus proving that nothing is denied to good conduct and industry.

NORWAY, SWEDEN, AND DENMARK.

These, with the province of Finland, form the north-western frontier of Europe, facing the North Sea or German Ocean, and reaching to the shore of the Baltic on the south. Norway lies on the shore of the North Sea, Sweden is behind it with its southern extremity to the Baltic, and Denmark is formed by the peninsula of Jutland, projected northwards from the Netherlands and Kingdom of Hanover into the mouth of the Baltic. Norway and Sweden are now erected into a kingdom, under one sovereign, much in the same manner as England and Scotland are united. Bernadotte, one of Bonaparte's commanders, has for a number of years been the reigning monarch. The united kingdom measures 1550 miles in length by about 350 in breadth. The country is mostly mountainous and pastoral, and covered with dense forests, producing the finest timber in the world. The climate is dry and cold, but that of Sweden is warmer than that of Norway. The mineral kingdom is rich, particularly in iron, copper, and silver. The inhabitants of these countries are of the ancient Scandinavian races; hardy, honest, industrious, and kind-hearted. In the sciences, the Swedes have shown a sound and penetrating mind. The two kingdoms, Norway and Sweden, had, in 1825, a population of nearly four millions of inhabitants. Stockholm, the capital, had a population of nearly 80,000; Gottenburg, the principal commercial city, had 24,000; Christiana, the capital of the Norwegian division, had 20,600; and Bergen, the chief commercial city in Norway, 20,800. Few towns, however, number more than 4000 inhabitants, and many have scarcely 500.

The Danish monarchy is composed of the peninsula already mentioned, with some islands and detached portions. The principal of the attached territories are the duchies of Holstein and Lauenberg; likewise the Feroe Islands, in the North Sea; Iceland; the western coast of Greenland; some places in Guinea; and the city and territory of Tranquebar, in the East Indies. The exact measurement of so scattered a territory is of little moment; and it is sufficient to state, that Denmark Proper and the duchy of Scleswick contain 17,375 square miles. Denmark Proper is estimated to contain 1,230,000 inhabitants; Holstein and Lauenburg, 370,000; and the total population under the monarchy amounts to something under two millions. The people are partly Danes and partly Germans. Denmark is a level country. The coasts are low, and protected from the sea by dykes. The soil consists partly of marshes and heaths, and is on the whole but moderately fruitful. By the improvident extirpation of the woods which protected the north and north-western coasts of Jutland against the sea, vast extents of fruitful territory have become barren and sandy deserts. The staple productions are grain, rapeseed, and tobacco; and the breeding of cattle forms a principal source of profit. Denmark now contains, without including Iceland and the Feroe Islands, 100 cities, 73 boroughs, 2305 parishes, and 5500 villages. The government is an absolute monarchy. Copenhagen, situated on the east coast of the island of Zealand, is the capital, and contains a population of 105,000 inhabitants.

HOLLAND AND BELGIUM.

These countries, under the general appellation of Netherlands, occupy a large flat territory stretching southward from the confines of Denmark on the north, to France on the south; having Prussia and the small kingdom of Hanover on the east, and the North Sea or German Ocean on the west. They therefore form that part of the continent of Europe which lies opposite the east coasts of Scotland and England. The entire extent of the Netherlands amounts to 24,870 square miles. Through the centre, from east to west, flows the Rhine, one of the finest rivers in Europe, and which parts into a number of channels before pouring its waters into the ocean. On the lower part of one of these channels stands Rotterdam, a large and flourishing commercial city. The surface of the Netherlands is flat, and rich in the luxuriance of vegetation. So low is the land, that it has to be protected from the sea by dykes or embankments. The country is everywhere intersected with canals, which are of prodigious use for commercial and general intercourse. Locally, the Netherlands are divided into a number of districts, among which the old Flemish or Flanders provinces find a place. The whole territory is nearly equally divided into the two distinct states of Holland and Belgium.

Holland is that part of the Netherlands which lies on the north-east side of the Rhine, while Belgium is upon the south-western side, or nearer to France. Holland is composed of the following provinces: North Brabant, Guelderland, North Holland, South Holland, Zealand, Utrecht, Friesland, Overyssel, Groningen, and Drenthe, being ten in number, containing, in 1833, a population of 2,444,550. Of these there are 1,541,748 Protestants, 836,920 Roman Catholics, and 45,493 Jews, besides a few thousands of other sects. The country, however, is essentially Protestant, notwithstanding that all sects are freely tolerated, and their clergy paid on a nearly equal principle by the state. The established church is Presbyterian, resembling that of Scotland both in discipline and doctrine.

Holland has been for ages a commercial country, its people chiefly subsisting in some way connected with ships and maritime traffic. It is, however, not at present advancing very sensibly, owing to the people's want of enterprise, and their hatred of modern inventions and improvements. Since 1830, when the kingdom of the Netherlands was divided by a revolution into Holland and Belgium, the country has been governed separately by a constitutional monarchy. The Hague is the capital of Holland, where the government is conducted, but Amsterdam is the chief town, both for commerce and amount of population—its population was some years since upwards of 200,000. The language of Holland is a species of German, spoken nowhere else in Europe.

The districts or provinces of Luxembourg and Limburg are now considered to belong to Holland. Luxembourg lies on the south of Belgium, and Limburg in the lower valley of the Meuse, on the Belgian side of the Rhine.

Belgium, the country of the ancient Belgæ, and in later times the country of the Flemings, now consists of the provinces of Brabant, Antwerp, East and West Flanders, Hainault, Namur, and Liege, the whole measuring 12,000 English square miles, and containing 4,000,000 of inhabitants. The people of Belgium are from the same original stock as the Dutch, but circumstances have made them widely different in manners. Belgium was long held in subjection by Spain and Austria, and afterwards was attached to France, and partly from this cause the prevalent religion is Roman Catholic, and the language chiefly French. These two peculiarities give a turn to the national feelings. The Belgians, though as industrious as their neighbours, the Dutch, are less steady of purpose, and more enterprising. Nevertheless, they are now a thriving people, under a constitutional monarchy, with Leopold as their king, and many improvements are at present in operation in the country. Brussels, a beautiful large town in Brabant, is the capital—population about 80,000. The manufactures, internal traffic, and commerce of Belgium, are undergoing a rapid extension. The towns next to Brussels in size and importance are Antwerp, a sea-port on the Scheldt, Ghent, Bruges, Louvain, and Liege. The two main rivers are the Meuse, which falls into the Rhine, and the Scheldt.

TURKEY.

Turkey is a territory partly in Europe and partly in Asia, and is inhabited by an Asiatic-Tartar race, called Turks, who in the year 1453 conquered that portion lying within the confines of Europe, formerly the metropolitan part of the western empire of the Romans, and have there ever since, at Constantinople, held a barbarous sway of this beautiful district of Europe. Turkey in Europe is separated on the south-west from Asia only by a long range of straits called the Dardanelles, and by the Black Sea, and is bounded on the northern side by the dominions of Austria and Russia. On the west it has the Adriatic Sea, which in part separates it from Greece, till lately a portion of itself. The Turkish monarchy nominally possesses Egypt and some other possessions in Africa; but, not computing these distant territories, it may be estimated that Turkey in the present day measures in Europe 178,928 square miles (but including the insecure provinces of Moldavia, Wallachia, and Servia), with a population of upwards of nine millions of inhabitants; and in Asia 425,000 square miles, with a population of above ten millions. The bulk of the population in both regions is Mohammedan, and uncivilized. The climate of Turkey is among the most delicious in the world; its soil is generally productive and its natural appearance is beautiful.

Constantinople, the capital (called Stamboul by the Turks), situated on the Bosphorus, a strait betwixt the Mediterranean and Black Sea, is a large and populous, though crowded and inconvenient city, excellently situated for trade, communications being carried on with it by the Mediterranean on the west, and the Black Sea on the east. Every region in Turkey yields its productions in abundance. The staple articles of export are wheat, rice, cotton, tobacco, silk, figs, and other fruits; hair, wool, and opium. Mining is totally neglected; and there is in general little manufacturing industry in the country The inhabitants are at once extremely ignorant, proud, and slothful, and the commerce carried on is chiefly in the hands of Jews and Christians. The spread of knew-ledge has been sedulously prevented; printing, till lately, was carried on only by Armenians, Jews, or Greeks; and transcribing books with the pen is pursued as a common employment. Painting and sculpture are neglected, because the Koran, or Bible of the Mohammedans, forbids the imitation of the human form. A great effort was lately made by the sultan Mahmoud to introduce some civilized usages, and, among other improvements, he established a newspaper at Constantinople, in French and Turkish.

The sultan, as caliph, or successor of the prophet Mohammed, enjoys the character of Pope to the Mohammedan world, and unites the highest spiritual dignity with the supreme secular power. He has unlimited control over the property and lives of his subjects, especially of the highest officers of state, whom he can remove or put to death at will. The people have no rights. Merit, or favour, or intrigue, can raise the lowest to the highest stations. There is no hereditary nobility. The succession to the throne is hereditary in the family of Osman; the will of the people and of the janizaries has often decided upon the individual. Women are excluded from the succession. The padishah or sultan is not crowned; he is merely girded with the sword of Osman, after he has sworn to uphold the religion of Mohammed. The women of his harem are for the most part Circassians or Georgians, who have been purchased as slaves. On account of this plurality of wives, and the number of male descendants, there is generally a contest for the throne at the decease of every monarch. Latterly there has been some improvement in this respect, still the whole arrangements for a regular succession are on a precarious footing.

The most remarkable thing about the Turkish system of government is, that the Koran, or Book of Mohammed, is the source of all civil, political, or criminal law. In addition to the code of laws, the interpretations of the ulema, or priesthood, have great weight in the tribunals. The mufti is not only the chief of the priests, but the highest interpreter of the laws. His decisions are collected. The highest tribunal, the divan chaneb, is held four times a-week by the grand vizier, in his palace, or in his absence by the tchaush-baschi. In the lower tribunals of the large cities, the mollas sit; in those of small towns, the cadis. The moslems are, under them, the executors of the sentences. The administration of justice is as simple as it is prompt and energetic. The common punishments are the bastinado, hanging, drowning, strangling, and impaling. The court or government of the sultan is known by the name of the Porte, Sublime Porte, or Divan, and the sultan has received from Europeans the title of Grand Seignior. In Constantinople and other parts of Turkey, English, French, and other foreigners from western Europe, are generally termed Franks.

The land forces were until recently organized on a miserable Asiatic system. They are now modelled, armed, and disciplined, on the common European principle, and partly dressed on the same plan. The navy of Turkey has been also organized according to the European system. In civil life many reforms have likewise been effected by orders of the late Sultan Mahmoud (deceased 1839), and altogether the Turkish empire may now be described as in a transitive state towards civilization.

GREECE.

The north-eastern part of the Mediterranean is divided into two large bays or gulfs, which run far up into the European continent; that towards the west being called the Adriatic, and the other the Ægean Sea. The peninsula, or tongue of land which lies between the two, is the original country of the Greeks. Colonies of the same nation have, from time beyond the reach of history, occupied the whole coasts and islands of both these gulfs from Sicily almost to Cyprus; but the parent states of the middle peninsula are those to which the Grecian name is indebted for all its splendour; and it is this country only which is properly called Greece. From the situation of the Greeks in a region whose bays, headlands, and islands, present a great extent of sea-coast, habits of adventure and mutual intercourse were produced among them in the earliest times, which had the greatest influence in cherishing a national activity of character, and making each community eager to rival the prosperity of the others. The people were early accustomed to make voyages, sometimes for traffic, sometimes for war, betwixt the opposite coast of their gulfs, guiding themselves by the stars from island to island. From this and other circumstances, Greece in early times attained the first rank as a state, or confederacy of states. (See article ANCIENT HISTORY.) After being conquered by the Romans, it fell a prey to the Turks, from whom it was in part only recently wrested by a skilful rebellion or revolution.

In the present day, Greece comprises in its northern parts the districts of Albania and Macedonia; next, in a southerly direction, Epirus and Thessaly; the Morea (anciently Peloponnesus) is an island-like peninsula, almost cut off from the latter divisions by a strait called the Gulf of Lepanto. Altogether, modern Greece measures about 400 miles in length, and little more than 100 in general breadth. Greece is a mountainous and romantic region, with several beautiful rivers. Its agriculture is in a very rude condition, but its commerce is increasing; and the long-exhausted nation is gradually assuming a settled powerful character. A constitutional monarchy, not very well organized, has been imposed on the newly erected nation by the European powers, with Otho, a Bavarian prince, as king. Athens, the chief town or capital, is now undergoing improvements, and frequently visited by strangers. The population of the continental part of Greece is stated at three millions, and nearly half a million for the islands adjacent.

ASIA.

Asia, which forms the eastern and northern portion of the great tract of land in the eastern hemisphere, is the oldest known portion of the globe, and is usually called the cradle of the human race, of nations, and of arts. It is separated from Australia by the Indian and Pacific Oceans; from America on the north-east by Behring's Straits, and on the east by the great Eastern or Pacific Ocean; from Africa by the Arabian Sea (with which is connected the Persian Gulf), and by the Arabian Gulf, or Red Sea, with the straits of Babelmandel; from Europe by the Sea of Azoph, with the Straits of Caffa, by the Black Sea with the Bosphorus, by the Sea of Marmora and the Dardanelles, and by the Grecian Archipelago. On the other hand, it is united with Africa by the desert Isthmus of Suez, and with Europe by the waters of the Wolga, which rises near the Baltic, and falls with the Ural into the Caspian Sea.

The area of Asia is about 16,175,000 square miles. It extends from 26° to 190° E. longitude, and from 2° to 78° N. latitude. Its greatest breadth, from north to south, is 4140 miles, and its greatest length about 8000. It is four times larger than Europe. It is divided into 1. Southern Asia, comprehending Natolia, Armenia, Curdistan, Syria, Arabia, Persia, Hindostan, Farther India, Siam, Malacca, Annam, Tonquin, Cochin China, Laos, Cambodia, China, Japan; 2. Middle or Upper Asia, containing Caucasus, Tartary, Bucharia, Mongolia Tungousia; 3. Northern or Russian Asia, from 44° N. latitude, containing Kassan, Astrachan, Orenburgh, Kuban, Kabarda, Georgia, Imireta, Siberia, with the alpine regions of Dauria and Kamschatka.

The large portion of Asia composing the northern and middle divisions, inhabited by wandering Tartar races, possesses little interest, and is generally viewed as little else than a great wilderness. The parts which are important, either from their historical interest or their present condition, are the three lobes or masses of land, partially jutting out from the continent on its southern side; the first, on the west, comprehending Arabia, Syria, and Persia, the second, or mid part, Hindostan or India; and the eastern part, China and Japan. Arabia is a fine large peninsular tract lying betwixt the Persian Gulf on the east, and the Red Sea on the west. It contains about 1,000,000 square miles, and is situated between the 12th and 30th degrees of north latitude. Its chief towns are Mecca and Medina, near the shore of the Red Sea. The southern portion is entitled Arabia Felix, or the Happy, and its northern part Arabia Petræa, or the Rocky. Adjacent to this northern division, and stretching along the border of the Mediterranean Sea, is Syria or Palestine, the ancient country of the Jews, but, along with the surrounding country, now held in subjection by the Turkish power, and in a state of barbarism. A description of PALESTINE is elsewhere given in the present work.

The district of country anciently termed Asia Minor, but now forming part of Turkey in Asia, and called Natolia or Anatolia, is a territory 650 miles long, and 400 broad, having Armenia on the east, and a part of the Mediterranean on the west and south. It is a fruitful and delightful part of Asia; its principal town and seaport is Smyrna, with which a considerable traffic is carried on with western Europe.

Persia lies on the eastern shore of the Persian Gulf, between the 25th and 40th degree of north latitude. It has the Caspian Sea, or a great inland lake, on the north, and the Arabian Sea on the south. It comprises about 390,000 square miles, with a population of about 6,500,000. The people are Mohammedans, and in a semi-barbarous condition, governed by a shah or despotic sovereign. Ispahan is the capital. Within a portion of country anciently called Mesopotamia, and now generally entitled Turkey in Asia, and lying at the head of the Persian Gulf, between Persia and Arabia, are the rivers Euphrates and Tigris, also the towns of Bagdad and Bassora. It was by these channels, the Persian Gulf, the Euphrates, and also the Red Sea, that a great trade was once carried on betwixt India and the shores of the Mediterranean Sea; now this traffic is at an end, in consequence of the barbarous state of the whole region round about, and the opening of a communication betwixt India and England. Of INDIA, and also CHINA, no account need here be given, as they are fully described in other parts of the present work.

In all parts of Asia, excepting the mid and northern regions, the climate is delightful, and Nature has spread her most bounteous gifts. "'Tis the clime of the East, the land of the sun," but sunk in false religion, superstition, and in a state of moral and intellectual torpor—"all but the spirit of man is divine"—and when or how it is to be rescued from such a condition, no one can foretell. In the southern divisions within the torrid zone, whose genial warmth converts the juices of plants to spices, balsams, sugar, and coffee, with which Asia has enriched the West Indies, the palms (sago, cocoa, date, and umbrella-palms) reach a height of 200 feet, and the white elephant attains a size surpassing that of all other quadrupeds. From hence the silk-worm was brought to Europe. This region conceals in its bosom the most beautiful diamonds, the finest gold, the best tin, &c., whilst the waves flow over the purest pearls and corals. The temperate zone has given to Europe the melon, the vine, the orange, and many of its most agreeable garden fruits, as well as the most productive farinaceous grasses, and the most charming flowers; and unites, in its productions, symmetry with richness, particularly in the western regions. Here the oldest traditions place Paradise; here lie the enchanting Cashmere and the Garden of Damascus; here blossoms the rose of Jericho, near the cedars of Lebanon. The eastern countries in the same latitude possess the tea-shrub and the genuine rhubarb. The camel, the Angora goat, the Thibetan sheep, the pheasant, and the horse, are natives of this zone. In the north blossoms the Alpine *flora* of Dauria, and from the icy soil grows the dwarf-like Siberian cedar, till, at 70°, vegetation mostly ceases. Here live the smallest of quadrupeds—the shrew-mouse of the Yenisey. Sables, ermines, foxes, otters, &c., afford the finest fur. The mineral kingdom furnishes rich ores, rare precious stones, and remarkable fossil remains of the mammoth, in high northern latitudes.

The inhabitants of Asia (amounting to 390,000,000; according to some, to 580,000,000) are divided into three great branches:—The Tartar-Caucasian, in Western Asia, exhibits the finest features of our race in the Circassian form; the Mongolian race is spread through Eastern Asia; the Malay in Southern Asia and the islands. The north is inhabited by the Samoiedes, Tchooktches, and others. Twenty-four tribes, of different language and origin, may be distinguished, some of which are the relics of scattered tribes of Nomades: Kamtschadales, Ostiacs, Samoiedes, Koriacks, Kurilians, Aleutians, Coreans, Mongols, and Kalmucks, Mantchoos (Tungoos, Daurians, and Mantchoos Proper), Finns, Circassians, Georgians, Greeks, Syrians and Armenians, Tartars and Turks, Persians and Afghans, Thibetans, Hindoos, Siamese, Malays, Annamites (in Cochin China and Tonquin), Burmese, Chinese and Japanese, besides the indigenous inhabitants of the East Indian islands, Jews and Europeans. The principal languages are the Arabian, Persian, Armenian, Turkish, Tartar, Hindoo, Malayan, Mongol, Mantchoo, Chinese, and Sanscrit. The principal religions which prevail are Mohammedanism in the western parts, the worship of the [illegible] Thibet in the central region, Budhism in the B[illegible] territory, and Hindooism or Brahminism in [illegible] These and other religions of the Asiatics are described in the article PAGAN AND MOHAMMEDAN RELIGIONS.

AFRICA.

Africa is a vast peninsula of a triangular form, with its narrowest point towards the south, containing 12,256,000 square miles; situated between 18° W. and 51° E. lon., and from 34° S. to 37° 30′ N. lat.; bounded on the north by the Mediterranean, on the east by Asia, the Red Sea, and Indian Ocean, and on the south and west by the Southern and Atlantic Oceans. It has a great breadth from east to west. The northern portion is much larger than the southern; the greatest breadth, from west to east, from Cape Negro to Cape Guardafui, is 69°. Under the equator, the breadth is 4500 geographical miles. The internal structure of Africa is marked by many peculiarities. It possesses deserts or arid sandy tracts of immense extent, uninhabitable by a settled population, and only traversed by troops of wild Arabs, and caravans or companies of travellers on the backs of camels. In these awful solitudes, lions, tigers, and other wild animals, hunt for a prey, and dispute possession with the savages who intrude upon their domain. Africa also possesses immensely long chains of mountains rising to an enormous height. Such are the Atlas mountains, the Mountains of the Moon, and others. The highest peak of the Camerones is 13,000 feet above the level of the sea. Africa has few rivers suitable for navigation, and hence its impenetrable character. The principal river is the Niger or Joliba, which flows some hundreds of miles from the interior, to the Atlantic on the west coast. In this quarter also are the Gambia, the Congo, and the Senegal. The Nile has been the longest and best known; it flows from Abyssinia through Egypt to the Mediterranean.

Excepting in some small spots on the sea-coast inhabited by European colonists, the whole of Africa is in the possession of races of men, black and fiercely savage, or very slightly civilized, and of a copper complexion. Of the latter variety are the Moors of the extensive region of Barbary on the north, and also the modern inhabitants of Egypt. Egypt, which is little else than the valley of the Nile, and lying adjacent to Arabia Petræa, and Syria in Asia, is the only country of Africa in which we can find any interest from historical recollections. It is described at length in a separate number of the present work. West from Egypt is Barbary, a country in part nominally subject to Tartary, and containing the districts of Tripoli and Tunis, also Algiers, which has lately been conquered and appropriated by the French. The empire of Morocco is likewise in this northern division, in the angle of territory between the Mediterranean and Atlantic. Central Africa comprises a number of savage states, among the rest Guinea on the Atlantic coast. Along this coast are certain British, French, Portuguese, and Dutch possessions. Southern Africa comprises the countries inhabited by the Hottentots and Caffres, and the Cape of Good Hope, which is at the extreme southern promontory, and now forms a flourishing British colony.

The islands considered to belong to Africa are the Madeiras, the Canaries, Cape Verd, and Azore islands, also St. Helena and Ascension, all in the Atlantic; and the large isle of Madagascar, with a few of smaller size, in the ocean to the east of the continent.

Madeira is the finest and most accessible of the African islands. It extends to about 37 miles in length by 11 in breadth, and lies at the distance of about five hundred miles from the coast of Barbary, in the route of vessels proceeding from Europe to the Cape of Good Hope or India. Lying at about the 31st degree of north latitude, it enjoys a delightful climate, suitable for the tender constitution of invalids. Vegetation is luxuriant, and the grape grows to great perfection, and yields a fine wine, usually called Madeira. The island is in possession of Portugal, but many English reside upon it, both for the sake of commerce and health.

The African races of men offer many points of interest to the inquirer. The majority of them are distinguished from the rest of the human family, not only by their black complexion and curly hair, but also by peculiarities in the construction of the bones of the head and even of the nerves. This seems to imply that the negro is originally a distinct race. It is thought that traces of this primitive race may still be detected here and there; for example, of the original Egyptians in the Copts, and of the Guanches (the original inhabitants of the Canaries) in the natives of Barbary. The population is probably between a hundred and a hundred and ten millions. The interior of the country must be very populous, since, within two centuries and a half, it has contributed forty millions of vigorous men to the slave-trade, and, notwithstanding, is any thing but depopulated. Even the countries along the coast are thickly peopled. Jackson computed the population of Morocco alone at seventeen millions, and the Barbary states, with Egypt, which constitute but an eighth part of the continent, contain twenty millions. The torrid Guinea has, on the whole, a numerous population; and large cities are situated on the Joliba, of which we hardly know the names. The inhabitants belong to two branches of the human family; to the black or Ethiopian race, which extends from the Joliba to the southern extremity, comprising, notwithstanding their tawny complexions, the Hottentots; and to the Caucasian race, which includes the natives of Barbary, Copts, the Arabs or Moors, the Agaziones or Abyssinians, and the nations of Nubia. The Arabs are not to be regarded as aborigines of Africa, but they have scattered themselves and become occupants of the greater part of the north and west.

The prevailing religions are Mohammedanism, and different kinds of Paganism. The arts are exercised only on the northern coasts, where the Moors manufacture much silk, cotton, leather, and linen; an active commerce is carried on by them with the maritime nations of Europe, and, by means of caravans, a traffic fully as important, with the interior, to which they convey their own products and those of Europe. The wants of the savage races are exceedingly simple, and every article used by them is prepared by themselves; the cloth which surrounds their loins, the hut which protects them from the weather, the bow and arrow necessary for the chase and self-defence, as well as all their household furniture, are manufactured by themselves; the gold which they collect from the surface of the earth is wrought by them into ornaments, and iron into arms. Commerce, however, with Europeans has taught them many wants, and increased their list of necessaries; among which may now be reckoned fire-arms, powder, brandy, tobacco, different kinds of cloth, glass beads, coral, &c.: for which they barter slaves, ivory, gold, and gums, the staples of Africa. The most odious branch of traffic is that carried on in the sale and export of slaves; although in some respect limited in recent times, it is calculated that still 50,000 negroes are carried off annually for the South American market. Of all the states of Africa, Barbary alone uses coin; in the rest not frequented by Europeans, money rarely serves as a medium of exchange; in some, on the western coast, cowries (small shells) are made to answer the purpose of coin; in others, pieces of salt.

AUSTRALASIA,

Which now ranks as one of the great divisions of the earth, consists of a number of large and small islands in the Indian or South Pacific Ocean, between the 10th and 45th degrees of south latitude, in a south-easterly direction from China, which is the nearest part of the Asiatic continent. These islands also lie in a south-easterly direction from India, or Hindostan. The chief island in the group is Australia or New Holland, which measures 2000 miles from east to west, and 1700 in breadth from north to south. The physical character of Australia is very peculiar. With the exception of some mountain ranges, it is generally flat, and in many places the inclination is inwards, instead of outwards, to the sea. There being a general absence of hills, clouds are not attracted over the land, and hence there is a deficiency of rain in the country; the climate is nevertheless one of the finest in the world, and no country on the globe seems so suitable for sheep pasturing. The chief native quadrupeds of Australia are pouched animals, such as kangaroos, of which there are several varieties. The native human beings are of the Malay race, and in a low state of barbarism.

Australia now possesses three distinct British settlements—New South Wales, which stretches about 1500 miles along its eastern coast, and some hundreds of miles inland; South Australia, on its southern shore, which has been but recently opened for emigration; and Western Australia, or Swan River Settlement. Van Diemen's Land is another British settlement. New South Wales, which is the oldest and most populous of the Australian colonies, lies at the distance of 16,000 miles from Great Britain, and its capital, Sydney, to which most vessels proceed, is reached in from 100 to 120 days' sailing. Lying on the opposite side from us, its seasons are reversed in relation to ours; its winter is in May, June, and July, and its summer in November, December, and January. Sydney, which is agreeably situated on a fine bay of the sea, called Port Jackson, now possesses a population of 25,000 souls. The whole population of New South Wales, free and convict, is understood to be about 110,000, but the number of inhabitants is rapidly increasing.

South Australia, to which no convicts are allowed to be sent from England, is at present a thriving colony; the town of Adelaide is its capital.

Van Diemen's Land is an island of about the size of England, lying at a short distance south from Australia, and possessing many excellent harbours. Van Diemen's Land is more hilly and better watered than Australia, and therefore better adapted for agriculture. Its capital is Hobart Town, on its southern side. On its northern shore, opposite Australia, is Launceston, the second largest town in the island, and a busy seat of trade. The population of the island was lately estimated at 35,000, about one-half of which were convicts.

The New Zealand Islands, which belong to the Australasian group, are situated at a greater distance to the east of Australia.

For a complete description of the whole of these interesting territories, we refer to the articles on the subject, in the present work.

AMERICA.

The continent of America lies in the western hemisphere, in a situation altogether aloof from the continents of the Old World—as Europe, Asia, and Africa, are termed. America, or the New World, was first discovered by Columbus, in the year 1492, but its coasts were not fully known to Europeans for nearly a century after that period. It was long a matter of doubt whether America was connected at its northern extremity with Asia, and many expeditions were fitted out to discover if such were really the case: it is now ascertained that it is not connected with Asia, but is a detached continent. Although Columbus is entitled to be considered the first discoverer of America, it happened that he was robbed of the honour of giving it his name by the superior address of Americus Vespucius, one of his adventurous successors. America consists of two large portions, very nearly separated by the intervening Gulf of Mexico, and only connected by a neck of land called the Isthmus of Darien. The northern portion is named North America; that in the south, South America. From its northern boundaries to the Gulf of Mexico, North America extends about 4376 miles in length, and 3000 miles wide at the broadest part. South America commences at the ninth degree of north latitude, reaching to the 56th degree south latitude, being a length of 4550 miles, by a breadth, at widest, of nearly 3000 miles. On this vast double continent, the works of nature are found on a large scale, calculated to excite our wonder. Mountain ranges, plains and rivers, are all larger and more magnificent in their proportions and appearance than those in the eastern hemisphere. The soil is also very generally fertile, and covered with the most lofty timber and luxuriant vegetation.

At the period of the discovery of America, it was found to be thinly inhabited by a number of tribes of aboriginal people, generally of a copper colour, and more or less savage in character and habits. The subsequent settlement of colonists from Spain, Portugal, Holland, England, France, and other European nati[illegible] had the effect of either extirpating these races, or of driving them westward towards the shores of the Pacific Ocean. They are now comparatively few in number. While they have decreased, the colonists have vastly increased in number by emigration, and the natural increase of population. In a general sense, North America has fallen to the share of British colonists, while South America has become the portion of the Spanish and other bigoted and bad-managing Europeans. In the course of time, the colonists in nearly all parts have emancipated themselves from the dominion of the mother countries, and set up as independent nations. In doing so, they have embraced the opportunity of trying to establish democratic institutions, with an absence of aristocratic distinction. The greatest of the republics thus established is that of the United States of North America. A third race, the descendants of negroes imported as slaves, is rising into a large amount of population over the whole continent, partly emancipated, and still partly as slaves; and being most unfortunately or inhumanely kept as a despised caste, their increasing numbers and condition are at present exciting the attention of the civilized world. It has been computed that the whites and their descendants in all parts of America amount in number to 15,000,000; Indians, 10,000,000; negroes, 8,000,000; mixed breeds, as mulattoes, mestezos, &c., 8,000,000; total, 41,000,000; but the number of Indians is declining so rapidly, that in all likelihood they do not at present amount to more than from six to seven millions, while the whites have increased in an equal proportion. It is reckoned that there are space and fertile soil on the American continent for at least 800,000,000.

South America comprises the states or independent republics of Colombia, Guiana, Brazil, Peru, Bolivia, Chili, Buenos Ayres, or the united provinces of La Plata and Patagonia. The principal range of mountains is the Andes, and betwixt these and the Atlantic are many great flat plains, receiving the name of Pampas. The rivers in South America are among the largest in the world; the principal are the Amazon, La Plata, Orinoco, Panama, Paraguay, St. Francisco, and Magdalena. The principal islands are the Falkland Islands, Terra del Fuego, off the southernmost point of land, Juan Fernandez, and the Gallapagos. For a complete account of South America, we refer to the article on that subject.

North America comprehends the following political divisions:—On the North, the country of the Esquimaux, who form independent tribes; also Greenland, a large insular or peninsular tract, stretching towards the north pole; next these, to the south, Labrador, a country belonging to Great Britain, and chiefly appropriated by hunters and natives; on the north-east coast the island of Newfoundland, a British possession; Canada, Nova Scotia, and New Brunswick, likewise British possessions; thus the larger portion of territory in the northern part of the continent belongs to Great Britain. Adjacent to Canada, and occupying the whole frontage to the Atlantic, are the United States. Behind them, on the west coast, are the united states of Mexico, and in the north-western part a territory claimed by Russia. The extreme southern part of North America, occupying a division of the isthmus of Panama, is the state of Guatemala, which now claims to be independent. Except in Mexico, the larger proportion of the western side of the continent is still in possession of native Indian tribes, but these are quickly disappearing before the advances of civilized man. To this continent belongs a series of islands on the Atlantic side, in the seas between North and South America, now bearing the name of West Indies. Among these are St. Domingo, Jamaica, and other islands of importance, chiefly devoted to the culture of the sugar-cane, coffee, and other tropical productions. (See article West Indies.)

North America abounds in fine large rivers, susceptible of navigation for several hundreds, and, in a few instances, thousands of miles. The principal river in the north is the St. Lawrence, which issues from a series of large fresh-water lakes, the most extensive on the globe; these are Lakes Superior, Huron, Michigan, Erie, Ontario, and others. They in general divide Canada from the United States. Next in size to the St. Lawrence, on the north-east coast, is the Hudson river, which enters the Atlantic at New York. The other chief rivers are the Mississippi, and its tributaries the Ohio and the Missouri. These flow through the central parts of the country, and terminate, on the south, at the Gulf of Mexico. The valley of the Mississippi is separated from the slopes on the Atlantic, by the Alleghany range of mountains. In the western part of the continent is a similar range called the Rocky Mountains, which are the boundary adjacent to the slopes on the Pacific. By means of these and other water-courses, personal and commercial intercourse can be carried on to a boundless extent, and, with the inexhaustible fertility of the soil, will in time render North America the most populous and wealthy region in the earth. Already, within the period of two hundred years, or more properly since the epoch of the American revolution in 1770–80, the Anglo-Saxon race, originally planted as settlers by Britain, has spread over a large portion of the country, and founded an immense number of towns and cities, and otherwise effected the most extraordinary improvements in all the arts of civilized life. The United States were lately twenty-eight in number, as follows:—Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, all which are known as the New England states; New York, New Jersey, Pennsylvania, Delaware, Columbia, Maryland, Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, Florida, Louisiana, Tennessee, Kentucky, Ohio, Indiana, Illinois, Missouri, Michigan, and Arkansas. The number is constantly increasing, by the acquisition of new territories. The principal cities are Washington the capital, New York, Philadelphia, Boston, Baltimore, and New Orleans.

The principal cities or towns in the British possessions are Toronto, Montreal, Quebec, Halifax, and St. Johns. For an account of the UNITED STATES, CANADA and NOVA SCOTIA, we refer to the separate articles on these subjects.

POLYNESIA.

Polynesia—a word signifying "many isles"—is the name now given to the numerous groups of small islands scattered over the Pacific Ocean, but principally lying in an easterly and north-easterly direction from Australia, within about thirty degrees on both sides of the equator. They are perhaps better known under their titles of the Sandwich, Friendly, Society, and Queen Charlotte's Islands, &c. They are many thousands in number, and are inhabited by races of men who have generally been found much more tractable than the barbarous tribes of the other parts of the world. Most of the islands are fruitful and beautiful; some are exceedingly high and romantic, and their climate is reckoned the most delicious on the globe. Otaheite is one of the principal of the Society Islands. Owhyhee, or Hawai, is the largest of the Sandwich Islands, and measures eighty-four miles in length by seventy in breadth. Here Captain Cook, in 1779, fell a victim to a sudden resentment of the natives with whom his party unfortunately had a dispute. The Islands are in the course of being Christianized and improved.

[WORKS ON GEOGRAPHY.

A general knowledge of geography has now become one of the elements of common school instruction. But the subject is sufficiently extensive and interesting to form a study for the riper years of those who have leisure for it. Among the school geographies, Morse's is preferred, on account of the great number and minuteness of the maps, which, in fact, are the principal thing in this study. Murray's Encyclopædia of Geography is a very extensive and interesting work abounding with maps and pictures, and going minutely into every branch of the subject. Malte-Brun's is another of the same class, and is greatly prized by scholars. The most convenient books of reference on this subject, of course, are Gazetteers, and of these Macculloch's is the most recent and extensive. The most agreeable mode of studying geography, however, is by reading books of travels, written by lively and interesting writers, like Stephens, Slidell, Darwin, Dana, Fisk, Mrs. Haight, Humboldt, Kendall, Kay, Kohl, Mackenzie, Dr. Olin, Captains Parry, Reynolds, Sedgwick, Cheever, and others of the same class. By reading their delightful books, with the map before us for reference, we have the features of the countries which they visited indelibly fixed in our minds, in association with the manners, customs, and history of the places.

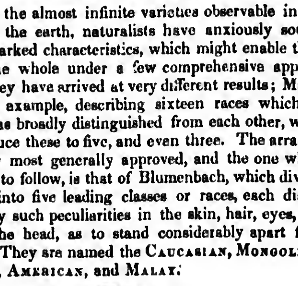
For the purpose of rendering our knowledge of geography still more minute and available, it is an excellent practice to draw maps, and however imperfectly or unscientifically this task may be executed, its effect in assisting the memory is acknowledged by all who have made the experiment. It is worth one's while, also, to embrace any opportunity which may present itself of examining the maps which have recently come into fashion, in which the mountains are represented in relief, being actually raised above the surface of the paper or card of which the map is made. Such maps are common in Europe; but few have reached this country, and we are not aware that the making of them has been attempted here.—*Am. Ed.*]

PHYSICAL HISTORY OF MAN.

The Physical History of Man is a science which proposes to investigate the characters of the different races of the human family, as they exist in different regions of the earth. The great distinctions between the various races must have been marked with wonder at an early period; but no serious effort was made to ascertain the nature and causes of those varieties till the present century, when the subject has been illustrated by the researches of Cuvier, Blumenbach, Pritchard, and some other writers. As yet the science is far from having arrived at distinct or satisfactory results; but much of what has been ascertained is nevertheless of a most interesting nature, and well deserving of general attention.

POPULATION OF THE GLOBE—RACES—THEIR GENERAL FEATURES.

Amidst the almost infinite varieties observable in the nations of the earth, naturalists have anxiously sought for well-marked characteristics, which might enable them to class the whole under a few comprehensive appellations. They have arrived at very different results; Malte-Brun, for example, describing sixteen races which he considers as broadly distinguished from each other, while others reduce these to five, and even three. The arrangement now most generally approved, and the one which we design to follow, is that of Blumenbach, which divides mankind into five leading classes or races, each distinguished by such peculiarities in the skin, hair, eyes, and shape of the head, as to stand considerably apart from the rest. They are named the Caucasian, Mongolian, Ethiopic, American, and Malay.



Caucasian Race.

1. The Caucasian race is one widely spread on the face of the globe, and, in addition to physical beauty of the highest order, is distinguished for intellectual eminence. The skin of this race may be generally described as fair; but it is susceptible of every tint, and in some nations is almost black. The hair is fine, long, curling, and of various colours. The skull is a large rounded oval, and the brow full and elevated. The face is comparatively small, oval in form, and well proportioned. The nose is arched, the chin full, and the teeth vertical. The chief families of the Caucasian variety are the *Caucasians proper*, the *Germanic* branch, the *Celtic*, the *Arabian*, the *Libyan*, the *Nilotic*, and the *Hindostanic*.

The race of *Caucasians proper* are traceable to the confines of the mountainous range of Caucasus, between the Black Sea and the Caspian—a region not far distant from the apparent birth-place of mankind. The Caucasians still dwelling there form at this hour the physical type of this great variety of human beings. The Circassians and Georgians are very perfectly formed, approaching closely in shape and features to the cognate race of Pelasgi or Greeks, who, emanating from this region, spread early over Greece and parts of Italy, and there founded Caucasian nations. At this day a great part of the people of Persia, and especially the upper classes, are of Caucasian descent, the remainder being Mongol Tartars, a race equally distinguishable when pure. The Persian men and women have, generally speaking, fine persons, and they are, like the whole of the pure Caucasian variety, highly imaginative, and fond of music and poetry. The tribes of Affghanistan and Koordistan belong in part to the same variety, and exhibit its wonted physical perfection.

A small body of pure Caucasians founded the Roman nation. The personal differences between them and the Greeks arose, doubtless, from the extensive admixture of the early Romans with the Sabines and other surrounding tribes.

The *Germanic* family, a great branch of the Caucasian variety, formed one of the mighty waves of population, which, emanating from the original seats of the race, passed over a great part of central and northern Europe, filling Germany and Scandinavia, and partly, also, Russia and Poland. In the latter regions, however, they met with Tartars from Asiatic Scythia, and the mixture of these races produced the Slavonic subvariety, and originated the Slavonic tongues. The decline of the Roman power brought out the Germanic tribes from their northern settlements, and, under various names, they formed new locations in the south-west of Europe. Among others, they founded the languages of England, Holland, Denmark, and Sweden, though at different periods. Robust forms, light hair, blue eyes, florid complexions, and large, broad-fronted heads, constitute the chief physical characteristics of the pure Germanic family; while, morally and intellectually, they stand preeminent above all the other tribes of mankind. They are conspicuous, in particular, for what may be called the *industrial virtues*, exhibiting a degree of indomitable perseverance in all improving pursuits, which has rendered them the great *inventors* of the human race. The admixture of German and Tartar blood in the north-eastern nations of Europe, has given to these darker hair and complexions than the preceding section, and has also lessened their propensity to intellectual cultivation. The effects of the Tartar conquest of Russia in the twelfth century by Zenghis Khan, whose successors held the country for 200 years, will probably be observable in the career of this people for ages to come, and, indeed, perhaps as long as the race exists.

The *Celtic* branch of the Caucasians formed extensive settlements, at a very early period, in Western Europe. The whole, it may be said, of Italy, Spain, France (called Gallia Celtica), and Britain, was peopled by them. The successive commingling of races, caused by incursions of the Greeks, Romans, and Germans, did much to obliterate the traces of this variety in its pure state; yet the race, language, and name, still remain in their primitive condition on the outskirts of the original Celtic dominions. We allude chiefly to parts of Scotland and Ireland: In Brittany, Gascony, and Biscay, the traces of the people are also distinctly observable. These pure Celts show us what the physical characteristics of their anceors were. Their frames are athletic, spare, and wiry; their forehe[illegible]rrow, and the head itself elongated; the nose and mo[illegible]arge, and the cheek-bones high; in all, their features are rather harsh. In character, they are hot and fiery, but generous and brave; and they are remarkably patient of fatigue. Intellectually considered, they are acute and ingenious in the highest degree, but are deficient in that breadth and solidity of understanding which distinguishes the Germanic family.

The present population of France partakes largely of the Celtic blood, notwithstanding various invasions of the Germanic tribes, from one of which, the Franks, came the modern name of the country. From the Celts, the French people derive their proverbial vivacity of temper, their quickness of perception, their dashing bravery, and, most probably, their undeniable inconstancy and flightiness of disposition. Britain, again, has retained comparatively slight traces of her early Celtic inhabitants. A branch of the Germans had visited the island even before the invasion of the Romans; and after the latter came Dane, and Saxon, and Norman, in such numbers, that the pure aboriginal stock were left but in the Highlands of Scotland, and partly in Wales. The Scottish Lowlands had early been colonized by the Picts, a people, there is every reason to think, of Germanic origin; and subsequent intermixtures with the southern inhabitants of the island speedily gave the population still more of the Germanic character. In this manner was formed the root of the existing British nation, one of the most remarkable on the face of the earth. Inferior to no one of the Caucasian families in intellectual endowments, and possessed of indomitable courage and unbounded enterprise, it has scattered its colonies over a large portion of the globe, giving to new regions its language, its genius, and its arts. Above all, it has given origin to the great Anglo-American nation—a nation, if inferior at all, inferior only to the parent stock, in those attributes that ennoble the race. Much of the excellence that belongs to the British character certainly arose from the preponderating infusion of Germanic blood, resulting from the incursions of the Norsemen upon the aboriginal Celts. But the sprinkling left of Celtic blood seems to have had its use also, in giving a share of vivacity to the comparatively heavy, massive temperament of the pure Germans. We may judge so from looking at the character of the unmixed Germanic families. The Dutch, for example, would evidently have been an improved race had their specific gravity of character been l[illegible]ned by a little infusion of Celtic mercurialism. The Belgians have a pretty equal share of Celtic and Germanic blood in their veins; and consequently, while they display the industrial virtues of the latter race, they also show no slight admixture of Celtic flightiness.

There may appear some fancifulness in this mode of analysis, but we believe that an accurate examination of the proportions in which the Germanic and Celtic blood are mingled in all the countries of Europe, would fully bear out the views now taken. In Italy, Spain, and Portugal, infusions of Germanic blood took place, but to a comparatively slight extent. The aboriginal Celts of Spain were extensively mingled with Roman immigrants; and it may be said that, at this day, Romanized Celts, with a sprinkling of Gothic (Germanic) and Saracenic blood in their veins, form the existing population. In them, the faults of the Roman character, as well as its haughty virtues, are even yet distinctly traceable. Romanized Celts constitute the basis also of the Portuguese and Italian nation, and the preceding remark applies to their character as much as to that of the Spaniards. The languages of the three countries bear out these observations.

The subject of the Germanic and Celtic branches of the Caucasian variety of mankind, as well as of the Caucasians proper, has been treated of at some length, because these tribes have been the great civilizers of the world. The *Egyptian* or *Nilotic* branch forms almost the only exception to this statement. Most of the existing nations of Europe can distinctly trace their origin to these Caucasian tribes. Dr. Pritchard traces a chain of connection between the roots of the Sanscrit, Greek, Latin, and German languages, which leads him to imagine them to have all sprung from a common original. A remarkable similarity has been traced between the Celtic and Phœnician languages. These and other circumstances, to a certain extent, point to a common origin and place of origin; but the affiliation of nations, as Humboldt justly observes, cannot be distinctly made out in this way. Conquest and colonizations must confuse all such attempts.

After treating of the three great influxes of population which founded the past and existing nations of the European continent, the *Arabian* and *Libyan* branches of the Caucasian family fall to be noticed. Spare but active persons, skins of a light brown, sallowed sometimes by unusual exposure, high foreheads, large dark eyes, oval features, with aquiline noses and small thin-lipped mouths, form the personal characteristics of the Arabs. They have occupied the confines of the present Arabia from time immemorial, and their natural habits have ever been pastoral and migratory. The Bedouin Arabs claim descent from Ishmael, and, however this may be, it is plain, from physical characteristics alone, that they are a cognate race with the Jews. The latter were originally derived from the Chaldeans, an elder branch of the Arab race settled in Babylonia, and they were a pastoral and wandering people like their congeners, until they settled in the cities of Palestine. A body of Canaanite Arabs, expelled by the Jews under Joshua, are understood to have settled in Africa, and become the nation of the Mauri or Moors. Governed by Mohammed and his successors, the Arab race rose to high consequence, and, under the name of Saracens, made great conquests of territory in Asia Minor, Africa, and in Spain. They were afterwards deprived of superiority in some of these countries, but left extensive tribes in the African continent and Asia Minor. The Berbers (or *Libyans*) are a race who seem of Arab descent, but who probably settled in Africa at a far distant date. They resemble the Arabs in person, but are more darkened in complexion. Under the name of Tuariks, they range both to the north and south of Mount Atlas. They are wilder in habits than the Arabs, but may be spoken of as the same race, and with the same capabilities. They form a large part of the existing population of the north of Africa, occupying, with the Arabs, nearly the whole of the Mediterranean shores of the continent, from the Straits of Gibraltar to Egypt; and, either under the name of Moors, of Arabs, of Tuariks, or of Felatahs, they are rapidly insinuating themselves within the tropics, obtaining everywhere that superiority over the Negro race, which the Caucasian family seldom fail to acquire wherever they plant the foot. It seems more than probable that the Arab race will ultimately push the Negroes from Africa; and indeed may annihilate them, as the European whites have done, or are doing, in the case of the Red Indians of America. In the latter instance, but a few centuries have been necessary to accomplish the change of population, and large as the African continent is, many centuries may not pass away ere it rest entirely in the hands of the Caucasian race.* The Negroes have indeed lost more than half of

* The Arabs are likely to be dislodged in turn by a more cultivated people. While they are pushing themselves into power amid the negroes of the interior, a Caucasian race, of higher civilization, has set its foot on the Mediterranean shores of Africa, and begun to push them out of their previous conquests. We refer to the occupation of the Algerine coast by the French. Strange how ceaselessly the round of substitutions seems to go on! From the immense extent to which they are spreading, one would say that the Caucasians seem destined to fill the earth. Certain it is, that they appear to have peculiar capabilities for successful colonization.

it already, for there can be little doubt that they once stretched to the Mediterranean. Benevolence at first shrinks from the idea of a consummation like this; but reflection soon reconciles us to it. The supplanting of one race by another does not imply the extensive destruction of individuals which it at first appears to do. It only, in the main, denotes a stronger principle of population in the one race than the other. The development of numbers in the one is repressed, in the other encouraged, till at length the first may be said to die out, leaving the intruding race in possession of the soil. Generally, where such changes take place, the soil becomes the means of supporting far greater numbers than formerly.

The Wahabees in modern times, and in past days the Phœnicians and Idumeans, whose respective capitals were Tyre and Petra, are further specimens of Arab tribes. The last two tribes sprung, it is probable, from the primitive Chaldean branch, settled at Babel or Babylon. Whatever be its ultimate destiny, we may anticipate that the Arab race will yet play a greater part on the scene of earthly affairs than it has hitherto done. The capacity of the race is high, and under favourable circumstances, as when settled in the cities of Spain, their native talents for poetry, music, and the fine arts, developed themselves in no ordinary degree. Planted in cities on the fertile banks of the Niger, of which they are rapidly assuming the mastery, they might in time renew there all the splendours of the Caliphate.

The *Nilotic* (Coptic or Egyptian) branch of the Caucasian family, is chiefly remarkable on account of its high distinction in past times, when the tribe founded the civilization of the world. The Nilotic branch consisted of the Egyptians, Nubians, and Abyssinians; and, though these nations have long been commingled with the Arabs, producing the mixed race of Fellahs, yet the pure Nilotic characteristics can still be traced among them. Slender persons, long limbs, and delicate feet, narrow oblong foreheads, eyes elongated in a peculiar manner, long noses, with swarthy brown complexions, seem to have been the main personal features of the old Egyptians. The pure Copts now-a-days exhibit various shades of colour, from a pale olive to a deep brown. The flat features and bushy hair of the Sphinx led the traveller Volney to form the hypothesis that the old Egyptians were Negroes; but his desire to arrive at a liberal conclusion carried him too far. The numberless paintings since discovered, in many of which negroes appear as captives, exhibiting features perfectly distinct from those of their Egyptian captors, prove incontestably that the Nilotic race were of the Caucasian variety of mankind. Even at this day, the Nubians, certainly the purest descendants, as a nation, of the old Egyptians, have in no case the woolly hair, flat features, or long heels of the Negro race, though sometimes nearly jet black in complexion. They have the Caucasian heads and forms most undeniably. At what time the banks of the Nile from the Abyssinian mountains to the seven-streamed Delta, were peopled by the Nilotic race, it would be vain to conjecture. It is only in the case of countries far more distant from the cradle of the race, that we can form any rational conclusions upon the date of immigration. It is scarcely necessary to add, that history proves the Coptic race to have possessed the highest intellectual capabilities.

The *Hindostanic* branch of the Caucasians presents an extraordinary variety of complexions, from a deepish black to a beautiful brunette. Shades of olive, however, are the predominant hues. Small, elongated, and narrow heads, oval faces, noses slightly aquiline, bright black eyes, and dark glossy hair, with very short slender persons, mark the pure Hindoo race. Passing by the claims which they themselves prefer to immense antiquity, there can be no doubt that they have been longer settled as a nation than almost any on the earth. They early attained to distinction in the sciences, and particularly in mathematics, poetry, and the drama. What was the precise place of their origin has been long a matter of dispute. From the great reverence borne by them for the north, and from the unquestionable intercourse existing between them and the Egyptians in the very earliest times, as well as from the numerous points of similarity between the two nations in many important respects, a common and intermediate spot might be regarded as likely to have produced both. But conjecture on this point would be fruitless.

We have now gone over the various prominent branches of the great Caucasian family. To them we owe nearly all that dignifies the name, and enhances the happiness of the human being. All that we possess of written literature—from the poetic, historical, and philosophic treasures of Greece and Rome, and the romantic creations of Arabian fancy, to the productions of the modern press—has emanated from the Caucasian variety of mankind. The Pelasgian branch in ancient times, and the Teutonic or Germanic in modern ages, have been most distinguished for their institutions, and the various productions of the higher intellectual powers.

The Germans, in an early age of their history, were the first who raised WOMAN from the condition of a slave to that of an equal with man, and made her a partner in his powers and rights. The importance of this change is best shown by the fact, that, to woman's condition among them at this hour, the Mongols and other varieties of men certainly owe much of their inferiority. Free political institutions, elective senates, and jury trials, came from the Germanic race. They were the discoverers of printing, of the compass, of the steam-engine, of gunpowder (a great invention, however abused), and of accurate time-measurers. To these discoveries numerous others might be added; but when we think how much the happiness of man now depends even on these few, we feel it unnecessary to extend the list. The Caucasians proper, and the Celtic family, have shown surprising genius in many departments of intellectual exertion, but, in all the industrial arts that bear practically on human comfort, they must yield the palm of merit to the Germanic family.

Mongolian Race.

2. The MONGOLIAN variety, as regards numbers, is a family of vast importance; the tribes of the Mongol-Tartars, the Turks, the Chinese, the Indo-Chinese, and the Polar races, being included in it. These tribes cover an immense portion of Asia, from the line of the Ural and Himmaleh mountains to Behring's Straits; and they are spread over more than one-half of North America, towards the Arctic Circle. They also occupy Greenland and a portion of the north of Europe, comprising the Finland and Lapland coasts.

The physical characters of the Mongolian race vary considerably, but the following general description will be found to apply extensively. The skin is commonly of a sallow or olive tint, and in some cases nearly yellow; the hair is black, long, and straight, seldom curling; the beard usually scanty; the iris black; the nose is broad and short, and the cheek-bones broad and flat, with salient zygomatic arches; the skull is oblong, but flattened at the sides, so as to give an appearance of squareness; and the forehead is low. In intellectual character, the Mongolians are by no means defective, but they are more distinguished for imitative than inventive genius. This faculty at the same time renders them highly susceptible of cultivation. In many cases, however, tribes of this variety have arrived at considerable proficiency in literature and the arts. Their moral character is decidedly low. China, Japan, Thibet, Boutan, and Indo-China, may be mentioned as locations where the best-marked specimens of the Mongolian variety are to be observed. The Turkish and Mongol-Tartar tribes have been great conquerors in past times, and have often even vanquished the Caucasians; but, in most cases, they have afterwards been repelled from their acquisitions by the Caucasians, succumbing to the apparent law of nature which gives these the ultimate superiority in all struggles with the other varieties of men. The Fins and Laplanders appear to be a remnant of some primitive Mongolian people, whom the Caucasians originally pushed to the extreme verge of the Arctic seas, and were content to leave there. The Esquimaux, as well as the people of Finland and Lapland, have some physical peculiarities distinguishing them from other Mongolians, but these seem to be the effect chiefly of local position, which undoubtedly exercises a *degree* of influence on the human frame.

Ethiopic, or Black Race.

3. The Ethiopic or Black variety of mankind are characterized by complexions of jetty hue, black woolly hair, eyes large and prominent, nose broad and flat, thick lips, and wide mouth; the head is long and narrow, the forehead low, the cheek-bones prominent, the jaws projecting, and the chin small. A long protruded heel, also, and a flat shin-bone, often distinguish this variety. The principal Ethiopic families are the Negroes of central Africa, the Caffres, the Hottentots, the natives of Australia, and some of the Islanders of the Indian Archipelago and the Pacific Ocean. The lands over which this variety is spread (numbers being left out of the question), are proportionally of somewhat smaller extent than those occupied by any of the other varieties of mankind, with the exception of the Malays. The Mongolians, to be more explicit, occupy the largest share of the globe; the Caucasians (their various colonial settlements being included) stand second in this respect; the Americans occupy a portion slightly less than that of the Caucasians; the Ethiopic variety stand next in the list; and the Malays are lowest of all in the scale. The following figures will further show the proportions of these territorial holdings in a rough manner:—Mongolians, 4; Caucasians, 3; the Americans, 2½; the Ethiopians, 2; and the Malays, 0-1-20th. The chief locations of the Ethiopic race are—Africa south of the desert of Sahara; New Holland; New Guinea; New Georgia; and a few other Polynesian islands. Most island Negroes are of a dingy brown hue. In disposition, this variety of mankind are easy, indolent, and cheerful; in intellect, the race varies much, though certainly the majority of its tribes stand low in this respect. This may be in part ascribed to want of cultivation, and opportunities for cultivation; but even while adopting this lenient view of the matter, it is impossible to shut our eyes to the fact, that the race have shown no inventive genius. They would otherwise have long ago originated the arts of civilization for themselves, as other varieties of men certainly did. At the same time, many of the Negro race have shown no mean degree of talent, and some of them have exhibited such address in the arts of politics and war, as indicated the capability of attaining to a high state of intellectual advancement, had their powers been properly fostered and directed.

American Race.

4. The American variety of mankind occupy well-defined territorial limits. They were originally spread over nearly the whole of the Americas, south of the sixtieth degree of north latitude, though their numbers are now thinned, and their territorial possessions curtailed, by the colonial incursions of the Caucasians. A reddish brown complexion, long black lank hair, deficient beard, eyes black and deep set, receding brow (sometimes from artificial compression), high cheek-bones, prominent aquiline nose, small skull, with the apex high and the back part flat, large mouth and tumid lips, with fine symmetrical frames of middle height, form the chief physical characteristics of this race. "In their mental character," says Professor Morton, by whom they have been thoroughly studied, "the Americans are averse to cultivation, and slow in acquiring knowledge; restless, revengeful, fond of war, and wholly destitute of maritime adventure." The same writer divides the Americans into two great classes, one of which (Toltecans) embraces certain semi-civilized nations, as the Mexicans, Peruvians, and Bogotese, while the other includes all the hunting tribes of North America, the Brazilians, the Patagonians, the Fuegians, and other minor tribes, none of whom have exhibited the same capacities for cultivation as the first-mentioned nations. The Americans differ much in colour of skin and stature. Some of them are not brown, but of a perfect copper tint. The Patagonians are of almost gigantic size, while the Fuegians are very short in stature. Yet there are characters common to all, which have led accurate inquirers to set them down as being throughout one and the same people. Their languages have certain peculiarities found to be of universal occurrence among them, from Cape Horn to the far north. By those who, like Cuvier, have not viewed the Americans as an indigenous race, the mode in which the New World was peopled has been curiously inquired into, and it has been conjectured that they either came by Behring's Straits from Asia, or that some small party, in ages long past, was wafted accidentally across the seas to these vast shores. Such an occurrence as the latter has been proved to be not impossible, to say the least of it. But assuredly the weight of evidence is in favour of the opinion that the Americans are, not a casual offshoot from some other human family, but a people so far indigenous, at least, and primitive, as to be derived from a common root, endowed with specific and unique physical characters. The manner in which they were planted in their destined

home, and received these peculiar characters fitting them for its inhabitation, must remain, according to this view of things, among the mysteries which the Creator has seen fit to leave in darkness. It is undeniable, it may be observed in conclusion, that the American race is tending to extinction

Malay Race.

5. The MALAY variety of mankind are characterized by tawny or dark brown skins, coarse black hair, large mouth, short broad noses, seeming as if broken at the root, flat expanded faces, with projecting upper jaws, and salient teeth. The skull in this race is high, and square or rounded, and the forehead low and broad. The moral character of the Malays, generally speaking, is of an inferior order. They are a race differing much, in some respects, from the Negro and Red Indian, being of peculiarly active temperaments, and fond of maritime enterprise. They exhibit considerable intellectual capacity, and are an ingenious people. Borneo, Java, Sumatra, the Phillipine Islands, New Zealand, part of Madagascar, and various Polynesian islands, are inhabited by this variety of men. It is extremely probable, from the fact of their being found in islands surrounded by others in the hands of the Ethiopic race, that the Malays have pushed out the less active variety from these isles, and, in short, annihilated them. It is but too likely, moreover, that the Malays will in turn suffer extinction at the hands of a superior variety, or a variety rendered superior by civilization, if not naturally so. Safely, indeed, may one prophesy that, in New Zealand, ere many years pass away, the natives will have disappeared before the European colonists. Not many months ago, the last native thus disappeared from Van Diemen's Land. So will it be ere long with New Holland, large as that continent is. Amalgamation of races is in these cases next to impossible, and no other preventive, as already stated, could be found.

DISTRIBUTION OF THE RACES—CHANGES AND AMALGAMATIONS.

This point, really one of the most curious and important connected with man's physical history, may be illustrated by further references to the changes in geographical position, undergone by the five great varieties of mankind now described, from the earliest periods. Very few portions of the earth have retained the inhabitants by whom they are known to have been first peopled. With respect to Europe, it seems extremely probable, as Dr. Prichard and others admit, that the Celtic and Germanic races were not the earliest settlers upon this territory. They pushed out, from some parts at least, a previous race, of which the Fins and Laplanders may perhaps be held to give us some idea. The Celtic population of the south of Europe were in a great measure overwhelmed by the Germanic tide from the north, and, though centuries of confusion followed the collision, the good ultimately effected by the intermixture was immense. It appeared, indeed, as if a savage people there crushed a civilized one, but the result, in reality, consisted in the infusion of healthy blood into a vitiated frame. At this day there is but one important part of Europe in the hands of the pure Mongolian race, namely, Turkey. But can we doubt that at this very hour the once formidable power of the Ottomans is verging to extinction! The Caucasian states around it have gradually seized province after province, and jealousy of each other alone prevents them from at this moment annihilating the petty remnant of the Mongols left in Europe. The power of the empire is not only going to decay, but, as M. Lamartine has lately shown, the Turks are in reality becoming extinct as a people. They are sinking beneath the pressure of the superior or superiorly cultivated nations around them.

In Africa, as has been said, the Negroes have already been stripped of one-half of their continent by the Caucasian Arabs, and are likely to be ultimately extinguished by them. If the climate of the same great country had been more favourable to the pure Caucasian whites than it is, they would assuredly have taken a larger share in the occupation of it than they have done. As the case stands their aggressions have been considerable. Not to speak of their coast stations, they have colonized the southern extremity of Africa, and the Caffres and Hottentots are falling before them, or are receding to the interior, to be finally crushed between the opposing forces of the Arabs and Europeans. The Arabs themselves are beginning to feel the retributive pressure of the French on the Mediterranean coast. In Egypt, again, we may trace striking proofs of the same grand movement. Altogether, what with the Arabs and the whites of Europe, Africa may be expected, ere many ages pass, to be in the hands of the Caucasians.

In Asia, the conquering Mongols long held extensive rule, but the semi-Caucasian power of Russia in the north, and the British in the south, have torn from them immense territories, and every few years behold additional losses on their part. Even at this time the great Mongol power of China, which, by a policy cautious to an extraordinary degree, maintained for ages its independence, has forgot itself so far as to provoke a struggle not likely to terminate until China becomes little else than a Caucasian colony. The Australian continent, and the Polynesian islands, are also on the direct way to the same consummation.

The truth of the view now taken is more remarkably borne out by the history of the Transatlantic Continent, than by that of any other country. Rapidly, indeed, have the red men of North America fallen before the march of Caucasian colonization. The numerous islands of the Mexican Gulf have been so completely cleared of all traces of native population, that it has become a matter of doubt whether, on several of these islands, any native population ever existed. South America has been largely subjected to the same influences, and would have suffered more from them, had the Caucasians who went thither been a branch specially adapted for the business of colonists, and had not a considerable admixture of races peculiarized that colonization. As it is, the natives have been thinned, though the amalgamation alluded to, arising from the *comparative* similarity between the races, renders the truth difficult of discovery. In short, if we look at the whole course of the past history of mankind, we shall find the Caucasian race everywhere gaining the ascendancy, and slowly but surely renovating the population of the world.

In those instances where an amalgamation of varieties of men has taken place to a considerable extent (and there are a few prominent cases of the kind to be observed at present on the face of the globe), a population of a most extraordinary and heterogeneous kind has been the result. In parts of South America and Mexico, not only Europeans and native Americans, but also Negroes and Malays, transported thither chiefly as slaves, have contributed to form the existing population. Europeans and Negroes produce a race called Mulattoes; the children of Europeans and native Indians are termed Mesti zoes; and those of Negroes and Indians are styled Zambos. Of course, the sub-varieties are numerous—indeed, almost numberless. The European and the Mulatto produce Tercerons; the children of the Terceron and the European are called Quarterons or Quadroons; and those of Quadroons and Europeans are Quinterons. In the Quadroon, little or no vestige of dark blood is visible; but in most countries where these admixtures take place, the rights of pure white blood are only assigned to the Quinteron. Mexico, and the greater part of the states of the South American continent, including Peru, Chili, and Brazil, with the colonies and islands of the West Indies, are the chief scenes of these amalgamations of blood. Undoubtedly their immediate consequences are pernicious. The white blood is everywhere haughtily disposed towards the dark, and all the jealousies and oppressions of *caste* are accordingly displayed to a dreadful extent. Whether, out of the numerous varieties and sub-varieties of species there at present to be beheld, *one* perfect and homogeneous race shall ever be formed, is rendered doubtful by the undiminished, if not increased, eagerness with which the purity of the white blood continues to be maintained. If we could suppose that the amalgamations of different varieties of mankind were never to produce happier consequences than in these instances, we might question whether such admixtures be desirable. The experiments of amalgamation and non-amalgamation may be said to have been tried, on great scales, in the two American continents, and it is of importance to notice the issue in the respective cases. In North America, we must ere long find the aborigines extinct; and in the place of hordes of savages, stationarily pursuing the wild and warring life led by their fathers from time immemorial, will be found a great and improving race, cultivating the arts of peace, carrying human civilization to the highest pitch, and extracting from their vast continent all the blessings with which the Creator has so liberally endowed it, and which he certainly meant not to lie unused.

The general characters of the great varieties or families of men, the mode of their distribution over the earth, and the causes which have affected, and are likely hereafter to affect, their future fate, have now occupied our attention; and our next duty is to advert to the most remarkable features of difference in the various branches of the human family.

VARIETIES OF SKIN IN MANKIND.

It has been already seen, that the Caucasians are generally distinguished by a white or fair skin, while the Mongolians are yellow, the Ethiopians black, and the Americans red or copper-coloured.

In former times, when only two varieties, the white and black, were recognised or thought of, it was supposed that complexion was simply a result of the action of the sun's rays. This idea would naturally arise from its being observed that exposure to the sun darkened a white person, while seclusion tended to bleach or whiten him; and that the black nations were those which chiefly occupied tropical countries, while the whites were placed in the temperate zone. The Greeks, who never doubted that they were the perfection and standard of human nature, and who entertained exaggerated notions of the heat of the African sun, were strongly impressed with the idea that the Negro nations had been originally white, and had been changed into black purely by the action of the solar rays. This notion continued to be set forward undoubtingly by naturalists down to the time of Buffon, and it is still the belief of the ignorant in most countries.

The views of naturalists on this subject have recently been considerably affected by the investigations of M. Flourens concerning the actual structure of the coloured skin.* The white, as is well known, has a skin composed of three integuments. First, is the outer or *scarf skin*, a thin transparent pellicle, seemingly secreted by the parts below, and devoid of recognisable vessels or nerves. Next below is the *rete mucosum*, a soft, pulpy net-work. Next, or undermost, is the *cutis* or true skin, a strong layer, abundantly vascular, and very sensible. It was formerly supposed that the colouring matter of the dark races lay in the *rete mucosum*, and that the only difference between the two races, in that respect, lay in the one having a mucous integument charged with globules of colouring matter, and the other a mucous integument in which there were no such globules. If the investigations of Flourens be correct, the difference is considerably greater. He states that, in a sufficient variety of experiments upon the skins of Negroes and red Americans, he has found, beneath the *rete mucosum*, two distinct additional layers, capable of being detached, and the outer of which is the true seat of the colour of those races. M. Flourens considers this as a difference much more important than any depending on form. Being a structural difference, he thinks it should be held as one of the first class, while differences of shape ought only to be considered as secondary. Without following him in these speculations, we may readily allow the importance of a peculiarity which consists in a distinct and additional *part*. M. Flourens, it may be remarked, has found the two layers also in Mulattoes. He had not had an opportunity of experimenting upon Mongolians or Malayans; but he infers, from the other cases, that in them also the extra integuments would be found.

M. Flourens adds, that, in the case of Europeans tinged by exposure to the sun's rays, the mucous web is what is affected, becoming, as it were, slightly dyed. No degree of exposure can, he thinks, confer the colouring layers of the Negro and other dark races. He remarks, that the African Moors, who have lived beside the Negroes for centuries, have never acquired the colouring apparatus of that race; and it has been observed by travellers (Captain Lyon among others) that the Tuariks, a race of African Caucasians, of a dark-brown complexion, are nearly as white on those parts of their bodies covered up from the sun, as most Europeans. It is also well known that the progeny of an European, however much he may have been tinged by the sun, is invariably as white as he himself was at first.

The black races are localized in the warmest regions of the globe, and their skin and general constitution seem to be fitted for their allotment. A black man can lie naked, exposed to the hottest sun, without injury, while the skin of the white man, if exposed to similar heat, breaks out in blisters. The black man can labour under a burning sun with impunity; but the white man sinks under exertion made in such circumstances, and this is well known to be the cause why slaves were introduced from Africa into the settlements of Europeans in tropical America. Sir Everard Home, who made some laborious investigations into this subject, was puzzled by the obvious physical fact that the black skin must absorb more heat than the white. But it has since been suggested by Dr John Davy that the black perspires most readily. "In the Negro," he says, "the blood flows more readily through the vessels, so as to promote perspiration, and by that means contributing to the cooling of the surface, it contributes again, when it flows back to the heart, to the cooling of the internal parts." After quoting this remark, Dr. Glover of Newcastle says—"Were the inhabitant of the tropic not possessed of this organization, his system could not respond to the stimulus of heat, by a determination of fluid to the surface of the body; and the heat absorbed by the skin being prevented from entering the system by the perspiratory process, the greater *radiating* power of a dark skin must be beneficial in cooling. Again, the dark skin places the Negro in the conditions of his climate, by causing him to radiate heat at night, and he

* On the Natural History of Man. By M. Flourens. Edinburgh New Philosophical Journal, July, 1839.

some at that time cooler than a white under the same circumstances." Hence the love of the Negroes for night dancing and exercise.

M. Flourens deems the difference of structure between the white and coloured races as sufficient to prove that they are of different stocks, and he accordingly speaks of them as "essentially distinct races." But there are some considerations which greatly confound all such conclusions, as drawn from differences of colour alone. Colours, it is to be observed, are not invariable characteristics of particular races. Most Caucasians, it is true, are white; but then there are also black Caucasians. The Hindoos are undoubted Caucasians, being proved to be so by many characters of form. Yet the Bengalese and Malabars, varieties of the Hindoos, are often as black as the generality of Negroes. Caucasians of similar colour are spread through Persia and Western Asia, into Northern Africa. It has indeed been said that the Hindoo branch of the Caucasians alone includes every variety of colour, from the deepest black to something very nearly white. There are similar variations in at least one of the other four races. "Although the Americans," says Dr. Morton, "possess a pervading and characteristic complexion [which he describes as more brown or cinnamon-coloured than red], there are occasional and very remarkable deviations, including all the tints from *a decided white to an unequivocally black skin*." The white tribes have been found chiefly in the high regions in the northern part of South America. With such facts before us, we cannot admit that the colouring apparatus of M. Flourens decides that the races are distinct.

DIFFERENCES IN HAIR AND EYES.

Dr. Prichard has endeavoured to class mankind, with a regard to the colour of their hair, into three varieties, the *Melanic*, the *Xanthous*, and the *Albino*. The Melanic, or black class, comprises all individuals or races who have black hair; the Xanthous includes all who have brown, auburn, or red hair; and the Albino all who are distinguished by white hair and red eyes. With all due deference for the able writer who proposed this arrangement, it seems one from which no distinct or useful conclusions are deducible. The hair, however, is certainly a strong individual characteristic in man. Its colouring principle is evidently the same, speaking comprehensively, with that of the skin. The hairs issue from bulbs or roots beneath the true skin, where vessels supply them with nourishment. An external horny covering, and an internal pith, constitute the body of each hair, and the pith is to some extent vascular, because liable to disease. It is, doubtless, in this vascular pith that the colouring principle lies. The fact of the pith being supplied both with vessels and nerves, is further proved by the effect which great grief can produce upon the colour of the hair. Dr. Prichard had personally observed one case in which the hair grew white in a single night through grief, and many similar cases are on record. One distinguished French anatomist went so far as to assert, that in the bulbs of the hair lay the whole colouring matter of the skin; but, admitting that minute hairs exist on the general frame, we could not thus explain the black hue of the inside of the Negro's lip, which is quite free from hair. However, when we consider that the woolly hair seems to be inseparable from the jetty skin of the Negro, and the lank straight hair from the red skin of the Indian, we must believe in the existence of some strong bond between these physical characteristics.

In like manner do we trace a general correspondence between the colour of the eye and the skin and hair. The hue of the eye depends on a pigment or dye, lining the choroid coat or membrane. According to the tint of this pigment, is the eye blue, gray, brown, hazel, or black. Generally speaking, light-coloured eyes are conjoined with fair complexion and light hair, and the converse holds as commonly good. To this rule, it is well known, there are exceptions; yet Mongols, Ethiopians, Malays, and Americans, in ninety-nine cases in the hundred, show the extent of its applicability. The Caucasians display, in this respect, greater variations.

The Albinoes are scarcely to be called a variety of mankind, being a race whose peculiarities depend on *defects*. Red eyes and white hair are their chief features, though these features vary a little according to the race to which the individual belongs; and there are Albinoes to be found in almost all countries. The redness of the eye depends on the absence of pigment on the choroid coat, permitting the red blood-vessels to be seen. From a deficiency in the power of absorbing the rays of light, which purpose is served by the pigment, the eyes of Albinoes are weak. The Albinoes of the black race are called white negroes, from the colour of their skin, and they have white woolly hair. Among the copper-coloured natives of the Darien isthmus, Albinoes are common. Their bodies are of a milk-white tint, covered with a short down; and they have white hair, with red eyes. They love such light as the moon gives, and by night are all life and activity, while by day they are miserable, the rays of the sun making their weak eyes stream with water. It is needless to dwell on this subject, however, as the Albino peculiarities are, in the main, much the same everywhere. Europeans of this description are sometimes exhibited in public. The connection between skin, hair, and eyes, and the unity of the source of colour for all these parts, is very strikingly exemplified by the peculiarities of the Albino race.

SKULLS OF MANKIND.

Amongst the external distinctions of races, the form of the skull calls for particular attention. In describing these varieties, the shape of the skull of each was noticed in a general manner, and it would be observed that great differences existed with respect to this feature. From observation of an immense number of heads, Blumenbach arranged the skulls of men into three great divisions, the Caucasian, Mongolian, and Ethiopic, holding these to stand at extremes from one another. The skulls of the American and Malay seemed to him to stand intermediately between these. As, beyond all doubt (without carrying our belief to extremes, as some have perhaps done), we ought to consider the form of the skull as indicative of the intellectual powers, the distinctions in this organ necessarily become of great importance. The most perfect type of the Caucasian skull is found, as might be anticipated, in the modern Caucasian-proper, such as as the Georgians. "The head [of a female Georgian, described by Blumenbach] is of the most symmetrical shape, almost round; the forehead of moderate extent; the cheek-bones rather narrow, without any projection, but having a direction downwards, from the malar process of the frontal bone; the alveolar edge well rounded; the front teeth of each jaw placed perpendicularly."

The head of the perfect Mongolian type is, says Blumenbach, "almost square; the cheek-bones projecting outwards; the nose flat; the nasal bones, and the space between the eyebrows, nearly on the same horizontal plane with the cheek-bones; the superciliary arches scarcely to be perceived; the nostrils narrow; the maxillary pit slightly marked; the alveolar edge in some degree rounded forwards; the chin slightly prominent."

In the Ethiopic variety of men, "the head is narrow, and compressed at the sides; the forehead very convex, vaulted; the cheek-bones projecting *forwards*; the nostrils wide; the maxillary pits deeply marked at points the jaws lengthened; the alveolar edge narrow, long and elliptical; the front teeth of the upper jaw turned obliquely forwards; the lower jaw strong and large."

In the American skull there is an approach in shape to that of the Mongol, with this difference, that the top is more rounded, and the sides less angular. The summit of the Malay head is narrow, the forehead a little arched, and the upper jaw pushed somewhat forward. It would be superfluous to enumerate here the particular tribes marked by these varieties of skulls, as this has been done with sufficient distinctness in the general classification of the races. Of course, among Caucasians, Mongols, and Negroes, there are considerable individual differences in the form of the head, but the preceding descriptions give the type of each division.

No mode of examination exhibits so strikingly the differences in shape between the skulls of different races, as that called by Blumenbach the *vertical* method, in which the various skulls are placed in a row, resting upon the lower jaws, and are then viewed from above and behind. Examined from above, the facial bones of the Caucasian skull are scarcely visible, both from their comparative smallness of size, and because they are hidden by the rounded and well developed forehead. A perpendicular line, falling from the middle of the brow, would barely touch the front of the upper jaw. The Negro head, in the same position, presents a strong contrast to the preceding one. The narrow slanting forehead here permits the *whole face* to come into view, the cheeks and jaws being somewhat compressed laterally, and greatly elongated in front. In the case of the Mongol, again, we find a contrast not less remarkable. The bones of the nose, cheeks, and jaws, are almost equally visible as in the negro, but are expanded on each side, not pushed angularly forward. The squareness of the Mongol head arises in a great degree from this lateral expansion of the facial bones. Dr. Prichard gives to these varieties of the skull the respective names of *mesobregmate*, *stenobregmate*, and *platybregmate*—words expressive of the characters which have here been assigned to them.

This remarkable contrast in the prominency of the facial bones, conjoined, as it commonly is, with an equally striking difference in the anterior development of the skull, has been deemed by some physiologists a feature of the highest importance. Camper founded on these physical characters a scheme for estimating the degrees of intellect and sagacity bestowed by nature on the whole members of the animal kingdom possessing a skull and brain. The *facial angle*, as he termed the degree of prominency in the facial bones, was measured by him in the following way. One straight line was drawn from the ear to the base of the nose, and another from the prominent centre of the forehead to the most advancing part of the upper jaw-bone, the head being viewed in profile. "In the angle produced by these two lines," says the physiologist, "may be said to consist, not only the distinction between the skulls of the several species of animals, but also those which are found to exist between different nations; and it might be concluded that nature has availed herself, at the same time, of this angle, to mark out the diversities of the animal kingdom, and to establish a sort of scale from the inferior tribes up to the most beautiful forms which are found in the human species. Thus it will be found that the heads of birds display the smallest angle, and that it always becomes of greater extent in proportion as the animal approaches most nearly to the human figure. Thus there is one species of the ape tribe, in which the head has a facial angle of forty-two degrees; in another animal of the same family, which is one of those *simiæ* approaching most closely to the human figure, the facial angle contains exactly fifty degrees. Next to this is the head of the African Negro, which, as well as that of the Kalmuc, forms an angle of seventy degrees, while the angle discovered in the heads of Europeans contains eighty degrees. On this difference of ten degrees in the facial angle the superior beauty of the European depends; while that high character of sublime beauty, which is so striking in some works of ancient statuary, as in the head of the Apollo, and in the Medusa of Tisocles, is given by an angle which amounts to *one hundred* degrees."

Dr. Prichard, in quoting this passage, remarks, that "the faculties of each race of animals seem to be perfect in relation to the sphere of existence for which they are destined;" and hence, in as far as the measurement of the facial angle is applied to the determination of the comparative intellectual characters of different tribes of the lower animals, he holds Camper's scheme to be imperfect and ineffective. As a method of distinguishing varieties in the shape of the actual cerebral case, moreover, the measurement of the facial angle is not always a safe guard. "I have now before me," says Blumenbach, "the skulls of a Lithuanian Pole and a Negro, in which the facial angles are nearly equal, but the difference between the shape of the two crania is otherwise prodigious." Nevertheless, as a general test of the mental capacity of individuals, "I think," says Prichard, "we must allow that experience is in favour of the position assumed by Camper. It is certain that every man is struck with the expression of dignity or elevation of mind and character in the ancient busts, which have a great facial angle, and that this expression would be lost if the facial angle were contracted. The fact seems, indeed, to be a general one, that men of great intellect have fully developed brains, as indicated by elevated and capacious foreheads." Since the time of Camper, it is scarcely necessary to tell the reader, the subject of craniology has been amply investigated by Dr. Gall and his followers, who have founded upon their inquiries a system of mental philosophy in a great measure new to the world, and of which the fundamental principle is, that the size and form of the skull, as depending on the size and form of the brain within, denote the intellectual and moral character.

Whatever may be thought of the phrenological doctrine in its details, it is at least scarcely possible to dissent from the moderate conclusion of Dr. Prichard, that "fully developed brains indicate great intellect." Hence, leaving out of the question the connection of the development of the skull with that of the facial bones, the simple *capacity* of the cerebral case becomes in itself a matter of the highest consequence. We happily have it in our power, from the experiments of a most accurate inquirer, Professor Morton, to determine the comparative capacity of the skulls of all the varieties of mankind. The following are Professor Morton's conclusions:—

Having obtained a considerable number of the skulls of the various races of men, Dr. Morton measured their internal capacity by means of white pepper seed, and found the following results:—

Races.	No. of skulls.	Mean internal capacity in cubic inches.	Largest in the series.	Smallest in the series
1. Caucasian,	52	87	109	75
2. Mongolian,	10	83	93	69
3. Malay,	18	81	89	64
4. Aboriginal American,	147	80	100	60
5. Ethiopian,	29	78	94	65

It thus appears that the aboriginal Americans rank fourth with respect to the size of their brains, the Ethiopians being lowest and the Caucasians highest.

This result is certainly the precise one to be expected, considering the capacity of the cranium as an index of intellectual power. The Caucasian race, which stands highest in the scale, is that which has produced the most civilized nations; while the Mongolian, the next in order of capacity of cranium, has produced a number of nations which remain at a fixed point in semi-civilization. The Malay is a degree more barbarous, and the American and Ethiopian the most barbarous of all.

Though thus compelled, both according to the views of Camper and those of other physiologists, to admit an inferiority of organization, accompanied by an inferiority of faculties, in certain races as they at present exist, there is yet an encouraging prospect to cheer us. Reasons exist for the belief, that cultivation, in the case of both races and individuals, is capable of modifying even the shape of the skull; and hence, whatever be the peculiarities attending this physical characteristic in any existing race, we are not left, in this view of things, to despair of the possibility of improvement. Without some such compensating prospect, it would be painful to admit that the protruded bones of the face, the proportionably small cerebrum, and the almost simious lowness of forehead in the Negro, indicated a natural inferiority in the race. Many writers will not, indeed, countenance this conclusion. "I have not met with an individual, out of a great number of intelligent West Indian planters and medical practitioners," says Dr. Prichard, "who has not given a most positive testimony as to the natural equality of the African Negro and the European." The same writer also points to instances in which Negroes became excellent scholars, and wrote elegant Latin verses. But, on the other hand, Mr. Lawrence, with many able physiologists, gives countenance to the supposition of a decided inferiority of cerebral organization in the Negro, attended with a corresponding inferiority of faculties. It is certainly one remarkable circumstance, that, in the majority, at least, of those cases in which Negroes exhibit striking talent, their heads are found to approach the Caucasian formation in respect of shape. Phillis Wheatley, for example, a coloured girl, who wrote very pretty verses at an early age, is represented, in the plate attached to her little book, as having not only a Caucasian brow and head, but these of the finest order.

The physical characteristic now under consideration varies considerably among the white nations of Europeans. The Turks, who, though originally a Mongol race, have had their primitive physical attributes modified by continual intermixtures with Greeks, Georgians, and Circassians, present a form of skull combining, apparently, the mingled characters of the two varieties. The square Mongolian head has been rounded off in their case, and we find it to be now almost a perfect globe. The Greek head approaches the same shape. It was long asserted that the globularity of the Turkish head resulted from artificial compression in infancy, but modern physiologists discredit this notion. "A single glance at the Turkish head," says Mr. Lawrence, "at the symmetrical and elegant formation of the whole fabric, the nice correspondence and adjustment of all parts, the perfect harmony between the cranium and face, in all the details of each, demonstrate most unequivocally that it is a natural formation, and a very fine work of nature, too." The writer now quoted proceeds also to remark, that, although no sufficiently extensive examinations have yet been made, the probability is, that between the European nations, such as the Germans, Swiss, Swedes, French, and others, distinct differences in the shape of the skull would certainly be found to exist on inquiry. Mr. George Lewis observed in travelling on the continent, that the French have the lower and anterior parts of the cranium large, while the upper and anterior region is more prominent in the Germans. The Italian head, though comparatively small for the most part, is marked by great elegance. The Jews have long been noted for the fine Caucasian shape of their heads.

It is worthy of remark, that, though the globularity of the Turkish skull is not to be deemed the result of art, there are certainly races of people who modify the shape of the head by compression in childhood, and the views of Camper, as well as of the phrenologists, must be applied with some reservation to the skulls of one great variety of mankind. Many, very many, of the tribes of North and South America are so partial to low and retreating foreheads, that they have long been in the habit of assisting nature in producing that form of head. The comparative softness of the osseous texture at birth, and the partially mobile state of the cranial sutures, enable them to effect this object. "The Caribbs," says Labat, in his account of a voyage to the isles of the Caribbean Sea, "are all well made and proportioned; their features are sufficiently agreeable, excepting their forehead, which appears rather extraordinary, being very flat, and as it were depressed. These people are not born so, but they force the head to assume that form, by placing on the forehead of the newly-born child a small plate, which they tie firmly behind. This remains until the bones have acquired their consistence; so that the forehead is flattened to that degree, that they can see almost perpendicularly above them without elevating the head." The consequence is, that the heads of these people, naturally somewhat depressed in front, become hideously so; and unnatural bulges behind show that the cerebral matter has been forced into new positions. The possibility of changing the form of the skull has been doubted by some physiologists, but the circumstance is authenticated beyond all question. In Morton's *Crania Americana* are delineated many specimens of skulls thus altered in form, some so greatly changed by a pressure which has been applied both before and behind, as to resemble half-moons. It is not necessarily to be inferred that injury results either to the mental constitution, or the general health, of those who submit to this process. Supposing the pressure to be slow and gentle, the ductile organs will easily accommodate themselves to it, and it is probable that the brain, as far as its size or volume is concerned, will remain unaffected. A skull in Dr. Leach's possession, bearing the marks of extraordinary compression, is known to have been that of a Caribb chief distinguished for intelligence and prudence.

TEETH OF MANKIND.

The general differences of features, accompanying these variations in the shape of the skull, were pointed out in going over the great divisions of the human race. The teeth of mankind differ very little in shape or position. "The oblique position," says Mr. Lawrence, "of the anterior incisors in the Negroes, and some other tribes who have prominent jaws, is the only *national* difference I know of in teeth. Their size and form exhibit merely individual differences." One of the most remarkable individual varieties in the teeth, it may be observed, consists in the phenomenon of a double set in the same mouth. This is of rather rare occurrence, but the writer is aware of one instance, in which both upper and under jaw are encircled by a double row of extraordinary beauty. In case of a colonial settlement being founded by such an individual, and the dental duplicity being perpetuated in numerous descendants, would we not be apt, seeing a peculiarity so striking, to entertain doubts of the descent of the parties from the ordinarily jawed race of men!

FIGURE—PROPORTIONS—WEIGHT AND STRENGTH

The differences which exist among the races of mankind, with respect to Figure, Proportions, and Strength, form a branch of the present subject not less interesting than any yet noticed. It has long been attempted, in the civilized regions of the world, to ascertain and fix a standard of physical perfection for the human body; and there certainly does seem to be a model, the closest approach to which combines the quality of pleasing the eye with the possession of the greatest degree of corporeal power and activity. Artists have usually looked to the model-figures of the Caucasians of Greece, or, in other words, to their ancient statues, as exemplifying the finest possible proportions of the human frame. But the taste of man varies so much, and habit modifies to such an extent his physical powers, that any standard of the kind alluded to must be open to numberless objections and exceptions. If judged of by the common artistical standard of the civilized world, certain races of men would be set down as out of proportion, and yet they possess physical powers of the most perfect kind. The Hottentot and the American savage will outrun wild animals, and hunt down the deer; the slim and "effeminate Hindoo," as we call him, will keep up with the horse for days; and the South Sea islander feels himself at home in the raging surf, which would whelm a boat or vessel. Yet these races depart widely, in many cases, from the Grecian model. Such facts show that physical power is at least not confined to men moulded after the Grecian artistical standard, though it may be that individuals so moulded would surpass in the exercises mentioned, with equal training, those otherwise fashioned.

STATURE.

Different races of men exhibit considerable diversities of stature, though there are no varieties of stature in different nations so remarkable as those which frequently occur in the same family. The tallest race of men, authentically known to exist, are the Patagonians, a tribe occupying the coast of South America, between the Rio de la Plata and the Straits of Magellan. The territory occupied by them is of immense extent, and they are probably migratory in habits; hence a considerable degree of discrepancy in the accounts given of them by different writers. Magellan's companions declared the Patagonians to be commonly about seven feet four inches in height, English measure. Commodore Byron saw and conversed with many companies of them, and states that few were under seven feet, while others were considerably above it. Nearly six feet high himself, he could barely touch the top of a chief's head, though standing on tip-toe. Captain Wallis, again, having probably examined a different tribe, says that the majority of the Patagonians seen by him averaged from five feet ten to six feet, and that he only saw one man so tall as six feet seven. By later and accurate measurements, made by the Spaniards, we learn positively, that there are at least Patagonian tribes, reaching the average height of from six and a half to seven feet. Were they even somewhat less, they would be decidedly the tallest *race* of men existing on the face of the earth. All voyagers admit them to be large and muscular in proportion to their height.

A people situated in the polar circles of the north, stand nearly at the other extreme of the scale as respects stature. The Esquimaux, or at least some tribes of them, are for the most part between four and five feet in height, and their congeners the Laps are also a dwarfish race. They are of the Mongolian variety of mankind. The Ethiopic variety also numbers some very small tribes, and in particular the Bosjesmans, a race said to be also very commonly deformed. Among the American nations, there are also dwarfish tribes, and in particular the natives of Terra del Fuego, near neighbours of the Patagonians.

These nations only present us with the extremes of the human race, as respects stature. The subject is worthy of much more minute investigation. It would be highly interesting, and indeed instructive, to know the comparative average stature of each of the ordinary varieties and sub-varieties of mankind. Unfortunately, the observations of naturalists respecting stature have not been carried far. Quetelet and others have attentively examined the relative heights of individuals of *single* nations, at different ages, with a view to determine the general phenomena of man's growth; but few observations have been made upon the respective heights of different races or nations. The stature of the Caucasian has not been fully compared with that of the Mongol, or the Negro, or the Red Indian; nor have single nations, belonging to any of these great varieties, been satisfactorily contrasted with one another, as respects height. No accurate comparisons, for example, have yet been made of German with Spaniard, of Briton with Frenchman, or, in fact, of any one European nation with another. The following table, exhibiting the comparative heights of a small number of Englishmen and Negroes, is given in the work of Mr. Lawrence, upon the Natural History of Man. The Negroes were from various regions.

	Stature. Feet.	In.		Stature. Feet.	In.
An Englishman,	6	4½	A Negro, -	5	10½
Ditto, - -	6	1	Ditto, - -	5	5½
Ditto, -	6	0	Ditto, -	5	8
Ditto, - -	5	9½	Ditto, - -	5	0
Ditto, -	5	7	Ditto, -	5	7½
Ditto, - -	5	4½			
Ditto, -	5	0			

The Caucasian here has considerably the advantage of the Negro, the average height of the former class being nearly 5 feet 9 inches, while the black averages little above 5 feet 6 inches; and the advantage would still be on the same side, were we to leave the first Englishman, certainly a man of uncommon height, entirely out of the reckoning. But it must be admitted, that from such an insignificant amount of examples, no satisfactory conclusions can be drawn. The accounts of recent travellers in Africa would lead one to imagine that the majority of the Negro nations, excepting in the case of a few particular tribes, such as the Bosjesmans, are not below the Europeans in average height. The Caucasians have indeed the advantage in one respect; no tribe or section of them sinks so low in the scale of altitude as some of the other races do.

The stature of the Chinese, who must be regarded as amongst the purest specimens of the Mongol variety, was accurately and extensively measured by Mr. Rollin, the surgeon who accompanied La Perouse. He found the ordinary height of the natives of the great Isle of Tchoka, on the east coast of China, to be *five French feet*.* The natives of the mainland, near the same region, measured 4 feet 10 inches (French). This examination places the pure Chinese below the average height of Europeans, and, we believe, correctly. Other Mongol races have not been accurately examined, with a view to the point under consideration. In that variety of mankind, however, as in the Ethiopic division, there are individual races which stand much lower in the scale of height than any Caucasian tribe. The Esquimaux and Fins prove this assertion.

The Americans also present great differences in height; so much so, that it would be vain to attempt to discover or strike an average for the whole variety—a variety which comprises the giant Patagonians and the dwarfs of Terra del Fuego. For determining the heights of individual tribes of Americans, we have at present no better authority than the loose reports of travellers. The same may be said of the Malays; and, such being the case, it would be a waste of time to attempt any comparative estimate, having reference to these races. One conclusion may be drawn

* The French foot slightly exceeds that of England, the proportions of the former to the latter being as 1·066 to 1·000.

from the little which we do know, and that is, that civilization equalizes the stature of mankind, and keeps it near a steady mean. All the less cultivated races present extremes not to be observed among the Caucasians.

Professor Forbes of Edinburgh (the able successor of Leslie, in the chair of Natural Philosophy) has recently made a series of experiments upon the physical differences between English, Scotch, Irish, and Belgians, the results of which constitute the most interesting information we are able to lay before the reader, with respect to the comparative heights of sub-varieties of the Caucasians. The following is a table drawn up by Professor Forbes, to exhibit the relative heights, at different ages, of the students attending his class, during a series of years, and belonging respectively to England, Scotland, and Ireland. The Belgian measurements were probably derived from other sources. The number of individuals subjected to examination was very considerable, so many as eighty Scotch and thirty English being occasionally measured at once.

*Heights—Full dimensions with shoes.**

Age.	English.	Scotch.	Irish.	Belgians.
	Inches.	Inches.	Inches.	Inches.
15	64·4	64·7	...	61·8
16	66·5	66·8	...	64·2
17	67·5	67·9	...	66·1
18	68·1	68·5	68·7	67·2
19	68·5	68·9	69·4	67·7
20	68·7	69·1	69·8	67·9
21	68·8	69·2	70·0	68·0
22	68·9	69·2	70·1	68·1
23	68·9	69·3	70·2	68·2
24	68·9	69·3	70·2	68·2
25	68·9	69·3	70·2	68·3

This table places the Irishman uppermost in the scale of stature, the Scotsman second, the Englishman next, and the Belgian lowest. The comparison seems to be fair as regards the parties taken, for, if there were any peculiarity in their condition as students, it must have been common to all. As a comparison of national heights, therefore, the table perhaps exhibits conclusions pretty generally applicable, and we shall find it borne out by similar comparisons of *weight* and *strength*. Professor Forbes's observations are confirmed, in one point at least, by the following passage in Quetelet's work upon Man:—"When in England, we chose the terms of comparison from rather higher classes of society [he has been speaking of English factory *children*]; we find the stature of man rather *higher* than in France or the Low Countries, at least for young persons between eighteen and twenty-three years of age." Quetelet then alludes to eighty different measurements of Cambridge students, taken in groups of ten each. The average height of every ten was 58 feet, or 5 feet 9 inches and 3-5ths to each man. This is above Professor Forbes's average; but, as the English universities are only attended by the aristocracy, who are undeniably a section of the people above the average national stature, it is probable that, as a national comparison, Professor Forbes's table approaches nearest to the truth.

The table alluded to indicates the cessation of growth to take place at twenty-two, the case of the Belgians being the only exception. This exception may be accidental, but it is remarkable that Quetelet, a Belgian writer, and whose observations were chiefly drawn from Brussels and Brabant, lays down the following as one of his conclusions:—"It does not appear that the growth of man is entirely completed at twenty-five years of age." One can scarcely doubt the accuracy of this conclusion, which was founded on an examination of 900 individuals at the ages of nineteen, twenty-five, and thirty. It is perfectly possible, however, that climate and other circumstances may cause a difference in this respect between the Belgians and British. We learn from another of the valuable inferences made by Quetelet from his investigations, that the stature is materially influenced by residence in town or country. "The stature of the inhabitants of towns, at the age of nineteen, is greater than that of the country resident by 2 or 3 centimeters." An examination, accompanied with vast labour, of not less than 3500 individuals living in towns, and 6000 residing in the country, brought Quetelet to this conclusion, which is therefore in all probability correct, and will be found to hold good in all situations. It was only at the age of nineteen, however, that the stature of the townsman was found by Quetelet to exceed that of the rustic; and he conceives it possible, though it was not in his power to obtain full proof on the subject, that, "the inhabitant of the country may attain to a greater height than the inhabitant of the town, before the completion of the full growth." The truth is, that circumstances greatly modify the rate at which the growth is developed. The law of nature on the subject is thus stated by Quetelet:—"The growth of the human being, from several months before birth up till the period of complete development, follows such a law of continuity, that the accessions of growth diminish regularly in amount, in proportion to the age." Here, of course, each successive addition of growth is considered relatively to the growth previously acquired. "We shall find," he says, "that the child increases in size 2·5ths from birth to the end of the first year; 1-7th during the second year; 1-11th during the third year; 1-14th during the fourth year; 1-15th during the fifth year; 1-18th during the sixth year, and so on; the relative growth always decreasing from the time of birth." This simple law of nature, however, is liable to be greatly affected in its operation by circumstances. "Dr. Villermé remarks," says Quetelet, "that the height of man becomes greater, and the growth takes place more rapidly, other circumstances being equal, in proportion as the country inhabited is richer, the comfort more general, houses, clothes, and nourishment better, and labour, fatigue, and privations less during infancy and youth; or, in other words, the circumstances accompanying misery put off the period of the complete development of the body, and stint human stature. There can be no doubt of the accuracy of these remarks. The simple exposure to the action of cold, not to speak of toil, materially influences the growth of man; and we see this proved, conversely as well as otherwise, in all the extreme climates of the world. The warmth and luxury of cities develop rapidly the growth of all but the lowest classes. Our British gentry bear out fully the conclusion of Quetelet, that "individuals who enjoy affluence generally exceed the mean height; hard labour appears to be an obstacle to growth."

Two other conclusions, of those which Quetelet gives as the result of his patient and cautious investigations, are as follow:—"The limits of growth in the *sexes* are unequal; first, because woman is born smaller than man; secondly, because she sooner reaches her complete development; thirdly, because the annual increase of bulk which her frame receives is smaller than that of man." The seventh and last deduction is, that, "from the fiftieth year, the human body undergoes a diminution of stature, which becomes more and more marked towards the close of life." The writer does not assert that the declension is more than in appearance, and it probably is nothing more, though not less palpable to measurement than if real. On the other points it is unnecessary to make any remark. The present treatise cannot be ca

* Half an inch may be reckoned as equivalent to the shoe

ried beyond generalities, and we must be content, in many particulars, to regard the sexes only under the common title of mankind.

WEIGHT OF THE HUMAN BEING.

The stature, weight, and strength of the human body, form but parts of one and the same subject. Each of these properties or characteristics, if not dependent on, is at least closely related to, both the others. As the object here is to make the view of the species comprehensive rather than minute, it were to be wished that the *weight* of the body, among the various races of men, had been inquired into with some attention by naturalists. But, as in the case of the stature, this has yet been done only to a very imperfect extent. Quetelet has fully examined the comparative weight of the human body at different ages, and of differently placed individuals in a single nation; but no attempts have been made to determine the comparative weights of Mongol and Caucasian, or American and Negro. The endeavour to do so would be attended undeniably with vast trouble, and some may think the matter not worthy of it. This, however, is not a correct view of things. In all undertakings that require the exertion of physical energy, and more particularly in war, bodily weight, it has now been clearly shown, is a most important element; and, wherever the superiority in this respect lies, thither will success, other circumstances being equal, almost infallibly tend. An observation of the various collisions of troops on the field of Waterloo, whether of horse or foot, has been found to substantiate this proposition.

Professor Forbes extended his inquiries among his students, English, Scotch, and Irish, to bodily weight, adding examinations of similar, and also of mixed classes of Belgians. The results were as follow:—

Weight in Pounds, including Clothes.

Age.	English.	Scotch.	Irish.	Belgians (not mixed classes.)
	lbs.	lbs.	lbs.	lbs.
15	114·5	112	...	102
16	127	125·5	129	117.5
17	133·5	133·5	136	127
18	138	139	141·5	134
19	141	143	145·5	139·5
20	144	146·5	142	143
21	146	142·5	151	145·5
22	147·5	150	153	147
23	149	151	154	148.5
24	150	152	155	149.5
25	151	152·5	155	150

Here, again, the superiority lies with the Irish, the others holding the same relative positions as in the case of stature. The mixed classes of Belgians, in whose case the weight of clothes was deducted, ranked exceedingly low—134 lbs. being about the average. We have it in our power, fortunately, to compare the conclusions of Professor Forbes with those of other inquirers, in as far as the English and Belgians are concerned. The eighty students of Cambridge, weighed (with the clothes) in groups of ten, gave an average, as we are informed by Quetelet, of 151 lbs.—the precise mean, it will be observed, of the Englishmen of twenty-five years of age weighed by Professor Forbes. The Cambridge students, however, were between eighteen and twenty-three years old, and therefore the Cambridge estimate is a little higher than that of Professor Forbes, as it also was in the case of stature. With respect to the weight of the Belgians, as examined by Quetelet, he states that the mean weight of the Cambridge students of eighteen and twenty-three much exceeds that of Belgians of the same age, being nearly the same as that of men of *thirty* in Brabant and the other departments of Flanders.

The superiority of the Irish in point of stature and weight is remarkable. We shall find it borne out by a corresponding superiority in physical power, as shown in the table of Professor Forbes having reference to that characteristic.

Quetelet's conclusions respecting the weight of the human being at various ages, and the general laws regulating his growth in this particular, are nearly as follows:—The mean weight of male children at birth is 3·20 kilogrammes.* The weight of female infants is less, being 2·91 k. A child loses weight for the first three days after birth, and does not make any decided increase until about the seventh day. Ages being equal, man generally weighs more than woman; but at the age of twelve this is not the case. The sexes are then nearly equal in this respect. The period of complete development in man, as respects weight, is the age of forty. Woman again does not attain her maximum till the age of fifty. According to observations made on the most extensive scale in Belgium, the mean weight of man at twenty-five is 62·93 k.; at the age of forty (the maximum period), it is 63·7 k. The mean weight of woman at twenty-five is 53·2 k.; at fifty (the maximum period), it is 56·16 k.† The maximum weight of the human being is nearly twenty times the sum of his weight at birth. The mean weight of the human being, neither sex nor age being taken into account, is 45·7 k. From the ages of forty and fifty, men and women begin respectively to sustain a decrease of weight, from six to seven kilogrammes being the usual loss before the close of life.

STRENGTH OF MAN.

The strength of the human frame is a subject which has received much more attention than has been paid either to its weight or proportions. It is obviously, indeed, a subject of the utmost moment, whether we view it with reference to the comparative physical powers of different races, or simply as a question interesting to civilized man from its bearing on practical mechanics. Various methods have been proposed for determining accurately the strength resident in the loins and arms of the human frame; and the instrument called the *dynamometer*, invented by Regnier, is that most generally approved of and employed to the purpose. The dynamometer, however, though used by Quetelet, Professor Forbes, and others, in their experiments, is allowed to be far from perfect, and it is only by uncommon care and caution, that results can be obtained from it worthy of being depended on. It is an instrument which cannot well be described in mere words, and all that may be said of it here is, that it is so contrived as to indicate to the experimenter, on a dial-plate, the physical power resident in the loins and arms of the parties subjected to trial.

Observing the extraordinary displays of physical power and energy frequently made by savages, scientific men were long of opinion that civilization diminished the strength of the human frame. Other circumstances tended to foster this belief. The Negro is possessed of longer arms, or at least forearms, than the Caucasian, holding in this respect, it is worthy of remark, a middle place between the white and the ape, which latter creature has arms of great length. "I measured," says Mr. White, "the arms of about fifty Negroes, men, women, and children, born in very different climes, and found the lower arm longer than in Europeans, in proportion to the upper arm and height of the body." The same writer says that whites of 6 feet 4 inches, whom he measured had shorter arms than Negroes of middle size. Similar sources of physical superiority appeared to voyagers to be possessed by the Pacific Islanders, the Malays, and many other uncultivated races. But more attentive ob-

* A kilogramme is as nearly as possible 2 1-5 lbs. English.

† The mean weight, therefore, of man in Belgium at the maximum period, is little more than 140 lbs. English. This is much below the average of man in Britain.

servation has disproved the supposition. The voyager Peron took with him to the southern hemisphere a dynamometer, with which he experimented on the following number of individuals: twelve natives of Van Diemen's Land, seventeen of New Holland, fifty-six of the island of Timor (a fine race of men), seventeen Frenchmen, and fourteen Englishmen. The following numbers express the mean result in each case, the strength of the arms and loins being respectively put to the test. It is by lifting a weight that the strength of the loins is tested with the dynamometer.

Mean strength.

	Arms. Kilogrammes.	Loins. Myriogrammes.
1. Van Diemen natives,	50·6	...
2. New Hollanders,	50·8	10·2
3. Timorians,	58·7	11·6
4. Frenchmen,	69·2	15·2
5. Englishmen,	71·4	16·3*

The highest power of arm shown by any of the Van Diemen natives, was 60; by the New Hollanders, 62; while the lowest in the English trials was 63, and the highest 83. In *lumbar* power, or that of the loins, the highest point reached by a New Hollander was 13; the lowest of the English was 12·7, and the highest 21·3.

"These results," says Mr. Lawrence, "offer the best answer to the declamations on the degeneracy of man. The attribute of superior strength, so boldly assumed by the eulogists of the savage state, has never been questioned or doubted. Although we have been consoled for this inferiority by an enumeration of the many precious benefits derived from civilization, it has always been felt as a somewhat degrading disadvantage. Bodily strength is a concomitant of good health, which is produced and supported by a regular supply of wholesome and nutritious food, and by active occupation. The industrious and well-fed middle classes of a civilized community, may be reasonably expected to surpass, in this endowment, the miserable savages, who are never well-fed, and too frequently depressed by absolute want and all other privations." Such is the case, as Peron's experiments show. But indeed the same thing is shown by a hundred historical facts. The Spaniards, on their first visits to the New World, found the natives much weaker than themselves, and this was proved not only by hand to hand struggles, but by the labour of the mines, in which the Indians were far deficient. The backwoodsmen of the States have always shown themselves stronger, in single combats, than the Indians. The Russians of Europe, also, are said by Pallas to excel the Mongol tribes of the empire, to a remarkable extent, in physical power.

Proper and extended comparisons are yet to be made of the relative physical power of the various Caucasian nations. The following table of Professor Forbes gives us at least a glimpse at the comparative strengths of English, Scotch, Irish, and Belgians:—

Lumbar Strength in Pounds.

Age.	English.	Scotch	Irish.	Belgians.
15	...	280	...	201
16	33[illegible]	314	...	236
17	352	340	369	260
18	364	360	389	280
19	378	378	404	296
20	385	392	416	310
21	392	402	423	322
22	397	410	427	330
23	401	417	430	335
24	402	421	431	337
25	403	423	432	339

* Peron—Corrected Edition of his Voyages. (The myriogramme is nearly 23 lbs. English.)

The same relations are here preserved as in the previous tables, and as, with respect to weight and height at least, there could be no mistake, the probability that the last table is correct is much strengthened by the conformity in question. The difference between the Irish and Belgians is immense, the former exceeding the latter in strength by nearly one-fourth; while between the English and Belgians there is also a great difference, amounting to 62 pounds. The English, in Peron's table, showed a lumbar strength equal to about 376 lbs., a point considerably below that of the English in Professor Forbes's table. But we might expect such a difference between students and sailors, or stout colonists, which latter classes were those examined by Peron. Between the Scotch and Irish the difference is small comparatively. It is much to be wished that the example of the Edinburgh professor were extensively followed, both abroad and at home, so as to give us satisfactory views of the relative physical powers of the different European nations. Such questions, as already hinted, will be found to bear more directly on the prosperity of nations than has hitherto been commonly imagined.*

Regnier, the inventor of the common dynamometer, was led to the conclusion, after many experiments, that, between the ages of twenty-five and thirty, man is at the maximum of his strength, and that he is then able, by pressing strongly with both hands, to make an effort equal to 50 kilogrammes, and to raise a weight of 13 myriogrammes. Man preserves (says the same observer) much of his physical power nearly till the age of fifty, when it diminishes progressively. The experiments of another Frenchman, M. Ransonnet, made upon 345 of his countrymen, sailors of the port of Havre, give results somewhat different from those of Regnier. Ransonnet found the mean manual power of these men to equal 46·3 kilogrammes; and the lumbar power, or that of the loins, to amount to 14·2 myriogrammes. There is every reason to believe, however, that the particular mode of using the instrument employed by each experimenter, is the cause of such differences in its results. Quetelet's observations led to the following conclusions:—

Lumbar Power of Men and Women.

Age.	Men. Myriogrammes.	Women. Myriogrammes
9	4·0	3·0
15	8·8	5·3
20	13·8	6·8
25	15·5	7·7
30	15·4	...
50	10·1	5·9

The highest point which the dynamometer here gave, for the power of the loins in Belgian men, was 15·5, twenty-five being the age when the power reached this maximum point. The conclusion agrees very closely with those made by Peron on the French sailors of his party, who exhibited a lumbar power equivalent to 15·2 myriogrammes, falling below that of the English, which was 16·3. Other observations, however, would lead us to suppose that the difference is more in favour of the British, when compared with the Belgians, than this cultivation would indicate; and this would probably have appeared, had Britons been tested under Quetelet's own eye, and by his directions.

The difference in lumbar strength between men and women is remarkable, as shown in Quetelet's table. At the age of twenty-five, when both attain the maximum of lumbar strength, the woman is deficient by more than one-half. "The difference," says Quetelet, "is commonly less in early youth than at the period of complete

* We have been informed that the mere physical power of the different companies of men to whom the Duke of Wellington was opposed in his campaigns, was always with him an object of serious consideration.

development, the ratio being at first as 3 to 2, and becoming afterwards as 9 to 5. The power of the right hand, when tried separately from that of the left, exceeds that of the latter by nearly a sixth. If the results which I have attained be compared with those of MM. Regnier and Ransonnet, differences of a remarkable kind will be observed, which I ascribe to the manner in which the hands were laid upon the instrument, and to the distance left between them. According to the researches, however, of the gentlemen mentioned, the mean strength of man is estimated at about 46·3 and 50 kilogrammes, a weight not equalling that of man himself. Hence a man should not be capable of supporting himself with his hands. Now, experience tells us the very opposite of this. Among the sailors examined by Ransonnet, there would not probably have been found a single man who could not sustain himself for some instants at the end of a rope. Peron, who estimates the manual force at 69·2 kilogrammes, approaches nearer to the truth, but my own experiments carry the estimate considerably higher."

These conflicting results cannot but lead us to look with suspicion on the dynamometer, when in the hands of *different* experimenters. But the conclusions of single experimenters, who have compared a variety of individuals, are still to be held of value, since they would cause the different subjects of experiment to operate on the instrument in the same way. The conclusions of Peron respecting civilized and uncivilized men, as well as Englishmen and Frenchmen, are by no means to be deemed unworthy of credit, because Quetelet arrived at different general conclusions; and the same may be said of the observations of Quetelet upon the comparative strength of man and woman at different ages. To the observations of Professor Forbes the same remark applies, and we believe, with reference to them, that the conclusions which they indicate will hold extensively good. The Belgians partake largely of the Celtic blood, and the Celtic race will probably be found inferior to the Germanic, in almost all cases, in height, weight, and strength of frame. The superiority of the Irish, it may be thought, does not countenance this view of things, as they are in the main a Celtic people. But it is the English portion of the Irish population, chiefly, who are in circumstances to quit their country in quest of academical education, and such was, in all likelihood, the character of the majority of those who became the subjects of experiment to Professor Forbes. The peasantry, in some of the more retired districts of Ireland, present characters very different from those of the parties settled within what was called the English "pale." They are pure Celts, unquestionably, with short, spare, wiry frames, and features strikingly Celtic. Not to these, but to the English portion of the nation, must the conclusions of Professor Forbes be held chiefly to apply; and the people of the Scottish Lowlands, who encircle and attend the Edinburgh University, are, in like manner, a Germanized race. It is in this light that English, Scotch, and Irish, are to be ranked together, and collectively contrasted, as being all of them branches of a Germanized population, with the continental Celts. In height, weight, and stature, the superiority, we repeat, seems to lie with the former, and their national career may have been more affected by the circumstances than has hitherto been dreamed of. Future inquiries are likely to give to such physical characteristics a degree of weight not ascribed to them in time past.

Leaving the question of comparative degrees of strength, whether in varieties or sub-varieties of mankind, a word may be said respecting the extraordinary physical powers which *individual* men, of various nations, have occasionally evinced. We learn from history, that Milo, a Greek, could fell an ox with his fist, and afterwards carry it home on his shoulders. Firmus, a man who lived in later times, being born in Seleucia about the reign of the Emperor Aurelian, could suffer iron to be forged on an anvil placed on his breast, his body being then in the position of an arch, with only the two extremities resting on supports. He exhibited other feats of muscular strength, nearly all of which were successfully imitated, during the past century, by a German named Van Eckeburg. This man sat down on an inclined board, with his feet stretched out against a fixed support, and two strong horses were unable to move him from his position. In imitation of Firmus, he lay down, with his body in the form of an arch, and allowed a stone, one foot and a half long and one foot broad, to be broken on his abdomen with a sledge hammer. He also stood on an elevated platform, and, by means of a rope round his waist, sustained the weight of a large cannon, a burden for several horses. A flat piece of iron was likewise twisted by him into the form of a screw.

Dr. Desaguliers, a scientific gentleman who witnessed the German's feats, showed, however, that skill was more concerned in the matter than mere strength. With the aid of some friends, the doctor actually performed many of the same feats, on the very night on which he witnessed them. The simple sustaining of the stone, it seems, was the chief difficulty in the most striking of the experiments, as the breaking of it caused little additional annoyance; and, in place of increasing, the arched position of the body greatly diminished the shock of the blows. In the case of many of the other feats, in like manner, a skilful application of ordinary physical powers was found competent to their accomplishment. There appeared, nevertheless, about the same time with the German, an Englishman, named Topham, who performed equally wonderful feats by sheer strength, unaided by skill. He out-pulled a strong horse by main force, though in attempting to pull against two, he ultimately got himself hurt, being totally ignorant of the contrivances which his German predecessor used in aidance of his muscular powers. Topham rolled up pewter plates with ease, and unrolled them; he struck an iron poker, three inches in circumference and three feet long, against his bare right arm, till he bent it to a right angle; he placed a similar poker against the back of his neck, and, with a hand on each end, twisted it round, till the points met in front; after which he pulled it nearly straight again, his arms acting in a most unfavourable condition while he did so; and, finally, among other feats, he lifted with his teeth, and held out for a time, a strong table six feet long, with half a hundred weight hanging at the farther extremity.

We have accounts of men performing more wonderful feats than these of Topham, but they are either ill authenticated, or seem to have resulted as much from skill as strength, as in the case of the German. Topham appears, on the whole, to have been gifted with physical powers as remarkable as any that we can believe any human being ever to have naturally possessed, judging from the details on such matters given in merely secular history.

MENTAL CHARACTER.

It is only a recapitulation of much which has been stated in the earlier sections of this treatise, that great differences of mental character are exhibited by the various races of mankind. The black intertropical nations, generally, are decidedly the lowest in the intellectual scale. They are generally characterized by great indolence, as well as by gross barbarism and superstition. The idea of a social community has made but a small advance among them, though more among some tribes than others. The lowest of the class are to be found in Australia and some of the islands of the Pacific. Yet there is scarcely any tribe of blacks so mean, but they possess certain traits of mind calculated to produce respect, being in some instances surprisingly ingenious in fabricating particular articles, or in the management of canoes and the use of warlike implements.

The red races of North America are a considerably superior race to the Negroes. Their associations for war and other purposes are upon a more complicated scale; they show many remarkable traits of ingenuity; and in many tribes we find kindness and courtesy approaching to our ideas of the chivalric character.

The Mongolians, and the Indian branch of the Caucasians, must be considered next in the scale. They have formed great states, and made advances in the arts and in science; but a stationary character appears to be impressed on them all, and ages pass without their manifesting the slightest moral or physical improvement. The Malayan variety exhibits a somewhat inferior character to the Mongolians, but not so different as to call for special notice.

The Caucasian variety, as a whole, stands greatly above all the rest. It is characterized by superior sagacity and sentiment, and, above all, by a progressive character which other races have only shown in a very limited degree. The social arrangements formed by some branches of this race, are the most calculated to insure the general happiness which have ever been known. Their industry and perseverance, aided by the lights which they have deduced from science, have led to the production of an amount of wealth beyond the dreams of Orientals. Their benevolence has led them not only to found institutions calculated to succour the poor and afflicted in their own country, but to exert themselves for the benefit of other nations in every region of the globe. Wherever this race sets its foot, it makes itself master—a result directly flowing from its superior energy, skill, and perseverance. Amongst the branches of the Caucasian variety, considerable differences prevail. The Indian branch approaches to the Mongolian variety, and it is in the Pelasgian branch in ancient, and the Teutonic or German in modern times, that we find the utmost development of the finest faculties of the species.

PERMANENCY OF TYPES.

This subject has been already touched upon; but it calls for some special consideration. We find some interesting light thrown upon it in a work entitled "The Physiological Characters of the Races of Mankind considered in their Relations to History," by Dr. W. F. Edwards.

This writer cites the Jews as an example of a race who, for nearly two thousand years, have been spread throughout a variety of climes, yet have everywhere preserved their original features. In Leonardo da Vinci's picture of the last Supper, painted three hundred years ago, the figures are represented with countenances exactly resembling those of the Jews of the present day. That the present well-known type of this people has undergone no change at any time, is proved by the paintings found by Belzoni in the tomb of an Egyptian king, probably not less than three thousand years old. These paintings represent four different races in procession—1. The natives, of a dark-brown tint; 2. Negroes, with black skins, thick lips, and woolly hair; 3. Persians; 4. Israelites, distinguished by their complexion and physiognomy. The paintings were exhibited in London, where Dr. Edwards particularly examined them: he says, "I had seen, on the previous day, Jews in the streets of London; I thought that I now saw their portraits."

Dr. Edwards shows that there is much error in our ordinary ideas respecting the effect of conquests in changing population. There is a tendency in savage races to sink under a superior intruding race, as the Guanches have done in the Canary Islands, the Caribbs in the West Indies, [illegible] a particular Indian race in New [illegible] but [illegible] the original people are to a certain [illegible] ized [illegible] therefore numerous in proportion to [illegible] law seems to be, that they continue to form [illegible] of the population, while the conquerors become [illegible] progenitors of an aristocratic class. Even when the cruel Genghis Khan deliberated as to the propriety of massacring the people whom he had subdued in the north of China, it was shown to him, and he yielded to the suggestion, that they were better spared, as being useful for producing victual and paying taxes. We see the Hindoos continuing to occupy their country on this principle, after being subjugated; and the British, though they have exterminated the intractable savages of Van Diemen's Land, seem to contemplate encouraging into their service the more docile races of New Zealand. Reason is shown by Dr. Edwards for concluding that, in several European countries which have passed through the hands of various masters, the bulk of the people are still the same as in very remote times. Rome, and the Papal states, yet show a people of exactly the same type of visage with the ancient Romans as represented in busts and upon bas-reliefs. A people of one type, supposed to be that of the ancient Gauls, were distinctly traced by Dr. Edwards in eastern France and in northern Italy. [illegible] also adduces reasons for believing that the early Britons still form a large portion of the present population of England. History itself, rightly read, bears out these propositions. The Franks, who acquired the mastery in Gaul in the 5th century, were rather an army than a migratory nation. The Lombards, who overran and seized the northern half of Italy, are supposed to have only been about 100,000 in number. The immigration of the Saxons into England seems to have been upon a greater scale; but the Normans, led by the Conqueror, were only 60,000 soldiers.

The sterility of the people on their original ground, and the permanency of their original character, are both shown in a striking manner by the description which Tacitus gives of the Gauls, Britons, and Germans. The Gauls he speaks of as "gay, volatile, and precipitate, prone to rush to action, but without the power of sustaining adversity and the tug of strife; and this is the character of the Celtic portion of the French people down to the present day. He represents the Britons as cool, considerate, and sedate, possessed of intellectual talent, and says that he prefers their aptitude to the livelier manners of the Gauls. The same mental qualities characterize the English of the nineteenth century, and they and the French may still be contrasted in similar terms. He describes the Germans, allowing for the state of their civilization, as a bold, prudent, self-denying, and virtuous people, possessed of great force of character; and the same features distinguish them still."* It is scarcely necessary to remark, that the blue eyes and fair hair which the Roman historian attributes to the Germans, are still widely-prevailing features of their external physiognomy.

The perseverance of national types is supported by circumstances favouring the same conclusion with regard to individual families. It has been repeatedly observed, in galleries of family portraits, that a particular style of face, or some shape of feature, is handed down from one generation to another, or, passing perhaps over one or two generations, revives in a third. A certain thickness in the under lip has been thus hereditary in the royal family of Austria for several centuries. The face of the British royal family has experienced nothing but minor changes since the Electress Sophia, if not from earlier generations. Mr. William Howitt, in his work entitled "Visits to Remarkable Places," gives a portrait of a school-boy who was pointed out to him at Stratford-upon-Avon as a descendant of Shakspeare, and it is unquestionable that the face has a considerable resemblance to that of the great dramatist. The present writer may be allowed to state, that he has seen a claimant of the Wintoun peerage in humble life, bearing precisely the peculiar physiognomy of two or three of the children

* Essay by Mr. Combe, in Morton's *Crania Americana.*

of the baron of Queen Mary's time, as represented in a family group painted by Antony More, and engraved in Pinkerton's Scottish Gallery. The likeness in this case was as great as is ever seen between brothers. Another circumstance, in which the writer was personally concerned, will perhaps be considered as a curious illustration of the same point. He was one day, while walking in the country, struck by the appearance of a middle-aged gentleman who passed in a carriage, and who strongly reminded him of the common portrait of Sir William Wallace. He had previously, as might be supposed, no inclination to attach any credit to that portrait, but he could not help being greatly surprised when, upon inquiry, he learned that the gentleman who had just passed was General Dunlop of Dunlop, whose mother he well knew to have been the daughter of Sir Thomas Wallace, of Craigie, the last lineal descendant of a branch of the family of the Scottish hero. It may be added that the rencontre took place sixty miles from the seat of General Dunlop. As Wallace is now known to have visited France, it is not impossible that his visage may have been painted; or, supposing the portrait not his, it is likely to be that of some early member of the Wallace-Craigie family, in which case the anecdote would be not much less valuable as a proof of the long descent of a family face.

EFFECTS OF LOCAL CIRCUMSTANCES IN PRODUCING CHANGES.

On the other hand, there are proofs of considerable alterations having been produced in the external features of races by peculiar local circumstances. The descendants of the English settlers in the American states display a considerable variation, in general form and aspect, from the parent nation. The children of European settlers in New South Wales are tall, thin, and weaker than their progenitors. In the West Indies, some distinct new peculiarities of structure have been observed in the descendants of English settlers. Their cheek-bones are higher, and their eyes deeper set in the head, than those of the English nation generally. In these respects, they approximate to the form of the aboriginal races of the American continent and islands; and it has been pointed out that such a form is useful in protecting the eye-sight from the glare of the tropical sun. The Creoles have also cooler skins, and are keener of sight, and more supple in the joints, than the English. It has been remarked of the descendants of Africans in the United States, that, after three or four generations, their features lose much of the native African cast, and approximate to those of the white people, the mouth becoming smaller, the eyes lively and sparkling, the nose higher in the ridge, and the hair considerably longer and less crisp.

Analogous circumstances are observed among the lower animals. For example, the woolly sheep, brought into a tropical climate, loses its fleece, and retains only a thin coat of hair. The hogs of Cuba, all of which are descended from a European stock, are twice as large as modern European hogs. The horses which run wild in Paraguay, though all descended from variegated European races, are now of one peculiar colour, which we cannot doubt is the effect of some peculiar local circumstances.

Dr. Prichard says—"On considering these and analogous phenomena, we can hardly avoid concluding that the variations of animals proceed according to certain laws, by which the structure is adapted to the necessity of local circumstances." If such be the case, it must be held as a circumstance favourable to the supposition that all the races are sprung from one stock. The variations might, in that case, be regarded as altogether produced by local circumstances operating during a long course of time.

It is certain that the Negro skin, and, indeed, the whole Negro constitution, are better adapted for a tropical climate than those of the white man. It is also true that intertropical countries all round the globe are inhabited by black races, excepting only those in tropical America, which are so much elevated as to enjoy a temperate climate. We here see much reason for believing that the Negro is a being adapted, in a special manner, to live in a high temperature; and this seems the more likely, when we consider that blacks, on settling in northern latitudes, become the victims of several severe ailments, which seem to forbid that they should ever multiply in such countries. Blacks, indeed, and whites, appear to be respectively adapted to tropical and to temperate latitudes; and their attempts to interchange their proper situations are not in general attended with good effects, although, as we have seen, there is reason to believe that nature makes an effort, to a certain extent, to accommodate them to the changed circumstances.

CONCLUSION.

From all that has been written or learned on the subject of man's physical and social history, it appears evident that the constitutional character of the human being admits of a very high degree of culture and improvement. Nature ushers him into existence more weak and helpless than any of the lower animals, and, left uncultivated, he grows up an ignorant savage. In the most debased condition, however, in which he can be found, he possesses the rude elements of intelligence, and aspires to a destiny altogether beyond the reach of the creatures over which he has acquired dominion. His pre-eminence in the scale of being may be proximately traced to the structure of his brain, or organ of thought, which greatly exceeds in relative magnitude that of any of the lower animals; likewise to the capacity for speech, and to his upright posture; his superior mental development, when operated upon by a combination of happy circumstances, usually classed under the name of education, enables him to trace effects to causes, to convey an account of his experience to his fellows, and, above all, to put not only this experience, but his numerous and varied thoughts, on record for the benefit of future generations. In this manner, the savage, which man originally is, is gradually improved. Each new generation enjoys the benefit of an accumulated experience; and at last, as cultivation advances, man is found to be a highly intellectual being, with a frame more elegant and powerful than he possessed when his race was in a state of heathen darkness.

Indian Savage.

Under an all-wise Providence, man has assuredly been placed on this earthly scene to perform a part immeasurably more dignified than that assigned to the lower orders of animals, each of whose generations is in no respect advanced, and cannot possibly advance beyond the precise and humble station which was first occupied by its race. "In this point of view," to use the language of Lawrence, "man stands alone: his faculties, and what he has effected by them, place him at a wide interval from all other animals—at an interval which no animal hitherto known to us can fill up. The man-like monkey, the almost reasonable elephant, the docile dog, the sagacious beaver, the industrious bee, cannot be compared to him. In none of these instances is there any progress either in the individuals or the species."

Elevated, however, as is the meanest among human beings above the higher of the animal tribes, it is evident that for the proper performance of his part he must employ means for advancement, else he rests in a condition of ignorance and barbarism most deplorable to contemplate. Placed in a large and beautiful world, abounding with animal and vegetable existences at his command, and accountable for his conduct, it behoves him to pursue such a course of activity as will enable him to enjoy the full benefits of his situation. By pursuing that line of policy which leads to social melioration, he rises step by step to a high degree of civilization, and bequeaths to posterity almost imperishable monuments of his greatness. Attaining this enviable height, should he pursue or be the victim of a contrary line of policy, he sinks in the same ratio, and perhaps with greater speed, down to the original and humble level from which he had formerly arisen.

To be assured that these are not merely conjectural speculations, we have only to direct our attention to history, wherein examples are offered of the gradual rise, the eminence, the decline, and the ultimate extinction, of civilization. Again, like the growth of a new order of plants on the soil of an exterminated forest, we find on the spot once consecrated by deeds of human greatness, a different branch of the family of mankind, pursuing by toilsome steps a similar rise from barbarism, and asserting, in their turn, the exalted capacity for improvement common to all varieties of our race.

Although it is established both by scriptural record and geological discoveries, that man was placed on earth last in the series of animal existences, his race possesses a sufficient antiquity to embrace various instances of the rise and decay of nations at a period so remote as to be beyond the reach of ordinary record, and only known by the wrecks of man's inventive genius. Thus, in the east, are found remains of architecture and sculpture, of the origin or meaning of which the oldest known nations were altogether ignorant, and which are a puzzle to modern archæologists.* Thus, also, throughout North and Central America, there are found vast monuments of antiquity and objects of art, of a date long anterior to that of the earliest recorded nations, and which these nations looked upon with awe and wonder. The valley of the Mississippi, in particular, abounds in an immense quantity of artificial mounds of various shapes and sizes, and forts of different kinds, the origin of which is altogether unknown, but which are doubtless the remains of an extinct civilized race. This country, as is well known, was found, in the earlier periods of American discovery, in the possession of those red races usually called Indians, who are now retiring before the advance of the whites. These red races manifest no symptom of possessing, or of ever having possessed, either the power or the inclination to erect such works: they disclaim having erected them, and in their traditions speak of them as the productions of a people who were their predecessors in the country, and have long been extinct.

* See article, Arabia Petræa.

To close this imperfect sketch of man's physical history we have only to add, that from all the existing remains of antiquity, both in the eastern and western hemisphere, and from all written history, it conclusively appears that mankind, taken in the mass, have in no respect degenerated in physical structure, but that individually they are as tall, bulky, and powerful, as they were in the earliest periods of their progress, while, as respects mental qualifications, they now, in all enlightened societies, occupy a station in the scale of being which it is reasonable to conclude was never before enjoyed.

Enlightened Englishman.

[BOOKS ON THE PHYSICAL HISTORY OF MAN

It is surprising that, when so much has been written on the natural history of all the inferior animals, so little has been written on that of Man. There are probably at this moment twenty books extant on the varieties of butterflies, for every one on the varieties of the human race. With respect to the anatomy and physiology of man, there are abundance of books, because the medical profession demands them; but his external appearance in different parts of the world, and the influence of climate, customs, &c., on his configuration, have been little studied by scientific men. The most complete general work on the natural history of man is that of Dr. Prichard, with coloured plates, of which a new edition was recently issued.

Dr. Morton's *Crania Americana* and *Crania Egyptiaca* are by far the most accurate scientific and important works connected with this subject which have ever appeared, as they not only discuss the present state, but the past history of the races to which they relate.

It is understood to be the intention of the United States government to publish a complete natural history of man, as a portion of the scientific result of the late Exploring Expedition; and a gentleman of profound science, who accompanied the expedition, has, since its return, visited Asia and Africa, in order to render the observations and researches required by so extensive an undertaking complete. Whenever this work shall appear, a most important addition will be made to the stock of information on natural science at present within the student's reach.

It begins to be understood that the distinctions of *race* have a most important bearing on national character and history; and under this impression inquiries into this branch of science will hereafter be prosecuted with great vigour and effect.—*Am. Ed.*]

CHINA AND THE TEA TRADE.

The Chinese Boodh.

GEOGRAPHICAL POSITION—BOUNDARIES AND DIVISIONS.

China—called by the inhabitants Tchong-Kouo, or the Middle Kingdom, from an idea that it is the centre or heart of the universe, around which all the other nations of the world lie scattered like minor provinces—is an immense country of Asia, extending from the 18th to the 41st parallel of north latitude, and from the 98th to the 123d degree of east longitude. The length has been estimated at 2000 miles, and the breadth at 1500; and, according to M. Gutzlaff, it contains an area of 1,298,000 square miles. It is conterminous with Asiatic Russia on the north-west; bounded on the south and east by the Pacific Ocean (that part of it being commonly called the Chinese Sea); on the west by huge mountains and sterile deserts, separating it from the great body of Asia; and on the north by the regions of Tartary, from which it is separated by the stupendous erection known by the name of the Chinese Wall, which extends 1500 miles in length. The Tartars call China, Catay and Nicancarou; the Japanese, Thau; and the natives of Siam and Cochin-China, Cin (pronounced Chin or Tsin). From the latter countries, lying nearest (nautically) to the Hindostan dominions, it is conjectured, with much probability, that the last-named appellation first gave rise to the European name of China. Some theorists, however, set down its derivation from the patronymic of the first imperial family Tsin, or Tai-tsin. The country is divided into eighteen provinces according to M. Gutzlaff; but other geographers enumerate only fifteen, and some fourteen. These provinces, as given by M. Gutzlaff, are—Chih-le, Shan-tung, Shan-se, and Ho-nan on the north; Këang-soo, Ganhwuy, Che-këang, and Fuh-keën on the east; Shen-se, Kan-suh, and Sze-chuen on the west; Kwang-tung, Kwang-se, Yun-nan, and Kwei-chow on the south; Hoo-pih, Hoo-nan, and Këang-se in the centre. These are again subdivided into portions corresponding to our counties, shires, and districts. Of these provinces, a survey was made by some Jesuit missionaries, employed by the Chinese government, nearly a century ago, the execution of which occupied about ten years. A manuscript map, by a Chinese, constructed according to this survey, is now preserved among the archives of the Royal Library of Britain. Po-cheli is now the principal province in the empire, from its capital Pekin being the residence of the emperor, and the seat of government. Its name signifies the northern court, in contradistinction to Nankin, or the southern court, where the emperor formerly resided.

INTERNAL APPEARANCE AND CLIMATE.

From its immense extent, it may easily be imagined that China presents almost every variety of scenery. It is intersected by three large rivers, one of which, the Yang-tsze-keang, is described as perhaps the largest in the world, and is connected with all the others by canals. There are also many other streams, and several large lakes in the interior; but nothing is known as to their actual extent. "In the long line of internal navigation," says Mr. Barrow, "between the capital (Pekin) and Canton, of 1200 miles, with but one short interruption, the traveller will observe every variety of surface, but disposed in a very remarkable manner, in great masses. For many days he will see nothing but one uniform extended plain, without the smallest variety; again, for as many days, he will be hemmed in between precipitous mountains of the same naked character, and as unvaried in their appearance as the plains; and, lastly, ten or twelve days' sail among lakes, swamps, and morasses, will complete the catalogue of monotonous uniformity. There is a constant succession of large villages, towns, and cities, with high walls, lofty gates, and more lofty pagodas; large navigable rivers, communicating by artificial canals, both crowded with barges for passengers and barks for burden, as different from each other, in every river and every canal, as they are all different from any thing of the kind in the rest of the world." One general feature, however, pervades the empire—the utter nakedness of the country as respects trees and hedges.

The climate of China embraces almost every degree of the thermometer. In Canton it ranges from 80 to 90 degrees during the summer, but the winter months are so cool that many of the inhabitants use fires. There can be no more certain criterion of the climate of any country than its vegetable productions, and we may therefore mention here generally, that within the bounds of China are all the varieties of tree, shrub, flower, and herb, to be found growing in every other country of the world. The temperature, however, may be generally described as rather warm than cold; but it is much affected by the direction of the winds, which may be literally said to "box the compass," with uniform regularity, during the various seasons of the year. They blow from the north and north-east in October, November, December, January, February, and March, during which months the weather is rather cold; in April and May, from east and south-east, when it is milder, but still cool; in June and July, from the south and south-west, when it is hot; and in August and September, from the west, when the temperature is oppressively sultry and hot. Speaking summarily, the coldest months are November, December, and January; the warmest, July, August, and September. Canton, although situated in the same parallel of latitude as Calcutta, is so much cooler during the winter months, that fires are generally used; nay, ice has frequently been found at Canton of the thickness of a dollar, but snow is never or rarely seen. The air is generally dry during the north, moist during the south, and clear during the west winds. The north winds are the most violent, and the south the most feeble. In the months of July, August, and September, the hurricanes, called by the inhabitants *Tay-fun*, usually occur, which, although extremely violent, and coming in sudden gusts, seldom occasion much disaster, owing to the inhabitants being prepared for them. The climate of China is, on the whole, highly salubrious; and many of the complaints common to the whole of Europe are there unknown. The Chinese profess to be free from stone, gout, and gravel complaints; and they are at all events seldom affected with cutaneous diseases. Much, doubtless, is owing to their uncommonly temperate mode of living, of which we will have occasion to say more hereafter. Epidemic fevers, however, are very frequent and fatal, arising from the crowded state of the towns and numerous swamps. The small-pox, too, was formerly very [illegible] the characteristic prejudice of the Chinese against [illegible] foreign innovations, however beneficial in the mode of treatment. Their physicians pretended to distinguish *forty* different kinds of small-pox; and when a favourable sort appeared, they endeavoured to propagate it, not by inoculation in the usual mode of incision, but by inserting into the nostrils a little cotton wool dipped in the *virus*, or putting on the clothes of the infected. Of late years, however, the European mode of vaccination has generally been adopted, and at [illegible] present moment has entirely superseded the ancient practice. Sore eyes, and even total blindness, are very common, and are undoubtedly to be ascribed to their low, crowded, and smoky habitations, conjoined with their practice of bathing the face in warm water even in the hottest of the summer months.

Several parts of China have suffered much from earthquakes; but there is no appearance of volcanic eruptions throughout the country, though various substances of that description are found in some of the islands along the western and southern coasts.

HISTORY.

From the grossly fabulous and exaggerated nature of the Chinese records, an air of doubt has been thrown over all their early annals. Pretending, as they do, to trace the foundation of their empire not only as far back as the time of the Deluge (of which, it is well worthy of remark, their traditions bear attestation), but even to a period long antecedent to it, it can scarcely be wondered at that a disposition should prevail to reject the whole as purely fictitious. There may be as much error in too great disbelief, however, as in too ready acceptance. The early annals of every nation are mingled up with much that is absurd, and obscured by the suggestions of ignorance and superstition. Nor are those Chinese historians, who trace the origin of their kingdom back through ninety millions of years before the Christian era, a whit more deserving of ridicule than the Romans themselves, who, with all their enlightenment, believed that the gods of their barbarous mythology took an immediate and active share in sublunary matters. The only substantial ground for wonder, in regard to China, is, that many modern writers, some even of our own country, should have given in their adhesion to the fabulous records of the native historians, and pretended to have established beyond doubt that the Chinese empire was founded more than 2000 years before the Christian era! The following may be given as an abstract of the res[illegible] of their veracious theories:—They suppose th[illegible] Moses, by Mount Ararat, does not mean to particul[illegible]ny individual mountain, but merely the first land [illegible] showe[illegible] itself upon the subsiding of the deluge, which they conjectured to be the elevated parts of Asia: That Noah followed the track of the large rivers of China which flow southward, as leading to a fertile and open country, and became the founder of the Chinese monarchy—identifying him with the Fo-nee or Foo-shee of their history: That, becoming offended with the impiety of his rebel offspring, he separated himself from them shortly before their presumptuous erection of the Tower of Babel; and, steering his course eastward, after 200 years' peregrination, settled himself in one of the northern provinces of China (2114 years before Christ). Here, having settled his colony, and established the religion, laws, and government, which he had received from his antediluvian ancestors, he died in the 115th year of his reign, and 950th of his life (1999 years before Christ). He was succeeded by Shin-nong or Zing-nung, who reigned 140 years, and at his death (1859 years before Christ) left the crown to Whang-tee or Hoang-tee the inventor of Chinese arithmetic and other arts, who reigned 100 years; and at his death left the crown to Shau-hau (1759 years before Christ).

But it were a mere waste of room to complete the enumeration of this genealogical succession of princes. Suffice it to say, that these theoretical historians trace it, with painful accuracy, down to the reign of Yau (1452 years before Christ), in the 67th year of whose monarchy happened the remarkable solstice mentioned in the book of Joshua, and which is actually noticed in the old Chinese annals, although without the specification of any year. From this time downward, the national records have undoubtedly some appearance of veracity, being principally contained in the *Shoo-King* (or history) written by Confucius, who lived about 500 years before the birth of Christ. Mr. Barrow, to whose researches the present age is chiefly indebted for the information most deserving of belief respecting this singular nation, suggests a much more moderate and rational supposition, of which the following is the substance:—He observes, that although the Chinese may be admitted to have been among the first nations of the world, after the Flood, yet they do not appear to have made such progress in arts and learning as the Chaldeans or Assyrians; that it is only from the time of Confucius that they seem to have advanced in civilization; that previous to his time, the country was divided into a number of petty kingdoms, under separate chiefs, with a recital of whose reciprocal wars and struggles for superiority the Chinese annals are chiefly filled; that their historical records are sufficiently abundant and complete during the last 2000 years, and the transactions of each reign fully detailed without interruption, down to the present time; and that, during this time, the empire of China has been less disturbed by [illegible]reign wars or intestine commotions than any other po[illegible] of the world of which we possess any accounts.

Even from this view of the subject very great deductions must be made. We are, however, compelled to walk according to our lights, and to offer the following summary of the Chinese dynasties, from the period when their chronicles begin to assume an air of probability:—

From the reign of Yau (mentioned above) until the final succession of the present royal family of Tching, or Tai-tsin, in 1644 (A. D.), the Chinese annals enumerate twenty-two imperial dynasties. Three royal families are mentioned as having possessed the throne from 1767 till 258 before Christ—Kia, Shang, and Chew. About the latter year appeared a Chinese hero, Chi-hoang-ti, who overran the empire, extirpating all the petty chiefs and rulers, and uniting the whole of China. He also built the great Tartar or Mongolian wall, and reigned until the year 207 before Christ. This prince was the first of the present family of Tai-tsin, who of course are justly proud of their great claims to antiquity.

The empire was, however, again dismembered, after his death, under his son Ul-shi, but was re-united, ten years later, by Lieu-pang. He adopted the new name of *Hang*, and founded the dynasty of Hang. The princes of this dynasty extended their conquests considerably to the west, and took part in the affairs of Central Asia. The religion of Tao-tse prevailed during their ascendency; and in the same period Judaism was introduced into China. In the course of time, the princes degenerated, and, under Hien-ti, China was divided into three kingdoms (220), which were again united by Wu-ti (280). Whilst the whole aspect of Europe was changed by the general migration of nations, two empires were formed in China, with the extinction of the dynasty of Tsin—one in the north (386), and the other in the south (420). After this, China was torn by internal commotions, and almost every province had a separate ruler, when, in 990, the people elected the able Shao-Quang-Yu emperor. He was the founder of the dynasty Sing, or Song, which reigned till 1279. His immediate successors resembled him, yet the country suffered considerably by the devastations of the Tartars. Under Yin-tsong (1012), the Chinese were forced to pay tribute to the Tartar Leao-tsang. Whey-tsong overthrew the empire of Leao-tsang (1101); but the Tartars possessed themselves of the whole of the north of China (Pe-cheli), 1125. Kaot-song II. was their tributary, and reigned over the southern provinces only. Under the emperor Ning-tsong, the Chinese formed an alliance with Genghis-Khan, and the Niu-cheng submitted to this great conqueror (1181). But the Mongols themselves turned their arms against China, and Kublai-Khan subjected them, after the death of the last emperor, Ti-ping (1260). Under the Tang dynasty, arts and sciences flourished in China; several of the emperors themselves were learned men. The Chinese authors call the Mongolian dynasty of emperors *Yuen* (from 1279 till 1368), and Kublai-Khan is by them called *Shi-tsu*. This was the first time that the whole of China was subjected by foreign princes. But the conquerors conformed themselves entirely to the Chinese customs, and left the laws, manners, and religion of the country unchanged. Most of the emperors of this line were able princes. But after the death of Timur-Khan, or Tsing-Tsang (Tamerlane), 1307, and still more after that of Yeson-Timur-Khan, or Tai-ting (1318), divisions in the imperial family frequently occasioned internal wars, which weakened the strength of the Mongols. The Chinese Chu took up arms against the voluptuous Toka-mur-Khan or Shunti, and the Mongolian grandees became divided among themselves. Toka-mur-Khan fled into Mongolia (1368), where he died (1379). His son Bisurdar fixed his residence in the ancient Mongolian capital Karakorum, and was the founder of the empire of the Kalkas, or northern Yuen. This state did not remain long united; but, after the death of Tokoz-Timur (1460), each horde, under its own khan, became independent; in consequence of which, they were, with few exceptions, constantly kept in subjection to China after this period. Chu, afterwards called Tai-tsoo IV., a private individual, but worthy of the throne, delivered his country from the foreign yoke, and founded the dynasty of Ming (1368 till 1644), which gave the empire sixteen sovereigns, most of whom were men of merit. On the frontiers of the empire, the remains of the Niudshee Tartars, now called Mantchoos, still existed. The emperor Shin-tsong II. gave them lands in the province of Leao-tong; and when an attempt was made soon after to expel them, they resisted successfully, under their prince Tai-tsu, and obtained possession of Leao-tong, upon which their chief assumed the title of emperor. He continued the war during the reigns of the Chinese emperors Huan-tsong and Hi-tsong, until his death. His son Ta-tsong succeeded him, and Hoai-tsong, a good but weak prince, was the successor of Hi-tsong on the throne of China. On the death of Ta-tsong, the Tartars did not appoint any one to succeed him, and discontinued the war. But in China, Li-tching excited an insurrection, during which Hong-Puan put an end to his life (1644). Li-tching's opponents called in the Mantchoos to their assistance. They got possession of Pekin, and of the whole empire, over which they still reign. Under Thum-chi, a child of six years old, the conquest of China was completed (1646–47), and the present dynasty of Tsing was finally established. He was succeeded, in 1662, by his son Kang-hi, who subdued the khan of the Mongols, took Formosa, and made several other additions to his empire. During the reign of this prince the Christian religion was tolerated, but his son Yong-ching prohibited it in 1724. The son of the latter, Kien-Lung, continued the persecution against the Christians (1746–73). He conquered Cashgar, Yarkand, the greatest part of Songaria, the north-eastern part of Thibet and Lassa, the empires of Miao-tse and Siao-Kin-tshuen, and extended his territories to Hindostan and Bucharia. He peopled the Calmuck country, which the expulsion of the Songarians had rendered almost a desert, with the fugitive Torgots and Songarians from Russia. In 1768, he was totally defeated by the Burmese of Ava: nevertheless, the Chinese took possession of a town in Ava in 1770, and returned to their country with the loss of half their army. They were more successful against the Miao-tse (mountaineers). Towards the end of his reign, his minister, favourite, and son-in-law, Ho-Tching-tou, abused his influence over him. Kien-Lung was succeeded, in 1799, by his 15th son, Kia-King. His reign was frequently disturbed by internal commotions. The Catholics, whom he favoured, have lost most of their privileges by their inconsiderate zeal; and at Pekin, the preaching of the Christian religion has been strictly prohibited. Kia-King was succeeded, in 1820, by his second son, Tara-Kwong, whom the Russians call *Daoguan*.

Such is a brief summary of the historical annals of this singular people. Throughout their chronicles occur many periods which are completely blank, and these chasms having been filled up, as usual, with gross fables, which throw an air of doubt over the whole; but it is worthy of remark, that many of the leading facts recorded in their more veritable histories, have been confirmed by contemporary travellers and historians of other nations.

On the whole, however, it appears, that, instead of having existed as a great and united nation from a period of 3000 years before Christ, as the natives pretend, China was not formed into one state until between 200 and 300 years before Christ. Since the establishment of the Mogul dynasty, the empire has not been again divided, but has experienced two great revolutions, at the accession of the Chinese dynasty of Ming, and the re-accession of the Mantchoo Tartar dynasty (Tsing) in 1644; and has scarcely in any reign been free from revolts, wars, and domestic seditions. Instead, therefore, of having a right to be regarded as a privileged country, governed from time immemorial by the same constitution, exempt from foreign conquest and intestine commotions, the only peculiarity it possesses, distinct from the other empires which have been swept from the earth, is—that owing perhaps to its peninsular situation, at the extremity of the habitable world, and its consequent exemptions from the destructive sweep of those conquering nations who supplanted those whom they overthrew, it has preserved its usages and manners in a great measure unaltered, amid the many internal revolutions it has undergone. Still, the fact of this, the greatest mass of population which was ever united under one government, being kept together in one bond of union for a period of time far exceeding that at which the earliest European nation may be said to commence, presents a moral phenomenon of the greatest interest, and seems altogether inexplicable by any of the usual principles which are supposed to bind society together. That it has neither been owing to the nature of the government, nor the virtue of the princes, nor the morality and peaceable disposition of the people, is certain; and we can only conjecture that the system of strict exclusion from all communication with foreign nations, and the national habit of appealing to ancient usage as the universal rule of conduct in all matters of life, have served to preserve their primitive habits and ideas in a great measure unchanged, and left unstimulated those energies invariably called into action by the free intercourse of mankind.

GOVERNMENT.

The government of China is not so much what is usually understood by an "absolute monarchy," as a specimen of what we learn from history to have been the social arrangement of a patriarchal family. The emperor, like the "head of a house" in those times, is perfectly unlimited in his power over all under him. He can dispose of the lives of his subjects at pleasure; can make or abrogate whatever laws he chooses; all offices and emoluments emanate from him alone; in short, he is equally the source of all power, honour, and mercy in the state. He can even appoint his own successor to the throne, either from his own family, or whatever class of his subjects he pleases. One of the leading principles in the Chinese constitution is to place as great a distance as possible between this universal autocrat and his subjects, and to hold him up as a demigod, a sort of *dragoman* betwixt heaven and mortals, alternately communicating the decrees of the one and the petitions of the other. He is altogether exalted above the common gross sphere of humanity. He is styled the "Holy Son of Heaven, sole guardian of the earth, and father and mother of his people." In fact, he is *believed* to be of heavenly origin; and this superstitious notion appeared sufficiently obvious by the obstacles opposed to the succession of the present Mantchoo dynasty, on account of their family not being able to trace its descent through more than eight generations. The new monarch, aware of the danger of this stigma to the stability of his throne, caused his genealogy to be drawn out and published, wherein it was given out that the daughter of heaven, descending on the borders of the lake Poulkouri, at the foot of the White Mountain, and eating some red fruit, conceived and bore a son, partaking of her nature, and endowed with wisdom, strength, and beauty; that the people of that nation chose him for their sovereign, and that from him was descended the present Son of Heaven, who filled the throne of China. This explanation at once satisfied all the scruples of his celestial subjects. Offerings are made to his person and throne, and he is worshipped by prostration, not merely in his presence, but in places where he is *supposed to be present*—as our sailors lift their hats on coming upon the quarterdeck of a man-of-war. When Lord Amherst, in his ill-starred mission to Pekin in 1816, stopped at one of the stages towards that capital, a repast was found prepared by orders of the emperor, and he and his suite were ordered to prostrate themselves nine times before the *table*, as if the descendant of the red fruit of Lake Poulkouri had been personally present. It is, of course, only in keeping with such superstitious notions, that the emperor should be reckoned not only the sovereign of China, but of all the world besides, the other royal personages being merely his vassals. "Heaven has not two sons; earth has not two kings; a family has not two masters; sovereign power has not two directors: only one God and one emperor." Such were the precepts of the learned Confucius, 500 years before Christ; and such is the doctrine of the Chinese at this hour.

This irresponsible autocrat bears two distinct characters: first, that of high priest; and, secondly, that of the sovereign of the empire, or "father and mother of the people." In the first character, he is sole mediator with Heaven for the sins of the nation; the sole officiator at all solemn rites and sacrifices for propitiating the favour of God. He has thus the exclusive credit of all the blessings the people enjoy—such as plentiful crops, favourable weather, &c.; and although occasions of public calamity, storms, inundations, and such matters, are also laid to his charge, yet such is the infatuation of the people, that they forgive his faults in consideration of the proof thus afforded of the attention of Heaven to his conduct! But care is always taken to present his character in the most amiable light possible to his subjects, who only hear of him as practising all the Utopian virtues of his station—remitting taxes and punishments, protecting virtue, punishing oppression, relieving the poor. So much for the head of the executive. What may be called the administrative government, consists of the emperor's council and the great public tribunals. The council is composed of the ministers of state, taken from the first order of mandarins, and presidents of the supreme tribunals, but is never assembled except upon occasions of extreme public importance; every thing being in general directed by an inner council, where the emperor sits in presence. There are six superior tribunals at Pekin. The first, named Lü-poo, watches over the training of mandarins, or persons to fill official situations, as well as over their conduct after being appointed to office; reports their proceedings and character to the emperor, and, in short, has them entirely under its surveillance. The second tribunal, called Ho-poo, may be designated the court of finance, where all the revenues of the empire, the royal treasures and domains, and every branch of public expenditure, are managed. The third tribunal, Lee-poo, or the court of ceremonies, superintends the observance of ancient customs and religious ceremonies; examines the public schools, and reports the progress of the sciences; receives foreign embassies; (a great tax on their time!) and regulates all matters of etiquette about the court. The fourth tribunal, Ping-poo, is something akin to our war-office, in having the management of all the military concerns of the empire. Fifth, Hong-poo is the police department, directing every thing relating to the detection and punishment of crimes. The sixth tribunal, Kong-poo, is the tribunal of public works, having charge of the palaces, public buildings, canals, mines, manufactories, &c. All these tribunals have under them a great number of subordinate tribunals scattered throughout the empire, subservient to their various objects of institution. Each of the six supreme tribunals has two presidents, one of whom must be a Tartar by birth, and the other a Chinese. They have, also, twenty-four assessors, who are half Chinese, half Tartars.

There is also another tribunal, the nature of which sufficiently demonstrates of itself the grand principle upon which the Chinese government is based—namely, of making every thing depend upon the emperor. This is a board of *censors*, who send an inspector to watch over the proceedings of each of the tribunals—both the supreme and subordinate. These functionaries take no part in the proceedings of the tribunals, but merely sit and attend to all the proceedings, which they report to their principals, and these again to the emperor. These agents are, in short, his spies; and by them he indirectly governs his empire. The mandarins are changed from one situation to another every three years, to prevent their acquiring too much influence with the people, at which times they are obliged to appear regularly at court—to resign the seals of office, we suppose, and kiss *the ground*, upon entering on a new one.

The beautifully complicated machinery of government just described, might be supposed, if properly regulated, well adapted for accomplishing its object; but it is only by that very elaborateness of construction rendered the more liable to be abused. The emperor being the prime source of all power, it would be requisite for him to manage the whole machinery with his own hands, or under his own inspection at least—a task which would require him to possess as many hands, heads, and eyes, as Briareus and Argus had between them. The necessity, therefore, of relying upon the fidelity of so many thousand agents for his information and the execution of his will, is in every department of his government taken advantage of; and the whole may be generally described as a uniform system of corruption, plunder, and oppression, from the prince to the beggar. As soon as the censors (or spies) visit the provinces, they are instantly waited upon by the mandarins, who attempt to purchase their favour with rich presents, the value of which has of course been raised by the most grinding exactions from the poor inhabitants. Every mandarin intrusted with any temporary lucrative commission from the court, makes all he can of it by the most unscrupulous means; and, by bribing the higher officers about the court, is allowed to sit down in quiet with his ill-got gains. As all complaints must pass through the hands of these officers, of course no remonstrance ever reaches the throne against such oppressions. It is true, frequent examples happen of a guilty mandarin, who is sometimes imprisoned, and his riches confiscated to the state; but it is well known that these examples of punishment do not originate in motives of justice. "The emperor," says M. de Guignes, one of the most intelligent of our modern travellers, "makes use of his grandees, as of a sponge, to suck up the riches of his subjects. When the sponge is full, he squeezes it, and sends it elsewhere to be filled anew." One mandarin, complained of by Lord Macartney, was dismissed by the emperor to the government of Quang-ton and Quang-see, with the following observation:—"I place you in a city where there are many European curiosities, but from which nothing is ever sent to me." The hint was not lost. Upon entering on his government, the inhabitants found it impossible to obtain an audience of him for less than a present of 15,000 or 20,000 piastres (£4500). "I have lived a long time in China," observes M. de Guignes: "I have traversed that vast empire in all its extent. I have everywhere seen the strong oppress the weak, and every man who possessed any portion of wealth, employ it to harass, to burden, and to crush the people." In fact the jealousy and suspicion which prevail between all the members of the government, from the emperor to the lowest of the magistrates, sufficiently evince how little they trust between themselves to their fine moral maxims, by the influence of which they pretend the throne is upheld, and the happiness of the people secured.

The great basis of the Chinese government is the strict inculcation of the sacred nature of filial obedience into the hearts of the young. The parent is understood to possess unlimited power over his offspring as long as they live—a maxim which has been for ages interwoven with their earliest feelings and ideas. The child stands in the same relation to the father as the father does to the sovereign. No wickedness or unnatural treatment by the father can relieve a son from his subjection. The merit of every good action performed by the son is ascribed to the father, but the son bears his own disgrace. In like manner, as already mentioned, the sovereign receives all the merit of the country's prosperity, but incurs no disgrace for its misfortunes. To be consistent, in thus placing the young and vigorous at the mercy of the old and feeble, the emperor sets an example, by prostrating himself, at the commencement of every year, before the empress-dowager, before receiving the prostrations of his officers and attendants. This same principle pervades all the branches of authority; the governor of a province or city being held as the father of all under his jurisdiction. The effect of this state-morality is, while it must certainly be viewed as the cause of the long stability of the government, to deteriorate the principles and feelings of the people, and destroy all genuine sentiment among them. From the beggar upwards to the sovereign, each individual is the slave of him immediately above himself; and, what is worse, all are aware of the hypocrisy of each other, and there are no other bonds to hold society together save the chains of tyranny

LAWS.

The laws of this singular nation may be described as those of the bamboo, the cord, and the scimitar. "This great nation," says Mr. Barrow, "may be aptly enough compared to a great school, of which the magistrates are the masters and the people the scholars. The bamboo is the ferula, and care is taken that the child shall not be spoiled for sparing the rod. The bamboo, however, is not used merely as an instrument for flogging the people. In the fundamental laws of the empire, it forms the scale by which all punishments are supposed to be proportioned to the crimes committed, and which are carefully dealt out by weight and measure. Punishment, as an example to deter others from the commission of crimes, would seem, indeed, to be less the object of Chinese legislation, than that of satisfying the claims of rigid justice—to wipe off a certain degree of crime by the infliction of a proportionate degree of suffering."

The laws are embraced in a code called the Leu-lee, which has generally undergone some modifications under each new dynasty, but has continued fundamentally the same from time immemorial. It is one of the duties of the mandarins to instruct the people in the provisions of these laws, and they are likewise promulgated in all the schools and public seminaries. The code of the present family, called Tai-tsin Leu-lee, consists of six great heads, to correspond to the functions of the six supreme tribunals, and embraces an epitome of the whole system of government. Our readers would not, we believe, thank us for an exposition of this institute of Asiatic jurisprudence; but the fifth division, relative to crimes and punishments, contains matter sufficiently curious and interesting. Treason—which, besides the crime of rebellion, comprehends nine other species of offence, among which are parricide, impiety, and desertion to a foreign power—is invariably punished with death, in the former case with the most lingering tortures. But it is not merely upon the criminal himself that the penalty for treason falls. All the male relations of such persons are indiscriminately beheaded, the females sold into slavery, and all their connections relentlessly put to death. And it is well did the vengeance of the law always terminate here; but it too frequently happens that whole villages, nay, sometimes entire districts, are [illegible]discriminately slaughtered for the crime of one indivi[illegible]. To intrude into the line of the imperial retinue while [illegible]eror is travelling, subjects the offender to [illegible] of the most extraordinary decrees is, that [illegible] physician is discovered compounding [illegible] manner not sanctioned by establi[illegible] with 100 blows. If any [illegible] majesty's food, the cook receive[illegible] [illegible] he mixes any unusual ingredient or [illegible] majesty's palate does not agree with, he rec[illegible] blows, and is compelled to swallow the article himself! All cases of deliberate murder are punishable by death; and death, with the most lingering torture, is denounced against parricides. The penalty of death is also awarded against a slave who shall strike his master; a son who shall strike his father or mother; a grandson who shall strike his grandfather or grandmother; a wife who shall strike her husband's father, mother, grandfather, or grand mother. But if a father kill a son, grandson, or slave, even designedly, the punishment is no more than sixty blows of the bamboo, and a year's imprisonment. Even this lenient punishment is generally remitted for a fine, as the law presumes the cause of the act to be the disobedience of the child, which is held as a crime of the deepest dye, as affecting the principle of the whole system of government. The jealousy of the Chinese law on this important point is further illustrated by the following decree—"That a child or grandchild, who is guilty of addressing abusive language to his or her father or mother, paternal grandfather or grandmother; a *wife* who is guilty of the same to her husband's father or mother, paternal grandfather or grandmother—shall in every case *suffer death by being strangled!*"

There are five degrees of punishment for offenders:—The first is inflicted by the lesser bamboo,* and is said merely to be in the way of reproof and admonition. The correction extends from four to twenty blows. The second degree extends from twenty to forty of the larger bamboo. The third is temporary banishment to the distance of 150 miles, extending from one to three years. The fourth degree is perpetual banishment, with one hundred blows of the bamboo. The fifth and ultimate punishment is death, either by strangulation or decollation. There are also various kinds of torture to extort confession and evidence. The punishment by the bamboo, however, is, in the case of offences committed by the officers of government, commuted to fine or degradation, and, under peculiar circumstances, the benefit of commutation by fine is extended also to private individuals. In fact, there is a regular scale of charges for those not legally excluded from the degradation of flogging, of which all who are rich enough may avail themselves. The motive of this regulation is evidently to fill the coffers of the royal treasury.

REVENUES.

No correct estimate, for want of the necessary data, has ever been ascertained of the actual amount of the revenues of this immense empire, and the most different statements have been put forth on the subject by various writers and travellers. The Chinese themselves, of course, attempt to impress foreigners with a most exaggerated idea of its magnitude. A Chinese minister represented it to Lord Macartney as amounting to a sum exceeding sixty millions sterling, of which, after defraying all the civil and military expenses, about twelve millions were supposed to remain for the emperor's private support. Mr. Barrow reckons "that fifty millions, in an economical government like this, where the officers and magistrates are so shamefully paid that they could not live without robbing the people, may be considered as an ample revenue for all the necessities of the state." Some late writers have reduced the estimate as low as twelve millions; but such a calculation is evidently absurd. Perhaps the nearest to the truth is that of the intelligent M. de Guignes, who accompanied the Dutch embassy in 1794. He drew up a minute summary of each individual tax and branch of expenditure, and their amount, and the result was as follows:—

Revenues, - - -	£31,555,554
Expenditure, - - -	22,222,221
Surplus,	£9,333,333

—the surplus, after the emperor takes what he immediately requires, being deposited in the public treasury. If this calculation be correct, it is evident that enormous sums must thus sometimes be accumulated. Mr. Barrow, it is true, says, "that the immense treasures said to have been amassed by the reigning dynasty, exist only in the imagination of the Chinese." But he seems to have forgotten what he himself states in another place, where, speaking of the various means adopted to preserve the emperor's popularity, he tells us that the sovereign sometimes remits a whole year's taxes to his people—a proceeding which could not easily be put in practice with an empty exchequer. The emperor has also private domains, the revenue of which was estimated by M. de Guignes at upwards of four millions.

The revenue is raised from a land-tax, amounting to about a tenth of its produce, one half of which is paid in money, and the other half in kind. There is, besides this, a tax on salt, coals, and manufactures; and a capitation-tax upon merchants, artisans, &c., who are held lowest in the scale of society. It is a curious fact, that the regulations for collecting the duties on manufactures, and preventing smuggling, resemble exactly the British system of permits, excise-officers, licenses, &c. In addition to these revenues is the large amount raised by the duties on foreign shipping and merchandise, of which we will have further to speak when we come to treat of the trade of China.

ROYAL FAMILY—COURT DRESS AND CEREMONIALS.

As may be imagined, the emperor is domiciliated in a style suited to his immense wealth, high rank, and pretensions to unlimited sway. His train of courtiers, officers of state, and other attendants, when he appears in public, which is exceedingly seldom, is inconceivably numerous; and being all apparelled in gorgeous silks and satins of the brightest dyes, garnished with gold and silver, their appearance is inexpressibly magnificent. But it is only while going through this public exhibition that all this show of wealth and magnificence has any reality. When released from duty, they retire to their mean and solitary cells in the outskirts of the palace, where they devour their rice out of wooden bowls with their chop-sticks, and then lie down on their mats on the uncovered floor, to slumber away the hours till their services are again required; for to enter into conversation with his fellow-slaves, would, as being so strange a departure from the national taciturnity, subject the parties to the suspicion of conspiracy.

The emperor has three classes of wives. The first consists of one who has the rank of empress; the second of two queens and their attendants; and the third, of six queens and their attendants. The emperor's wives and women are doomed to reside for ever within the walls of the palace, and are, after his death, imprisoned for life in a prison called the "Palace of Chastity."

The princes of the blood who are descended in a direct line from the reigning family, have their names and dates of birth registered in a yellow book, and have the privilege of wearing a yellow girdle; but those who are only of collateral descent, have their names enrolled in a red book, and wear a red girdle. So inimical is the spirit of the government, however, to a multitudinous nobility, that even the princes of the blood beyond the third generation, unless they have talents and learning to recommend them to some honourable employment to which rank is attached, gradually merge into the common mass. The princes have the privilege of being tried only by their peers, and may procure exemption from any corporeal punishment by a fine. The persons of those who wear the yellow girdle are held so sacred, that any one insulting them incurs death. Those who hold no office, only receive a salary equal to the pay of a common soldier in the Tartar bands, and receive 100 taels (about 30 guineas sterling) at their marriage. The emperor and his children wear robes of satin of a bright yellow colour, while all the other branches of the royal family, like the mandarins, wear robes of a violet colour. The emperor, his sons, and those of the first rank, are also distinguished by figures of dragons with five claws embroidered on their vestments; princes of the second rank have dragons with four claws: those of the third rank, as well as the mandarins, have, instead of dragons, serpents with four claws. The *button of ceremony* on the head-dress of the emperor consists of three dragons of gold, placed one above the other, encircled and studded with pearls. His upper robe has four circles embroidered

* This instrument, which makes so conspicuous a figure in the Chinese code, is of two sizes: the larger is five feet eight inches long, and two and three-fourth inches broad, and two inches thick, weighing two and two-third pounds; the smaller is the same length, two inches broad, one and one-fifth thick, and weighs one and five-sixths of a pound. The infliction is applied in open court, immediately upon sentence being passed.

with dragons. His necklace, which in his case alone is composed of pearls, consists of 1?2 pearls, and other ornaments of rubies, sapphires, and amber. His girdle is of a bright yellow, with four circles of gold, studded with rubies, sapphires, and pearls. The oldest son of the emperor, called Hoang-tay-tse has a similar button with his father, only with fewer pearls. His necklace is of coral, and he has a bright yellow girdle like his father, but unadorned. The bonnets of the sovereign and heir-apparent have also a figure of the idol *Fo*. The other sons of the emperor are adorned in much the same fashion as the eldest, but with fewer ornaments. All these distinctions of dress in the royal household—as indeed the apparel of every class in the kingdom—are expressly regulated by law.

The public exhibitions of the royal person, amid all the pomp and circumstance of his household, are limited to certain fixed festivals, such as the anniversary of his birth, beginning of the year, &c. "Those on the former occasion are the most splendid, all the principal officers of the government, tributary chiefs, and Tartar princes, being in attendance. As the ceremonies observed on such occasions—like every thing else in China—never vary, the following description of one in 1793, given by Lord Macartney, may be taken as an equally faithful account of the exhibitions of the present day:—'The 17th September being the emperor's birthday, we set out for the court at three o'clock in the morning. We reposed ourselves about two hours in a saloon, at the entrance of the palace enclosure, where fruit, tea, warm milk, and other refreshments, were brought to us. At last, notice was given that the festival was about to begin, and we immediately descended into the garden, where we found all the great men and mandarins in their robes of state, drawn up before the imperial pavilion. The emperor did not show himself, but remained concealed behind a screen, from whence, I presume, he could see and enjoy the ceremonies without inconvenience or interruption. All eyes were turned to the place where his majesty was imagined to be enthroned, and seemed to express an impatience to begin the devotions of the day. Slow, solemn music, muffled drums, and deep-toned bells, were heard in the distance. On a sudden the sound ceased, and all was still. Again they were renewed, and then intermitted, with short pauses; during which, several persons passed backwards and forwards in the *proscenium*, or foreground of the tent, as if engaged in preparing some grand *coup de theatre*. At length the great band, vocal and instrumental, struck up with all their powers of harmony; and instantly the whole court fell flat upon their faces before this invisible Nebuchadnezzar. The music might be considered as a sort of birth-day ode or state-anthem, the burden of which was, 'Bow down your heads, all ye dwellers on the Earth! Bow down your heads before the great Kien-long! the great Kien-long!' And then all the dwellers upon China-earth there present, except ourselves, bowed down their heads, and prostrated themselves upon the ground, at every renewal of the chorus. Indeed, in no religion, either ancient or modern, has the Divinity ever been addressed, I believe, with stronger exterior marks of worship and adoration than were this morning paid to the phantom of his Chinese majesty. Such is the mode of celebrating the emperor's anniversary festival, according to the court ritual. We saw nothing of him the whole day; nor did any of his ministers, I presume, approach him, for they all seemed to retire at the same moment we did."

All who are admitted to the honour of an audience of his "celestial majesty," are compelled to perform the ceremony of prostration, or *koutou*, which consists in prostrating themselves nine times on the ground, and beating it as often with their foreheads. This humiliating ceremony is exacted from foreign ambassadors as well as natives, as typical of the emperor's dominion over all the earth, and has been hitherto complied with by all the European plenipotentiaries who have visited the Chinese court, with the exception of the British; of which more hereafter. Of the other internal regulations of the royal household, nothing is known.

CLASSES OF POPULATION—OCCUPATIONS.

The population of China, under the emperor himself and his family, may be divided into eight distinct classes. And one of the most striking circumstances in the social system in this great despotism is, the want of that which has almost universally been reckoned indispensable to the stability of a monarchy—*a nobility*. With the exception of the princes of the blood, whose persons are in some degree held sacred, there is no rank but what is derived from the holding of some office in the state. But although those thus favoured are, by courtesy, esteemed noble, and even some families are, by the emperor's favour (such as the descendants of Confucius), allowed to retain a title of honour, they derive no power, privilege, or emolument therefrom. The sons of the highest mandarins derive no dignity or advantage from the rank of their fathers. As the possessions of the parent, too, are all equally divided among his sons, the riches of the greatest families diminish in proportion to the number of heirs; and if these are no way distinguished by talent, they soon sink back into the common mass of the people.

The great body of the people may be divided into the following classes:—The Mandarins, the Military, the Literati, the Bonzes (or priests), the Husbandmen, who are the most favoured class in the state, the Artisans and the Merchants, who are the *least respected, especially those who traffic with foreign nations!* It is one of the most curious features of this singular government, that, being so essentially despotic in itself, both in principle and practice, it possesses one feature generally reckoned the main principle of a democracy—namely, that *the highest honours and offices in the state are alike open to all classes of the people*. The meanest origin is no bar, and the proudest rank is no recommendation to the individual. This system, no doubt, soothes the public mind, and induces the people to bear with greater patience that insolence of office and stretch of power which they themselves have the prospect of exercising in turn. The result, however, is exactly in the inverse ratio to the plausibility of the system. "Where the offices of state," says Mr. Barrow, "are open to the very lowest of the people, when possessed of the requisite qualifications, the candidates for employment become so numerous, that every trifling fault is laid hold of to create a vacancy; and these frequent removals and degradations fall in precisely with the system of government, which is to break down all connection between the officers and the people, and to turn the respect and veneration of the latter exclusively to the sovereign." It is found, that the more mean the original condition of a mandarin has been, the more oppressive and extortionate is his conduct to those under him, not only with the view of making his origin be forgotten in his present elevation, but, knowing the insecurity of his situation, of making the most of it while it is in his power. The people, however, submit patiently to his exactions, assured that his dismissal (of which they are certain) will open the way for one of themselves to enjoy the same opportunities of robbery and oppression.

In accordance with the national system, however, the office of mandarin, to which all ranks eagerly aspire, is almost wholly engrossed by individuals selected from the three humblest classes—the husbandmen, the artisans, and the merchants. Those who have acquired wealth, by whatever means, generally enter into some of these occupations to render them more eligible for the office, in order that, by attaining it, they may enjoy the possessions in more security. Others purchase the office with their whole fortune, secure of finding the means of recruiting their finances during their three years' administration.

The mandarins consist of two classes, the civil and the military. The former, however, are the chief officers who govern the empire, although they are placed under such restrictions as to prevent their ever becoming dangerous to the emperor. They cannot marry in the province or city they govern, nor hold office in a province within fifty leagues of that where they were born, until they are sixty years old; with many other despotic regulations of the same nature. A mandarin has unlimited power in his district, but his conduct is watched by those above him, as it is the policy of the Chinese government to make every department responsible for the one immediately inferior to it. Notwithstanding this surveillance, however, and although their salary is barely sufficient for simple maintenance, it is regarded as a phenomenon by the Chinese to see a mandarin leave office without amassing great riches. Their means of accomplishing this we have already explained under the head of Government. Notwithstanding their infamous exactions, the people observe towards them the greatest reverence. They are saluted with the title of "Great Lord," and every one bends the knee while addressing them. The two chief classes of mandarins are divided into nine different orders, who are all minutely distinguished by particular parts of their dress. The most marked, however, is the button on the bonnet, which, among those of the first order, consists of a red ruby; others of a meaner order have a rock crystal; and the most inferior, one of gold. The number of civil and military mandarins is calculated at between 20,000 and 30,000.

The *literati* form the most distinguished part of the Chinese nation, as it is from amongst these that the individuals necessary for discharging all the higher duties in the state are recruited. To insure the adequate accomplishment of these learned statesmen, there is, as before stated (under the head of Government), a board of censors, named *Lü-poo*, to direct their studies, and examine into the progress of their erudition; and government has fixed for every city of the first, second, and third class, the number of literati allowed to qualify themselves annually in each, by taking out a diploma, corresponding to the degree of Bachelor of Arts in Britain. There are, then, in China, upwards of 24,700 individuals annually added to the qualified literati; and it is therefore conjectured, that there are never less than 495,000 of this body. These are all exempt from taxes of every description; and as soon as they have taken out their degrees, their names are enrolled in the lists of the *Lü-poo*, who choose from amongst them the higher orders of mandarins.

It is, however, in productive labour that perhaps two-thirds of the Chinese are employed; the remaining third, amounting, after deducting the civil and military officers, students, literati, &c., to about ten millions, being engaged in trading and manufactures. It is the great maxim of the Chinese government, that agriculture is the true source of national prosperity and wealth; and they have in every age honoured and protected the cultivators of the soil. This class, indeed, may be considered much the happiest and most independent of the nation; for although they pay to the amount of a tenth annually to the emperor, they have neither priesthood nor poor to support—unless the poor of their own families, whom all classes are bound to provide for. The monarch is the universal proprietor of the soil, and the tithe exacted from it is the whole rent paid by the farmer. But though the cultivator is thus in a manner a tenant at will, he is never disturbed in his possession so long as he continues to pay his land-tax, and has the power of letting out any part, or the whole, if he pleases, to another. As there are no public funds in which to vest capital, and commercial speculations are reckoned degrading, all classes are eager to lay out their capital in land. It is for this reason that even the princes and nobility vie with each other in countenancing agriculture. Yet, notwithstanding all this encouragement, the amount of land cultivated is trifling in comparison to the extent of the empire. By a report made to Kien-long in 1745, it appeared that there were only about 6,000,000 of acres under cultivation, out of the 640,000,000 calculated to be capable of tillage. From the want of enterprise, but still more from the want of skill and suitable implements, immense tracts of land are allowed to lie waste; and it is estimated that a fourth of the whole country consists of lakes and swamps, most of which are capable of being drained. It will easily be seen how inadequate the produce of the soil is to insure a regular supply of food to the inhabitants, in seasons of scarcity, occasioned by long droughts, which frequently occur; and when it is considered that there is no foreign supply of grain to make up for deficiencies, little wonder need be expressed at the terrific famines which often afflict the nation. To provide against these scarcities, a year's produce of the land is always kept stored up in public granaries; but this provision is never found sufficient to prevent the frequent recurrence of the most dreadful scenes of starvation.

We are somewhat puzzled what to say regarding the amount of the population of China; for although all accounts agree that it is something enormous, there is a difference of millions between the statements proceeding from what may be termed the most authentic sources known. The mandarins attendant on Lord Macartney, in the year 1793, gave out the population at 333 millions; and by a census taken in 1813, by order of the Chinese government, this enormous mass is swelled up to 367,821,647, which gives about 268 to the square mile. According to a statement in a Chinese official document which is quoted with approbation by Dr. Morrison, the population at present is 352,866,012. Of the truth of this statement nothing can be said, and, considering the small extent of cultivated land in the empire, it appears to be greatly exaggerated. The supposition is, that it not only includes China Proper, but all the surrounding states, which are either dependant upon, or pay tribute to the empire. According to Thom, the population is 181,788,163, which he divides into the following religious sects:—

Followers of Confucius, Laou-tsze, and Taou,	159,220,163
Worshippers of Lama,	18,000,000
Mohammedans,	1,600,000
Roman Catholics,	88,000
Jews,	50,000
Boodhists and others,	2,830,000
	181,788,163

This table is perhaps as near an approximation to the truth as can be made, although the calculation is thought by some to be too high for the extent of cultivated ground. According to a parliamentary paper published in 1830, the population of China Proper, exclusive of Tartary and the other dependencies, is 111,170,000 souls. In the German Statistical Almanac, published at Weimar in 1838, the population of China Proper is estimated at 118,000,000. From the same authority we learn that the army in 1835 was 1,250,000 strong; comprehending 830,000 infantry, and 420,000 cavalry; and the naval force is calculated at 32,440 men.

PRODUCTIONS—AGRICULTURE—TEA CROP.

The staple productions of China are rice, tea, silk, cotton, sugar, salt, porcelain, tin, lead, musk, rhubarb, quicksilver, saltpetre, wines, fruits, and various manufactures.

Rice is the great staple article of food, and so much is its importance regarded, that a high festival is held at the commencement of each seed-time. The emperor performs in person, and prepares himself for the solemn occasion by three days' fast and prayer. He then goes forth in great pomp, takes the plough in his own hands, opens a furrow, and throws in the first seed of the season. The same is done in every part of the empire, on the same day, by the viceroys and governors. The grain reaped from this seed is preserved in granaries, and reserved for sacrifices. The cultivation of this grain, of which there are two crops annually, requires little or no labour; water supplies every purpose, and for the most part this element is abundant in every part of the empire. The growers display great ingenuity in their various contrivances for raising the water from the rivers, by means of wheels, levers, swinging buckets, &c. The first crop of rice is sown in March, and the second in July, the grain being ready for the sickle three months after it is sown. Exclusive of rice, there is a great deal of barley grown in some districts, besides wheat, maize, peas, and beans. Oats, which spring up spontaneously, are pulled up as a useless weed. The implements of husbandry are extremely simple. The plough is held by one hand, and consists but of a single piece of crooked timber, the lower extremity of which is armed with a hook, and the superior guided by the hand; while a perpendicular piece of wood rises from the middle of the beam, across the top of which another piece is placed lengthways, one end of which is fixed to the handle, while the other is connected with the traces. This implement does not turn up the earth to the depth of more than six inches, so that new earth is never reached; and being thus exhausted, the ground requires often to be left fallow for want of manure.

Agricultural improvement in China has in all ages been encouraged and honoured. The husbandman is considered an honourable and useful member of society, and ranks next to men of letters and officers of state. The soldiers and the priests alike cultivate the soil; the latter generally having land attached to their convents. The empire, however, is not so generally cultivated as has been asserted by many travellers: some districts are almost entirely under cultivation, but many contain extensive tracts of waste ground. Dr. Abel is of opinion, that, "as horticulturists, the Chinese may perhaps be allowed some merit, but on the great scale of agriculture, they are not to be mentioned with any European nation." The productions extend to every useful vegetable, there being scarcely a grain, a fruit, a tree, or a culinary vegetable of Europe, that they do not cultivate.

The Chinese excel in gardening more than in agriculture, and especially in the art of laying out garden grounds; and this may be considered the only one of the elegant arts in which they display genius or taste. Their style, indeed, strongly resembles that of England. The most magnificent and extensive of the emperor's gardens are those of Yuen-min-yuen, at Pekin, and of Gehol in Tartary; the latter of which is described in glowing terms by Lord Macartney, who says it reminded him of the pleasure-grounds at Lowther-Hall in Westmoreland. They are, however, on a somewhat larger scale, being ten English miles in diameter, or 60,000 acres, containing within their precincts thirty separate habitations for the emperor, each resembling a village of considerable size.

Landed property is considered the absolute right of the emperor; the land being held by a sub-proprietor, or first holder, who is allowed to keep possession so long as he continues to pay a tenth of what his farm is supposed capable of yielding. If one person holds more land than his family can conveniently cultivate, he lets it to another, on condition of receiving half the produce, from which he pays the emperor's tax. There are no extensive estates or farms in the country. The whole ingenuity of the inhabitants seems to be exercised on the cultivation of small spots, rather than in cultivating large tracts.

The Tcha, Tha, or Tea-tree, grows equally in the mountainous and level districts, but prefers a light and rocky soil. It is sown by putting seven or eight seeds into a hole, two or three of which only spring up, and these are afterwards transplanted into rows. They begin to yield leaves three years after being planted, but require to be renewed every five or six years, as the leaves then begin to grow hard and harsh. The appearance of the tea-shrub resembles that of the broad-leafed myrtle, with a flower like that of the wild white rose. There are different modes of cultivating the tea-crop in different provinces; but there are in fact only two distinct species of it, the green and the black. All the rest are mere combinations of these two in different proportions, or are simple varieties produced by difference of soil, culture, gathering, or curing.

The black tea is grown in the maritime province of Fo-kien, with the exception of about one-third of the bohea, which is produced in the north-east corner of Canton province, in a district called Wo-ping. Green tea is all grown in the maritime provinces of Kiaguan, Kiang-si, and Che-Kiang, but chiefly in the two former. Some of the buds of the plant in Fo-kien are picked in the early part of the spring, before they have burst, and a small portion of these is mixed with the best parcels of congou, to give them a flavour. Pekoe is also brought to Canton unmixed with other leaves.

In the beginning of April, the leaves are stripped off the plant; a new crop is then thrown out, and picked about six weeks afterwards, and a third crop about the end of May: the two first pickings are the best, and nearly equal in quality. The third crop of leaves yields tea of little strength and inferior flavour: hence the best crops are composed wholly of the choice leaves of the two first gatherings, with a small sprinkling of the buds or pekoe. The inferior crops contain a larger share of the third pickings, and none of the pekoe. The black tea in Fo-kien is cultivated largely by cottagers in small plots of ground or gardens. The leaves are picked by the family, and immediately sold to persons whose business it is to collect quantities of them, and manufacture them in parts, that is, expose them to be dried by the wind under the shade, and afterwards to be further dried in a heated warehouse. The tea-merchants and the agents of the Hong merchants come to the tea districts, and purchase quantities of the dried leaves of the first, second, and third gatherings, discriminating the leaves of the young and old plants, and those grown in well-known favourable spots. They then complete the drying or roasting process, and employ women and children to select the hard, the best leaves, with more or less discrimination, according to the object of making very fine, middling, or common tea. The green tea is less highly dried than the black; and Mr. Barrow supposes that it is from the former thus retaining much of its natural juices, that its nervous properties (generally ascribed to its being dried in copper vessels) are to be imputed. The green tea is usually pressed into chests while hot, to give it a finer flavour. The tea is made into parcels of from 100 to 600 chests each, with a distinctive name to each parcel, and conformity of equality, where the tea-merchant acts honestly; hence those parcels of tea, which, under certain Chinese names, have proved, in a series of years, of excellent quality and similar characters, and which are greatly sought after at the London sales, are not the produce of any particular farm, but owe their character to the skill and good faith with which the tea-merchant or the Hong merchant's agent have executed their commissions in selecting only superior parcels of leaves in the markets of Woo-y-shan. Like the black tea, the different classes are formed by selecting the better from the inferior leaves after they have been dried; the light leaves separated by a winnowing machine from the heavier, the latter of which constitute the gunpowder tea; the lighter are of inferior quality, and only used by the common people. The blooming appearance of hyson, gunpowder, &c., is said to arise from the effects of carefully roasting the leaves in iron vases placed over a fire, and by rubbing them against the sides of the vessel; in this process, with the green teas, much skill is requisite, and there is a class of persons hired by some of the tea-merchants to superintend their respective manufactories. The bohea tea is composed partly of the lower grades of the Woo-y-shan tea, which has been left unsold after the departure of the last ships of the season, and partly of the tea grown in the district of Canton called Wo-ping.

The tea-chests undergo severe scrutiny in Canton, previously to being purchased; and if, when finally examined at the period of their shipment, they are found superior to the quality which has been attached to them, their price is raised; if inferior, they are rejected, or their price lowered. The scientific mode of proving the finer teas is to put a small quantity into a cup; pour on it pure spring water at full boiling heat; place the saucer above the cup, filling it also with boiling water to increase the heat: after a sufficient time has elapsed for the leaves to unfold themselves, to examine the appearance, flavour, but particularly the *Colour* of the infusion. The latter quality is of course only known to the initiated.

Tea is the universal beverage of China. It is drunk at all meals, and is almost the only liquor used at feasts, and while visiting each other. But it is a general rule amongst them never to drink tea immediately after a long fast, it being apt to affect the nerves, and create giddiness. The tea-shrub is cultivated only in China and Japan, and is supposed to be indigenous to one or both of these countries. All attempts to introduce it into Europe have hitherto failed.

The quantity of tea annually plucked in China, it is impossible to calculate, unless we also knew the quantity consumed by the natives. About 54,000,000 of lbs. are annually exported from Canton to all parts of the globe; and it is a remarkable fact, that of this quantity Great Britain and Ireland alone consume nearly 32,000,000 lbs.—being about 10,000,000 lbs. more than all the nations of the civilized world put together!

As substitutes for tea, the Chinese use a species of moss common to the mountains of Shan-tung; an infusion of different sorts of ferns, and the leaves of the common cammelia.

A plant called the oil-bearing tea, is much cultivated for its seeds, from which an oil is expressed, in very general use in the domestic economy of China. The seeds are ground to a coarse powder, boiled in bags, and then pressed, when the oil is yielded. There is also cultivated a tree of considerable height, called the tallow-tree, from the seeds of which a substance is prepared, having all the properties of animal tallow. A species of white cabbage is in very general use, and is considered to be to the Chinese what the potato is to the Irish. Fruits of every kind abound, but they are not considered good, except the orange, and a species called lee-tchee.

MANUFACTURES.

From the inveterate adherence of the Chinese to ancient customs and practices of every description, they have been left comparatively behind by almost every civilized nation in all useful mechanical arts, even those which originated with themselves. Every thing seems to have stood still in China but time. Nothing can be more illustrative of this fact than the case of the silk-manufacture, of which they were undoubtedly the inventors, and the knowledge of which, as their annals boast, they possessed 3000 years before Christ. The native reeler and weaver still continue to labour on by the same tardy process, and with the very same materials, as were used by their ancestors; while in England, where the manufacture was totally unknown until the fourteenth century of the Christian era, Sir Thomas Lombe, so far back as 1718 erected at Derby a machine driven by a water-wheel, by every revolution of which wheel 73,726 yards of organized silk-thread were thrown off, and amounting per day to 318,504,960 yards! At this day, the silks of China will not bear comparison with those of Lyons, Spitalfields, and Edinburgh; the first for light fabrics, the second for the more substantial, and the last for shawls. Again, in the article of porcelain (from the Portuguese *porcella*, a cup, they being the first who introduced it into Europe), which, until a very late period, continued to be the admiration of the world, we have been enabled, through the researches of Reaumur and other chemists, to compound earths matching that with which nature voluntarily furnishes the Chinese, and not only equal them in the fineness and durability of the ware, but infinitely excel them in elegance of manufacture. For nearly a century, the clumsy fabrics of the Chinese, with their daubs of blue paint, which formerly were the principal ornaments of the mansions of the wealthy, have been driven out of the market by the beautiful wares of Dresden, Staffordshire, and Severs.

The same remarks may be applied to all the other manufactures of China, the principal of which, besides the two above mentioned, are those of cloth, nankeen (or cotton), linen, paper, and ink. In whatever department of art the Chinese continue to maintain a superiority over, or equality with, the rest of the world, the cause is to be found in the bounty of nature, not their own ingenuity. Thus, the beautiful yellow which distinguishes the nankeen cloth, is a natural quality of the cotton grown in the province of Kiang-nan (of which Nankin is the capital), and is to be found in no other district of China. The Chinese still pertinaciously adhere to their ancient practice of fabricating their paper from the bark of the bamboo and koo-tchoo (by the latter of which names they term it), notwithstanding their being perfectly well aware of the superiority of that made from rags, and the infinitely greater cheapness and simplicity of the manufacture.

The Chinese ink is obtained from the soot produced by the smoke of pines and the oil in lamps, mixed with the isinglass of asses' skin and musk, to correct the odour of the oil. It is principally made in the province of Kiang-nan.

ARTS AND SCIENCES.

What we have said respecting the stationary condition of the manufactures, applies equally to the arts and sciences of China. The process of printing continues the same as when originally invented by themselves about 1700 years since. The characters are first written on paper, which is glued upon boards of hard wood, and the engraver carves the characters upon the wood, hollowing out the intermediate parts. When an impression is to be taken off, the printer lays on the ink with a brush, applies the sheet of paper, which he presses down with a softer brush than the other, and with a greater or less degree of pressure, according to the quantity of ink laid on. Such is the primitive mode of printing still persevered in throughout the interior of China, although movable types are of course necessary in printing the Royal Gazette of Pekin, which is issued daily, and other documents.

One of the most singular features of Chinese genius is developed in their attempts at painting. They display extraordinary powers of minute imitation, and will copy with the utmost exactness the number of petals, thorns, spots, &c. of a flower, and the scales of a fish; but they are, utterly unable to mix and soften their tints, and copy every defect as well as excellence in the object of their imitation. They have not the slightest idea of perspective, considering the diminished and faded appearance of distant objects as the consequence of a defect of vision; and they therefore insist upon placing every object in the foreground. When one of their ministers of state beheld a portrait of his Britannic majesty, he remarked that it was a pity it should have been spoiled by the dirt on the face —meaning the shading of the nose. When they draw a picture of the emperor, they consider it would be almost impious to represent him of the ordinary human proportions, and therefore make him twice as large as any of his attendants—the head particularly. But this self-conceited people consider themselves in this, as in every other art, pre-eminent over all other nations, and reject with disdain the remonstrances of European artists.

In sculpture, as in painting, the Chinese have no conception of order, attitude, or proportion; and there can be nothing more monstrously grotesque than the figures which *adorn* their temples, bridges, and tombs. It is affirmed, indeed, by recent travellers, that there is not a statue or column in the whole empire worth not .e.

The Chinese music remains in that state of primitive simplicity in which it has been observed to exis in all barbarous nations. Dr. Burney says, that "all the melodies of this nation have a strong analogy to the old Scottish tunes;" that "both resemble the songs of ancient Greece;" and that "the music of all three ought to be considered as *natural* music." Their gamut, like that of the Greeks, consists of five natural tones, and two semitones; but they use neither lines nor spaces in noting down their music, which they do in a column confusedly, without any attempt at marking time, key, or expression. They always endeavour to play in unison, having no idea of counterpoint or parts in music. Their musical instruments are extremely rude, consisting chiefly of drums, bells, triangles, &c.; and the only kinds resembling those of Europe are a species of lyres or harps, with strings of silk, and a small organ, or rather Pan's pipe, made of unequal reeds, struck into a hollow cup of wood, and blown by a pipe for the mouth, which conveys the wind to all the reeds. Dr. Burney tried in vain, however, to adapt a scale to this instrument. The great delight of Chinese taste, in short, is in the commingled sounds of all sorts of instruments at once. An anecdote is told of a Chinese of rank, who, being in London, was carried by a friend to one of the theatres. When the orchestra at first commenced, he appeared inexpressibly pleased, but listened with the utmost indifference to the beautiful overture that followed, asking impatiently if the musicians were not going to play again the fine air they did at first? His friend was puzzled to imagine what the air could be; until upon the performers proceeding to re-tune their various instruments after the first ac. was over, the Chinese exclaimed, in rapture at the medley of sounds, "There it is —that's it now!" The affected gravity and unsocial life of the Chinese, indeed, are unfavourable to the cultivation of music. They like to see dancing, but not to practise it—like the Turks, considering it a species of labour, not of pleasure. It is told of a Turkish ambassador that when he saw, at a ball given by some nobleman in London, all the n bility and gentry of both sexes capering about on the floor, he expressed unfeigned wonder at their giving themselves so much trouble, and observed contemptuously, "We make our slaves do all these things for us!" And thus it is with the Chinese.

In almost all the mechanical arts, however, the Chinese are wonderfully expert, and in some have attained a degree of perfection unrivalled by any other nation. No people have carried the art of dyeing, or of extracting dyeing materials from animal, mineral, and vegetable substances, so far as the Chinese have done, and this without any scientific chemical knowledge. They show particular dexterity in fashioning ivory fans, baskets, nests of eight or nine movable balls one within another: "yet it does not appear," says Mr. Barrow, "that they practise any other means than that of working in water with small saws. As little can Europeans pretend to rival their large horn lanterns, of several feet in diameter, perfectly transparent in every part, without an opaque spot, and without a seam; yet a small portable stove or furnace, an iron boiler, and a pair of common pincers, are all the tools required for the manufacture of those extraordinary machines. Their expertness in cutting tortoise-shell, mother-of-pearl, and all kinds of stones and gems, is extraordinary, and in all the metals they work with extreme neatness."

Respecting the state of science in China, Mr. Barrow says, "Nothing has yet appeared in Europe, from an authentic source, to warrant any other conclusion than that of the utter ignorance of the Chinese in the pure, speculative, and abstract science of mathematics. Their knowledge of arithmetic and geometry is bounded by mere practical rules. Their numerical notation is marked down by symbols of the language, as that of the Greeks and Romans was by letters of the alphabet. The common operations of arithmetic are generally performed by a few balls strung on wires (called the *swam-pan*), somewhat resembling the Roman abacus, and sometimes by joints of the fingers. The measure of quantity is usually determined by reducing all surfaces and sides to the dimensions of squares and cubes; and with those few practical operations they contrive to manage all the common purposes of life." All other recent observers concur with Mr. Barrow in attesting the defective knowledge of the Chinese in the science of astronomy, for their proficiency in which they have hitherto enjoyed a great reputation. Their high pretensions in this department turn out to be founded fully as much on superstition as scientific observation. So sensible are the Chinese monarchs of this fact, that for many generations the construction of their vaunted Imperial Almanac has been intrusted to foreigners, the native astronomers only contributing the important department of fixing the lucky and unlucky days, days of festivals, &c. "The Chinese system, if system it can be called," says Mr. Barrow, "resembles so closely that which remains of the Hindoos, that both must have been derived from the same source. The period, or cycle of sixty years, by which their chronology is regulated—the period of 10,800 years observed by the Tao-tse, which is the sum of the first three Hindoo ages, with their intermediate periods—the division of the zodiac into twelve signs, and also into twenty-eight constellations, or habitations of the moon, corresponding with the twenty-eight Hindoo maschatras—are so many signs of a common origin; and both may perhaps have derived the remains of this science from some third nation, more ancient than either; as the little which both nations do possess appears to be the remains rather than the elements of the science." There is, nevertheless, a board of astronomers and mathematicians maintained at Pekin, which is, in fact, one of the official departments of government; and a committee is annually appointed with great ceremony to superintend the compilation of the national calendar. It is curious to see this ostentatious show of a love of learning kept up by a people who are still so ignorant as to reckon that the firmament is a body encircling the earth, the latter of which is a solid fixed square, and round which the sun revolves, as well as the moon; that all the stars are stuck into the sky at an equal distance from the earth:—who gravely decide, by the state of the planetary system, the days proper for taking medicine, marrying a wife, setting out on a journey, laying the foundation of a house, &c. Their geographical is on a par with their astronomical knowledge, as may be imagined from their supposing China to be the middle region of the globe, and termin one m[illegible]tain, which is reckoned the centre of the empire, the "[illegible]vel of the Earth." The more educated are at this day well acquainted with the fallacy of such doctrines, but they are still propagated amongst the mass of the people, as it would be equally impolitic and dangerous to expose the delusions which have obtained credence amongst them from time immemorial, and the gross ignorance of their idolized sages. The fact is, that the pretended knowledge of the literati, and ostentatious patronage of learning by the government, is a mere state-trick, for the purpose of exciting the veneration of the ignorant multitude.

Of natural philosophy, or chemistry, the Chinese know literally nothing, except from a prac cal acquaintance with the result of certain causes. Of medicine, as a science, their whole stock of knowledge is a combination of quackery and empiricism; and it is a remarkable fact, that the healing art, which, in almost every other quarter of the known world, whether savage or civilized, justly obtains for its professors the highest respect, honours, and emoluments, is in China so little estimated, that all classes are allowed to practise it *ad libitum*. There are no schools for medical instruction; the theory of the human frame is wholly unknown to them; and they even reject the doctrine of the circulation of the blood. Their remedies are chiefly of a vegetable nature, and consist almost solely of *ginseng* (a native root, which they pretend to prepare in seventy-seven different ways), rhubarb, China-root, and tea. Their surgical knowledge is equally defective, as may be judged by the fact, that the practice of it is limited almost entirely to the honourable fraternity of barbers. Their operations consist in setting a fracture, reducing a dislocation, letting blood, by scarifying, cupping, or acupunctuation (for they entertain a sentimental horror of the lancet and scalping-knife), cutting corns, cleaning the ears, tweaking the nose, beating the back, pulling the joints till they crack; in short, we may sum up our account of Chinese knowledge of the healing art with the remark of the late Dr. Gregory of Edinburgh, that "the emperor of China could not command in all his dominions such medical aid as a smart boy of sixteen, who had been apprentice for one year to a well-employed Edinburgh surgeon, would be able to afford."

LANGUAGE AND LITERATURE.

The language of the Chinese is another branch of their history, respecting which the rest of the world has been impressed with the most preposterous and exaggerated ideas. It has been represented as consisting of millions of characters—as being perfectly unattainable by foreigners, and so forth; and thus has this truly barbarous nation acquired a reputation for philological science as spurious as that which they have enjoyed for other branches of antique erudition. "It is true," as Mr. Barrow says, "that their language, more than any thing else, stamps them as an original people. It has no resemblance whatever to any other language living or dead, ancient or modern. It has neither borrowed nor lent any thing to any other nation or people, excepting to those who are unquestionably of Chinese origin. The written character is just now as distinct from any alphabetical arrangement as it was some thousands of years ago; and the spoken language has not proceeded a single step beyond the original meagre and inflexible monosyllable." All this certainly goes to prove the Chinese to be a primitive people, and so far the circumstance is a moral curiosity; but at the same time it shows their inveterate and immovable obstinacy in adhering to a system of characters so utterly unreducible to any kind of intelligible vocabulary. The foundation of the language is purely hieroglyphic and symbolical, including all the remarkable objects of nature, such as the sun, moon, earth, fire, water, wood, stone, a horse, a cow, a dragon, &c.; the utensils most commonly in use—a knife, a spoon, a box, &c. the primary relations of life—a father, mother, brother, son, &c.; some of the most obvious qualities of bodies, as straightness, crookedness, &c., &c. To give a detail of the history of the Chinese language, through its various modifications and arrangements, would occupy a space of volumes, and to no purpose beyond the amusement it might afford to those antiquarians who delight in the investigation of matters as frivolous as they are obsolete. Suffice it to say, that the Chinese language, which has hitherto proved such a mystery to all the rest of the world, has at length been fathomed and rendered clear by the industry of British genius. In fact, the difficulties attending the acquisition of it have proved almost altogether visionary. The industry of Mr. Marshalman and Dr. Morrison has supplied us with grammars and dictionaries of this singular language, and placed within our reach all the supposed treasures it contained. "Europeans," says Mr. Barrow, "have been deceived as to the vast number of characters in this language, which was supposed to create its difficulty. In the great Dictionary of Kaung-hee there are not more than 40,000 characters, of which about 30,000 only are in use. The Lexicon of Scapula contains about 44,000 words. Ainsworth's Dictionary 45,000, and Johnson's about the same number. The whole works of Confucius contain only about 3000 different characters. The *Leu-lee* may have, on the whole, about 100,000 characters, but not more than 1860 different ones throughout the whole work. Where, then, can there possibly be any difficulty?" The same writer also adduces numerous instances of Europeans acquiring the Chinese language in a comparatively short time.

From all that has yet been seen, the trouble of learning the Chinese language will be very inadequately compensated by the literary "treasures" of which Mr. Barrow speaks. There are no doubt a profusion of poems (so called), novels, histories, and dramas, &c.; but of what character are they? From the translations which we have yet been favoured with, the poems, like some of Ossian's sublime passages, consist of unintelligible imagery; their novels of silly and pointless stories; their histories, as we have already seen, of fables; and their dramas, although for the most part true to nature, yet exhibiting nature in her most revolting forms. M. de Guignes, Mr. Barrow, and other visiters of Pekin, assure us, that the theatrical exhibitions are beyond every thing abominable and disgusting.

It has furnished matter of surprise to all writers, how a government so despotic as that of China should make the cultivation of letters a subject of such special anxiety Even the intelligent Mr. Barrow makes a marvel of this fact, notwithstanding that his own writings (had we no other authority) furnish a sufficient explanation of the seeming anomaly. It is true, there is a school to be found in every village of China, and that the instruction of the pupils forms one of the most anxious concerns of the government: but what is the nature or purpose of their education? To instruct them in all the erroneous doctrines of their parents—to confine their knowledge to the native productions of Chinese writers—to make, in short, Chinese politicians of them. The boasted system of education in China is not for the purpose of enlightening the people, but of keeping them in darkness. They are allowed to know nothing of other nations, and cannot therefore comprehend their own degraded and enslaved condition.

RELIGION.

The religion of the Chinese is allied in character to the Boodhism of the Birman empire, Japan, Siam, and other parts of Eastern Asia; and, under whatever name, it may be defined as a superstition intimately associated with ceremonial observances in pagodas and temples. According to Howard Malcom, the latest authority on the subject,* the Chinese are divided into three sects, namely, those of Ju-kea-su, Taou, and Boodh.

"The Jukeasuists are the followers of Kong-foo-tze, or, as the Jesuits Latinize it, Confucius, who flourished about 560 years before Christ, and was therefore contemporary with Pythagoras. He was of royal decent, and a mandarin, but early resigned official life, and devoted himself to literature, morals, and political economy. Reducing the maxims of former sages to order, he added valuable extracts from current works, and prudent sayings of his own, and produced a digest which continues to be the *ultima thule* of Chinese piety. Travelling extensively as a popular lecturer, and sustained, not less by his high birth and eloquent address, than by the excellence of his doctrines, he soon founded a sect which became virtually the state religion. It is, however, much less intolerantly maintained than either Popery or Protestantism, where united with the state. The other religions are allowed, and sometimes fostered. Great officers, and even the emperor himself, build and endow Boodhist and Taouist temples.

"The system of Confucius is highly extolled by European writers, and most extravagantly by Chinese. As accounts of it are accessible to all readers, I need not stop to describe it. He seems to have regarded religion less than politics, and the burden of his works relates to social virtues, civil government, and adherence to ancestral habits.

"The sect of Taou (literally *reason*) was founded by Laou-Keum, a contemporary and rival of Confucius. His followers may be called the mystics of China. They profess alchemy, assume mysterious airs, read destinies on the palms, and make great pretensions to deep research and superior light. Their practical works contain, in general, the same laudable precepts which distinguish the system of the Ju-kea-su.

"The third sect follow Fo-e, sometimes spelled *Fohi*. Foe is said to be the old orthography of *Fuh*, which is the Chinese abbreviation of *Fuh-ta*, or Boodha. The Boodhism of China is the same as that of Birmah," (for an account of which we refer to the article PAGAN RELIGIONS, in the present series of papers.) "The system is certainly far older than either of the others. It is generally supposed to have been introduced about A. D. 70. Kempfer dates the introduction about A. D. 518, when 'Darma, a great saint, came from the west, and laid the foundation,' &c. Chinese historians agree that the worship of Fohi was originally brought from India. Sir William Jones says confidently, 'Boodh was unquestionably the Fo-e of China.'

"This sect probably embraces one-third of the entire population. The government acts with indecision towards it, at one time denouncing it as dangerous, and at another contributing to its support. M. Gutzlaff saw at Pooto some placards calling on the people, in the name of the emperor, to repair to the Boodhist temple of that place, in order to propitiate Heaven for a fruitful spring. The priests are numerous, but not greatly respected. I saw some of them in the streets daily. A few were exceedingly well-dressed, but generally they were both shabby and dirty, sometimes quite ragged."

Mr. Malcom gives the following account of a visit to a Boodhist temple at Canton:—"There are 124 temples in Canton, besides the numerous public altars seen in the streets. I saw the principal ones without the walls, which are said not to be inferior, on the whole, to those within. They strikingly resemble the monasteries of Europe. The handsomest is one of the Boodhists, in the suburb of Ho-nan, on the opposite side of the river. Being accompanied by Messrs. Bridgman, Parker, and Morrison, who were acquainted with the superior, I was not only shown every part by his order, but had the pleasure of his society for an hour. Cloisters, corridors, courtyards, chapels, image-houses, and various offices, are scattered with little regard to order, over a space of five or six acres. Priests, with shaven crowns and rosaries, loitered about; but I never saw common people come to worship either at this or other establishments. Some of the priests occupied small and mean apartments; but those of the superior are spacious, and furnished not only with the ordinary conveniences, but with chandeliers, mirrors, pictures, &c., and with an extensive library. The buildings are chiefly of brick, one story high, the walks handsomely flagged, and the courtyard ornamented with large trees, or beautiful parterres of flowers. The printing-office contains stereotype plates enough to load a small vessel, so arranged as that every work is readily accessible. The principal apartment or temple is about 100 feet square, with the usual images, &c. We attended here to witness the regular evening service. It seemed to create little interest, for out of 160 resident priests, there were but fifty present; and these uttered their repetitions with the most obvious indifference. Their prayers are in Pali ostensibly, but I am told not truly, as their mode of writing renders it utterly unintelligible to any one. They keep time by striking a wooden drum, and occasionally a bell. At a certain stage of the process, the whole company formed into single file, and marched round the hall, without ceasing their repetitions. This gave us a full view of their countenances; and so far as these indicated, a more stupid set could not be picked out in all Canton. I have already remarked this characteristic of the Boodhist priesthood in other countries, and am confirmed in the belief of its being attributable to the character of their religion, and the nature of their duties.

"Instead of the humble dress of Birman and Siam priests, these were as handsome as they can get, with shoes and stockings. What is worse, some are in rags, barefoot, and squalid, with apparent poverty. They have, however, a common refectory, where I presume all fare alike. The buildings were erected at different times by the munificence of individuals, and by the revenues of the establishment, which amount to about 8000 dollars per annum.

"While we walked over the premises, the superior had prepared us a repast of sweetmeats and fruits, to which he sat down with us. His manners are easy and elegant, his dress unostentatious, and his countenance full of intelligence and mildness. His age is but thirty-eight. We of course endeavoured to make the visit profitable to him. My heart yearned over him; and when he assured me that he meant to visit America in a year or two, I was happy to promise him a most cordial reception. Priests may leave the country and return, without the restraints which make it dangerous to others.

"The whole number of priests in Canton is estimated at 2000; of nuns, 1000. The annual expense of the 124 temples is 250,000 dollars. An equal sum is required for the periodical festivals. Half a million, annually paid in one city for religion, by pagans! And the whole amount which all Christendom gives for pagans in a year, is but six times as much!"

For many years, Christian missionaries of different denominations have been established at Canton, Macao, and other parts of China; but they make little progress in proselytizing the population, on account of the difficulties of the language and the rigorous adherence of the natives to ancient customs. China likewise contains some Mohammedans and Jews; and these, with the Christians, seem to be tolerated merely on account of the public usefulness and learning of the missionaries of these sects. The Christians, for the same reason, are the most generally respected, but have been treated, from time to time, with the most arbitrary capriciousness, being persecuted by one emperor and encouraged by another. In the year 1747

* Travels in Hindustan and China. (People's Editions.)

five missionaries were beheaded in Fo-kien, and two Jesuits strangled in the same year in Kiang-nang, all of which was done "according to law," which says, that the chief of any sect who seduces the people from their duties under religious pretences, shall be strangled.

REVIEW OF MANNERS, CHARACTER, AND CONDITION.

From all we have said, it will be evident that civilization has as yet advanced but little beyond the infancy of what may be called agricultural society in China. It may be readily admitted that they were among the first of existing nations who arrived at a certain degree of excellence; but it is not less evident that they have long remained stationary, and have even in some points retrograded. "They can only be said," observes Mr. Barrow, "to be great in trifles, whilst they are really trifling in every thing that is great." The following assertion of Sir William Jones may almost be literally adopted:—"Their letters, if we may so call them, are merely the symbols of ideas: their philosophy is in so rude a state as hardly to deserve the appellation; they have no ancient monuments from which their origin may be traced, even by plausible conjecture; their sciences are wholly exotic; and their mechanical arts have nothing in them characteristic of a particular family—nothing which any set of men in a country so highly favoured might not have discovered and improved."

In their moral qualities, the Chinese are a strange compound of vanity and meanness, affected gravity and real frivolity—an utter want of all manly judgment and sense, combined with the most insidious art and cunning, the usual accompaniments of vulgar ignorance. The Tartar race are distinguished by a blunt and unstudied frankness of manner and openness of disposition; but the true Chinese betray the most debasing servility of tone and manner—plausible, sly, and artful. They have not the slightest regard to truth, and will assert and deny any thing with the most unblushing effrontery, being also entirely destitute of shame. The pain inflicted by the bamboo is the only consideration they attach to public and disgraceful corporal punishment. They have neither sense of honour nor self-respect. "A Chinese prince, or powerful mandarin," says a recent traveller, "will commit extortion or oppression whenever he can do it with impunity, and regards it as a matter of right attached to his station. A Chinese trader will cheat and defraud whenever it is in his power, and even piques himself upon his skill in overreaching, as a proof of his talent. A Chinese peasant will pilfer and steal whatever is within his reach, whenever he can hope to escape detection; and the whole nation may be affirmed to have almost nothing in view but their own self-interest and security. Their general character, in short, in point of morals, compared with the minute enforcement of duty by the penal laws, affords an irresistible proof of the utter incompetency of legislation, without the aid of religious principle, to reach beyond the mere external conduct of individuals, or to produce any thing like real social virtue among human beings." In their feelings, the Chinese are cruel, sensual, and vindictive. Mr. Barrow, M. de Guignes, and other travellers, all agree in their representations of the inhuman conduct of those in authority. One of the arbitrary laws of China is the compelling of the natives to pull the imperial barges along the canals; and Mr. Barrow had several opportunities of witnessing the merciless exercise of this authority on the part of the military. The impressed labourers took, of course, every opportunity of deserting; and whenever there was a deficiency of hands, the despotic officials set off to the nearest hamlet, roused the natives out of bed with the whip, made them jump into the water to assist the towing operations, lashing them with long cart-whips all the while with the most ruthless barbarity. Mr. Barrow also relates another specimen of Chinese indifference to human life, which he witnessed in passing down the great canal betwixt Canton and Pekin. Several persons who had crowded to the brink of the canal, had posted themselves upon the high projecting stern of an old vessel, which broke down with their weight, and precipitated the whole group into the water. Although numbers of boats were plying about at the very spot, not one was observed to go to the assistance of the drowning wretches, whose shrieks and cries were totally disregarded.

Nothing is so significant of the moral condition of a people as their treatment of the female sex, and nowhere are the women so inhumanly used as in China. They are not permitted to stir out of doors, excepting the wives of the lower orders, who are to be seen toiling at all kinds of laborious tasks, while their indolent husbands are sitting quietly smoking their pipes. In the country they are even to be seen drawing the plough and harrow, while their lazy helpmate drives them on.

The practice of deforming the feet of females of the better classes has long been prevalent. While still children, the feet are bound or compressed in such a manner as completely to prevent their growth. "At five, the rich man's daughter has her foot so firmly bound, that, in the native phrase, the whole is *killed*. The foot below the instep is pressed into a line with the leg, to add to the height of the little sufferer, while two of the toes are bent under the sole, that its breadth may be only of the least dimensions. The agony of such a process it would be hard to estimate; but it is said to last about six weeks, when I suppose the wasting of all the parts, and the cessation of many of the functions, have rendered the whole insensible to pain. The development of the muscles which form the calf of the leg being checked, the limb consequently tapers from its socket down to the foot, without any risings or inflections. This is regarded as the perfection of beauty by the Chinese, who say that the knee of the female is not protuberant, like the knee of the male, and is so well covered, that she can remain kneeling a long time without inconvenience. It is perhaps less throughout its length than when the foot is allowed to retain its natural size; but whether this be from the want of exercise, which ever acts as a stimulus to muscular deformity, or from the lack of nutriment through functional disturbance, I cannot take upon me to say; but I suspect the former is the real cause; otherwise the matter would grow from bad to worse, till the whole was destroyed by atrophy. A foot two inches in length is the idol of a Chinaman, on which he lavishes the most precious epithets which nature and language can supply. But its beauties are altogether ideal; for when stripped of its gay investments, it is a piteous mass of lifeless integuments, which resembles the skin of a washerwoman's hand after it has undergone a long maceration in soap and water. The sight of it is well fitted to excite our compassion, not our commendation—a beautiful limb crushed into a heap of deformity! It was the custom in former ages for the dames to wear long robes, which swept upon the ground, and kept the feet out of sight: it would be an ingenious device for the ladies to restore them again to use, and allow the instruments of progression to retain their natural size in the asylum of a long train. Poets might still celebrate the little 'golden lilies' in conformity with hoary custom; and it would be indifferent as to the morality of the thing, whether he said a foot was only two inches long, which was thrice that length; or called that the perfection of beauty which is, in truth, only a mass of deformity."*

Amongst the other moral iniquities of the Chinese, is the crime of infanticide; and from the contempt in which females are generally held, parents expose their female children without the slightest remorse. It is a part of the duty of the Pekin police to go their rounds with carts

* Lay's "Chinese as they are."

an early hour of the morning, to pick up the bodies of the infants that have been thrown out into the streets in the course of the night, and to carry them, without inquiry, to a common pit without the city walls, where they are thrown in promiscuously. It has been calculated that there are between 20,000 and 30,000 female infants thus yearly sacrificed in China!

In comparison with the lower orders of the Chinese, the condition of the slaves in our West India colonies was that of princes. They have scarcely an article of furniture, besides two or three jars, a few basins of coarse earthenware, a large iron pot, a frying-pan, and a portable stove. They use neither tables nor chairs, but at meals all the family sit upon their heels round a large pot, with a bowl in each of their hands. After taking the rice from the pot with a spoon, they then take their chop-sticks, which consist of two small pieces of wood, or generally of porcupines' quills, and are held between the two first fingers of the right hand. With this strange utensil they throw their food into their mouths with remarkable expedition. Boiled rice is their staple food, with the addition of millet or barley; but they likewise eat all sorts of animal and vegetable putrescent substances. The dead hogs thrown overboard the ships in the river at Canton, are greedily picked up by the natives; ... in the public market, dogs, cats, and rats, are exhibited for sale. The most degrading social vice of the Chinese is that of opium-smoking, the effects of which are much worse than those from an indulgence in intoxicating liquors.

INTERCOURSE WITH FOREIGN NATIONS—BRITISH TEA-TRADE.

The systematic discouragement which the Chinese government offers to all intercourse with foreign nations, explains the trifling amount of commerce carried on in a country adapted better than any other in the world for its prosecution, whether we consider its geographical situation, its productions, or the genius of the people. The innumerable rivers and canals with which the country is intersected, present facilities for internal communication possessed by no other country; yet there is no regular system of trade among them: it consists almost solely of barter, there being no circulating medium, excepting a small copper coin, the value of which is almost too minute for calculation. It is reckoned, that on the grand Pekin canal there are upwards of 10,000 boats and barges of various descriptions continually employed in the interchange of national produce. Of the commercial capabilities of China, indeed, we have ample evidence in the immense number and crowded state of the cities. These are divided by the Chinese into three classes, according to the number of leagues which they occupy; and of the first class alone—or *imperial* cities, as they term them—the natives enumerate upwards of 4000. There is much exaggeration here, no doubt; but even estimating the number of social communities at a third, or even a fourth, of what is set down by a Chinese, what an enormous source of consumption for all the necessaries of life is here shown! What an unbounded mart for all kinds of British manufactures would be thrown open by the removal of the government restrictions upon commerce! That the people of China are anxious for this free intercourse with other nations, has been abundantly shown; and in fact their greedy and peculatory disposition sufficiently guaranties the readiness with which they would engage in foreign traffic. But the all-powerful constraints of the government hang like a millstone round their necks. Whatever be the ignorance of the lower classes, there is no want of enlightenment in the executive, which is conscious that a free trade would inevitably lead to the breaking up of the whole despotic system of ruling. Their jealousy, indeed, is not so much to be wondered at, considering the precedent before them in the rise of the British power in the neighbouring peninsula of India; the only wonder is, that amid all the turmoils of war which have disturbed the world during so many ages, this country, so fertile in every thing which can make a country desirable, should have remained comparatively unmolested.

It is well known that the foreign trade of China is confined exclusively to one port—that of Canton. The overland trade with Russia and India has now almost entirely ceased. So great is their jealousy of the Russians, indeed, that the latter are the only people interdicted from even visiting Canton.

Tea does not appear to have been known in Britain previous to 1650; and it is evident, from the following note in Mr. Pepys' Diary, that many years elapsed previously to its coming into general use:—"September 25, 1661. I sent for a cup of tea (a China drink), of which I had never drunk before." And in 1664, there is mention made of the East India Company commissioning their foreign agent to purchase 2 lbs. 2 oz. of tea as a present to his majesty! From this time forward, however, the consumption of tea increased with a rapidity scarcely less wonderful than the progress of the British cotton manufacture.

Canton, at which the principal foreign commerce is carried on by the Chinese, and at which all the exports of tea take place, is situated on the eastern bank of the river Pekiang, a beautiful placid stream, as wide as the Thames at London. This great outlet of Chinese trade is about 400 miles in length, and Canton stands at the distance of 80 miles from its mouth. Canton consists of two descriptions of towns—that which is enclosed by walls, and the suburbs; both together, they are said to contain from seven to eight hundred thousand inhabitants. The circuit of the walls, which are of a moderate height, and furnished with a few cannon, is estimated by some at five, and by others at nine miles. Only about a third part, however, of the space enclosed is covered with buildings; the rest is occupied with pleasure-grounds and fish-ponds. The neighbouring country is very charming—hilly towards the east, and presenting in that quarter a beautiful prospect. The streets are long and narrow; the houses generally low, and towering above them may be seen temples and pagodas. At night the gates are closed, and bars thrown across the entrance to the streets. From this enclosed city, as well as from every other town in China, all foreigners are rigorously excluded; and these, if they obtain permission, must take up their abode in the suburbs, which contain a very miscellaneous population, though not therefore inferior in point of accommodation or appearance. But the most curious particular regarding Canton is the existence of a floating town on the river, consisting of perhaps forty or fifty thousand barks, junks, and vessels of various kinds, arranged close to each other in regular rows, with passages between them to allow other vessels to pass. This floating town extends several miles in length. For what reason we know not, the owners of these vessels and their families are not allowed to come ashore, and so they spend the whole of their lives on the water.

Foreigners are not permitted to go ashore and reside at pleasure at Canton. Their only land establishment consists of *hongs* or factories, which extend in a line along the banks of the river, from which they are distant about a hundred yards. They are built on a broad quay, with a spacious promenade in front. The hongs or factories individually consist of courts or lanes, admitting of no thoroughfare, and solely dedicated to the accommodation of the foreign residents. Large warehouses for the reception of goods are adjacent. The place of the Chinese suburbs which is most frequented by foreigners, is termed China Street, consisting entirely of shops, in which the native dealers are to be seen seated from morning till night. Their tricks in entrapping British seamen into purchasing their commodities, have long been matter of notoriety. Their signs uniformly exhibit an English name as well as a Chinese one; and having picked up an acquaintance with the most familiar of Jack's expressions, their mode of addressing their rough customers evinces at once the crafty and unscrupulous disposition of the natives.

The manner in which foreigners have heretofore conducted business at Canton is as follows:—When a ship arrives, it is necessary immediately to get a native merchant (or, as he is called, a hong merchant) to become security for the import and export dues, as well as for the good behaviour of the crew. In this there is never found the slightest difficulty, there being, on the contrary, always a competition amongst the natives for the honour of a consignment. The import duties consist of a tax upon the different species of goods, as well as a tonnage upon the vessel. In addition to the tonnage and cargo charges, there is also levied what is called a *kumshaw*, or present to government, exigible from ships of every burden alike. It has been estimated that all these various port-charges, including the expenses of victualling a ship, &c., amount to about 7000 dollars on a ship of 400 tons register.

The foreign merchants of Canton consist of British, American, French, Dutch, Danish, Swedish, Spanish, Portuguese, and Indian British subjects, who in 1832 amounted to 110. There are eight British establishments, seven American, and one joint Dutch and French establishment. Two English newspapers are published in Canton: the Canton Register once a fortnight, and the Chinese Courier once a week.

The personal intercourse of Europeans with the Chinese at Canton is chiefly carried on by means of a gibberish (for it cannot be called a language) composed of English, Portuguese, Chinese, and other words, but the whole greatly broken or altered in sound, and possessing no sort of grammatical construction.

At the entrance to an estuary of the river on which Canton is situated, is the island of Macao, containing a town of the same name, part of which forms a settlement or tenancy of the Portuguese, and here also the families of European merchants at Canton have been suffered to reside. The Portuguese privileges have been latterly much circumscribed, and their trade greatly diminished. "From Macao to the Boca Tigris or true entrance of the river (proceeding upwards) is just forty miles, affording a very safe channel for the largest ships. As far as the Boca or Bogue, the whole is a broad estuary of the sea, interspersed with islands, of which the well-known Lintin lies just midway between Macao and the Bogue. Lintin is on the right of the channel for ships, and abreast of it on the left is Lankeet Island, forming behind it the harbour of Kumsing-moon, where the opium ships of late years were accustomed to lie at anchor in safety. There is no entrance to the Canton river to the eastward of the Boca Tigris; but on the west the case is widely different; and it is there that the principal difficulties of a blockading squadron exist. The main part of the river flows through the Bogue; but to the westward there stretches a great delta, which has been gradually formed by depositions of soil from the turbid waters, and is crossed in all directions by shallow channels communicating with each other and with Canton. Some of these channels form the *inner passage*, by which the British traders used generally to proceed between Canton and Macao, passing a town called Heang-shan, the residence of the chief magistrate of the Macao district. These shallow channels to the westward, though they are impassable by English ships, present no obstacle to the flat-bottomed trading craft of the Chinese, below the size of the larger junks."*

It has been by means of the navigable inlet thus described, that nearly all intercourse with the Chinese has taken place; all the other ports which lie to the northward being shut against European commerce. The greatest possible care has at least been taken to prevent any intercourse by the river Yang-tse-Keang, which, by its connection with the great canal, leads to Pekin and the chief northern districts.

The principal traders with the Chinese have latterly been the Americans and British. "The American intercourse with China," says M'Culloch, "commenced shortly after the termination of the revolutionary war, and has since gone on rapidly increasing, so as to constitute one of the most valuable branches of the trade of the United States." Mr M'Culloch gives a table showing the extent of the exports from Canton to America from 1804 to 1826–7, by which, in the last-mentioned year, it is seen that the Americans had twenty-six ships in the tea-trade, and that the total value of exports from China was 4,363,788 dollars. "The principal articles," continues this most accurate authority, "carried by the Americans to China, are bullion, furs, Turkey opium, English woollens and cottons, and ginseng. The commodities exported by the Americans from China are tea, nankeens, raw and wrought silk, sugar, cassia, and camphor, with minor articles." The Americans are exceedingly enterprising in this, as in every other trade in which they engage.

The British trade with Canton was formerly carried on by the East India Company, but by an act of parliament which came into operation in April, 1834, the trade was thrown open to all classes of British subjects. From enjoying a monopoly, the East India Company were the only sellers of tea in this country, and could therefore regulate the price as they thought proper. It is but fair to say, that the Company did not abuse this monopoly; but, from the expensive manner in which the trade was carried on at Canton, the price of tea was greater in this country than it has been since competition was allowed. The duty on tea, down to the 22d April, 1834, was 96 per cent. on all teas sold under two shillings a pound, and 100 per cent. on all that were sold at or above two shillings. A discriminating scale of duties was afterwards established, with a view to allow the introduction of the cheapest kind of tea at the lowest duty; but it was found that merchants did not scruple to introduce better qualities of the article under inferior denominations; and to put an end to this impropriety, as well as stop all clamour on the subject, a statute was passed (1836), enacting that 2s. 1d. per lb. should be charged on all teas without exception, entered for home consumption in the United Kingdom. In 1835, the first year of open trade in tea, the imports to the United Kingdom amounted to 43,000,000 lbs., being more than 10,000,000 above what had ever been imported in any single year by the East India Company. In 1837, the imports were 36,973,981 lbs. (of which 30,625,206 were retained for home consumption), and the duties produced a revenue of £3,223,840. In exchange for the tea brought from China, there is imported into that country woollen and cotton articles, copper, iron, lead, glass, earthenware, and jewelry, the value of which in 1831 was £593,755. Bullion used formerly to be sent to China; but of late years it has been imported from China into England, instead of the contrary.

The preceding details refer to that condition of affairs which prevailed previously to 1838–9, when British intercourse with China was suddenly brought to a close by events consequent on the forcible suppression of the "opium trade." As already mentioned, the Chinese indulge in opium-smoking, but from the injurious effects of the practice, it is ostensibly prohibited, and the introduction of the article is legally declared to be contraband. Notwithstanding the illegality of the traffic, however, it

* Davis's Sketches of China: 1841.

has ever been extensively carried on, [illegible] in a secret, but open manner, by smuggling-vessels on the coast. Remonstrances against it by the Chinese government were generally disregarded, because the mandarins and others sanctioned it for private reasons; and it was observed that all menaces on the subject were merely empty threats, apparently put forward for the sake of external decency. Lulled into fancied security, and feeling that they were more encouraged than discouraged, the British continued to pour in opium from India, till, by a sudden outbreak, the whole stock in the vessels at Canton was seized and publicly burnt, causing a loss of from two to three millions of pounds sterling to the parties interested. It is here necessary to mention, that the chief promoters of the opium trade were the East India Company, and the stoppage of it was likely to prove most disastrous to British interests in that great empire. The rajahs and petty princes of Hindostan are the chief growers of the poppy, and it is important to conciliate their favour. The best opium is produced in Malwa, a district of India. From that quarter it pays at Bombay a [illegible] of 125 rupees (£12 10s.) per chest, fetching in [illegible] from 400 to 500 rupees (£40 to £50). This [illegible] ells on the Chinese coast for 700 dollars (£15[illegible]), and perhaps much more. The temptation [illegible] large a profit, sets all plans for stopping the [illegible] nce. "The opium trade (observes Lord Jocely[illegible] ver hateful it may appear in the eyes of many, [illegible] be recollected, a source of great benefit to the Indian government, returning, I have heard, a revenue of upwards of two millions and a half yearly. It therefore becomes those who are so eager for its suppression, to point out some method of making up the serious defalcation of revenue that must necessarily accrue to the Indian government, whose expenses already outrun its present income."

The seizure and destruction of the opium, as is well known, precipitated a quarrel with China, which is still (May, 1841), far from being settled to the satisfaction of the British people and government. The contemptuous manner in which the Chinese have always treated the English as well as other Europeans, has tended greatly to aggravate the dispute. Puffed up with a singular degree of vanity, the Chinese government has been in the habit of treating and speaking of the English as *barbarians*, and has on no account allowed the settlement of a consul or ambassador to watch over British interests. The only channel of communication has been by a Chinese commissioner at Canton and a commissioner or envoy from Britain, who in late times was not allowed to land. Added to this, the mean cunning and deceit of the Chinese have proved an obstacle to every kind of fair negotiation. The depreciatory view taken of the English power, having frustrated the peaceful adjustment of the dispute, nothing was left the British but to compel attention to their claims for compensation, and an apology for indignities, by force of arms. Consequently, the year 1840 was destined to present the extraordinary spectacle of a British naval and military force on the coast of China. Chusan, an island on the coast, was captured in the month of July, after a feeble resistance, and various other successes attended the British arms in a few months afterwards. Up till the period we write, however, owing to the temporizing policy of the British commissioner, nothing definite has occurred in the war, and we therefore leave it to the course of events. Meanwhile, the tea-trade has suffered no material interruption, as it has been carried on in a great measure under cover of other flags than the British, though with a loss to British naval interests.

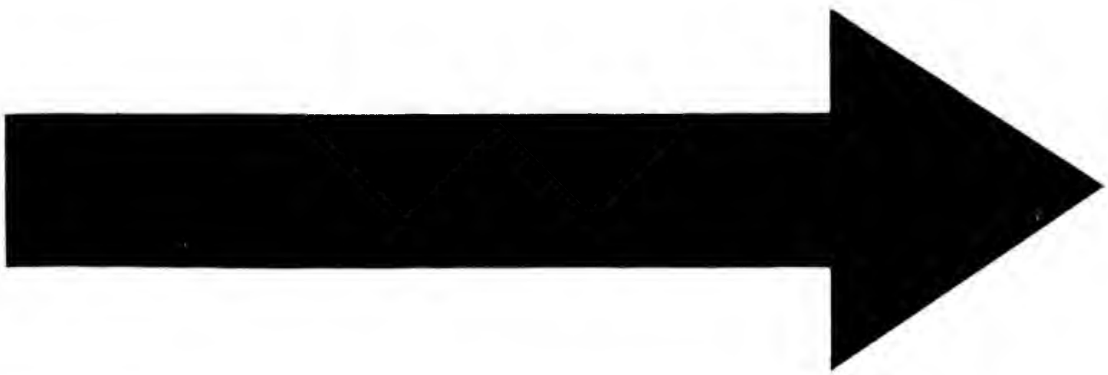
* Six Months with the Chinese Expedition

WORKS ON CHINA.

Among the recent works on China, there are several of value and interest. "*The Chinese—A General Description of the Empire and its Inhabitants*, by John Francis Davis, Esq.," published by the Harper[illegible] one of the best. It is founded on the authority of [illegible] travellers, and well embellished with maps and eng[illegible]. This is the most complete account which has [illegible] lished in this country. M. Pauthier, Member of the Asiatic Society of Paris, has published a volume as part of "*L'Univers Pittoresque*," entitled "*Chine, ou Description Historique, Geographique et Litteraire de ce vaste empire, d'apres des documents Chinois, Premiere Partie, comprenant un Résumé de l'histoire et de la civilization Chenoises depuis les temps les plus anciens jusqu'à nos [illegible]rs.*" In writing this work, M. Pauthier appears to have exerted the same spirit of indefatigable research which actuated M. Champollion in his inquiries respecting Egypt; and his revelations are not less interesting and surprising than those of his illustrious cotemporary. One feels amazed at the fact, that almost every modern improvement in the arts of life was anticipated by the Chinese some centuries ago. Their progress in political science, moral science, legislation, and the ornamental arts, is not less surprising. All these are developed from original Chinese authorities by M. Pauthier, in the course of his history. The work is embellished by seventy-two copperplate engravings, the greater part of which are copies from Chinese originals.

The recent war between Great Britain and China has caused a multitude of books to be written respecting the latter country, most of which are worthless; but the late treaties between China and England, and China and the United States, will occasion more intercourse than hitherto between the Celestial Empire and the nations of Europe and America. The gentlemen who were attached to the American embassy have not yet published the result of their inquiries; but it is to be hoped that there is something worthy of notice yet to proceed from them.

From what is already disclosed in the work of M. Pauthier, it is quite apparent that there yet remains an immense amount of interesting, historical, antiquarian, and ethnographical information to be found in the archives of the Celestial Empire and the numerous works of its literati, to reward the persevering researches of future inquirers.—*Am. Ed.*]



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THE OCEAN—SHIPS—NAVIGATION—MARITIME DISCOVERY.

THE OCEAN.

The Ocean may be comprehensively described as a sheet of water, resting in the hollows of the solid structure of our planet, and covering not less, probably, than two-thirds of the entire surface. From calculations, its greatest depth is believed to be about 30,000 feet, or between four and five miles, which, it may be remarked, is also the greatest height of any land above the surface of the ocean. But the greatest depth which has been ascertained by actual measurement is not more than 5000 feet; for such is the pressure and density of the liquid mass at that depth, that no sounding-lead or apparatus possessed by mariners can possibly be made to sink below that point from the surface.

The quantity of water composing the ocean, by the unalterable laws of evaporation and condensation, remains always at a fixed point, there being neither increase nor decrease. It has been remarked by La Place, a French astronomer, that if the existing waters of the ocean were increased only one-fourth, the earth would be drowned, with the exception of some of the highest mountains; and that if, on the other hand, the waters were diminished in the same proportion, the largest rivers would dwindle to the capacity of brooks, and some of the principal arms of the sea would entirely disappear, while at the same time the earth would be deprived of its due proportion of humidity, and the face of nature be dried up and rendered desolate. Broad, therefore, as are the limits of the ocean, they are only in exact agreement with the wants and arrangements of nature in the inhabitable portion of the globe, and as such afford a convincing testimony of the power, wisdom, and goodness of the Divine Creator.

The bottom or bed of the ocean is marked by the same irregularities of surface as the dry ground. It consists of heights and hollows, rocky protuberances and caverns, hills and vales, sand-banks and reefs, of every imaginable form and extent. Like the land, also, it bears a luxuriant vegetation, consisting of plants of various kinds, all of which are exactly suited to their respective situations. The sea has likewise its tribes of animals, from the huge whale down to the minute coral insect, by whose incessant labours the hardest rocky substances are constructed and reared to the surface of the waters. When the more elevated protuberances in the bed of the ocean are raised above the surface level, they assume, as is well known, the character of islands, and when of a large size, of continents. Thus, the tracts of dry land are in one sense the tops of mountains rising from the bosom of the deep. How islands are formed, sometimes by the action of volcanoes bursting upwards in showers of lava in the midst of the sea, and sometimes by the gradual accumulation of matter deposited by coraline insects; and also how tracts of land are added to continents, and also sometimes taken from them, by the influence of currents, rivers, and other natural causes, has been already explained in the article Geology.

TIDES.

The waters of the sea may exhibit to the eye a calm, unruffled surface when not agitated by winds, but they are never altogether still. Their ceaseless motion, which has the important effect of preserving them from stagnation, is caused by two great risings and depressions, or flowings and ebbings, of the waters, in the course of twenty-four hours, known by the name of *tides.* The two tides or flowings of the sea are experienced daily all over the globe, though in some seas, from peculiar local causes, they are less powerful than in other places. It is not a little remarkable, that the condition of high water, or full tide, occurs at directly opposite sides of the earth at the same time. When it is high water at longitude 0, it is also high water at longitude 180, and so on with every other two opposite points of the earth, on the same parallel of latitude.

It has been ascertained, beyond all reasonable doubt, that the tides are caused by the attractive influence of the moon. By the universal law of attraction or gravitation, all masses of matter have a tendency to be attracted or drawn towards each other. The moon, therefore, as a mass of matter, in passing round the earth, has a tendency to draw the earth after it, or out of its natural relative position, and it really does so to a small extent. As it passes round, it draws up the waters in a protuberance, or, in common language, draws a huge wave after it. But it also draws the land beneath the protuberance, and so causes the opposite side of the globe to be drawn away from the ocean, leaving the waters there to form a similar protuberance or high wave. In the one case, the water is drawn directly up or towards the moon; in the other, the water is in some shape left behind by the land being pulled away from it. In both a similar effect is produced; two high tides are caused at opposite extremities of the earth. Where the higher part of either of these great billows strikes our coast, we have the phenomenon of high water; and when the lower touches us, it is low water. Each of the waves is brought over any given place in the circumference of the earth in twenty-four hours, so as to cause high water twice a day. The sun is also known to have a certain attractive influence on the waters of the ocean; but from the great distance of that luminary, the effect is comparatively small. But when this minor influence of the sun coincides with that of the moon, or acts in the same way, we perceive a marked increase in the tides; on such occasions we have what are called *spring* or *large* tides. When the solar and lunar attractions act in opposition, we have *neap* or small tides. The spring tides happen twice a month, when the moon is at full and change; and the neap when the moon is in the middle of its orbit between those two points. A tide requires six hours to rise, which it does by small impulses or ripplings of the water on the shore, and six hours to ebb or fall; but every successive high water is from twenty to twenty-seven minutes later than the preceding, or, on an average, about fifty minutes for two tides, in consequence of the earth requiring that time above the twenty-four hours to bring any given point again beneath the moon. The tides are thus retarded by the same reason that the moon rises fifty minutes later every day. It is evident that the tides will be greatest at that point of the earth's surface which is nearest to the moon, or where the latter is vertical. She is so between the tropics; and accordingly the tides are there greatest, and they diminish as we approach either poles. It is further to be remarked, that the moon does not anywhere draw up the tides immediately. Three hours elapse before the waters are raised, in consequence of the law of inertia, or a disposition which everybody has to continue in the condition of rest or motion in which it happens to be placed. This stubbornness to resist the moon's influence is only overcome by a three hour's action upon the waters; and thus the tidal wave is always three hours behind the moon in its passage. Twice a year, namely, in March and September, the tides are higher than at other times, because then the attraction of the sun and moon is strongest. In some of the firths or arms of the sea on the east coast of Scotland, it has been occasion-

...ndy noticed that there have been four high waters in the twenty-four hours. These, however, are not simple tides. The double risings are caused by the irregular passage of the tidal wave from the Atlantic round the north and south points of the island of Great Britain. When that portion of the wave which proceeds by the south reaches the east coast sooner than that by the north, or *vice versa*, there will be two risings of the water instead of one. A similar phenomenon may perhaps be observed in other parts of the earth. In the Mediterranean Sea the tides are small, and in some places scarcely perceptible; this is caused by the general confinement of that inland branch of the ocean, by the Straits of Gibraltar, which prevent the full action of the tidal wave either in its rising or recession.

CURRENTS.

Besides being affected by the regular motion of the tides, the ocean, in many parts of its extended bounds, is influenced by currents, which act continually in particular directions. Currents are the result of various causes, such as temperature, winds, peculiar construction of coasts and inlets, but chiefly, as is believed, of the rotatory motion of the earth. The globe in its diurnal motion leaves, as it were, the fluid behind; and hence there is a perpetual flow of the sea from the western coasts of Europe and Africa towards the eastern *land-board*, as it is called, of America, and from the west of America to the eastern coast of Asia. This movement is chiefly confined to the tropics, unless where the sea is turned aside by the land, and caused to diverge towards the north or south. If we start in a survey of this motion from the western coast of America, we find it producing a constant current across the vast expanse of the Pacific, till it is turned off by Asia and Australia. A great division of its force is directed through the seas on both sides of the latter continent, and so on through the Indian Ocean, and round the Cape of Good Hope, till it reaches the free expanse of the Atlantic, across which it proceeds in the same manner as across the Pacific. The current of the Atlantic strikes the coast of Brazil, and breaks at Cape St. Augustine into two divisions, one of which proceeds round Cape Horn into the Pacific, while the other advances through the Caribbean Sea, and so on into the Gulf of Mexico. This latter branch conspires, with the vast issue of fresh waters which pours into the Gulf of Mexico, to raise the level of that sea above that of the neighbouring ocean; and causing the surplus to force its way out between Florida and Cuba, produces the celebrated Gulf Stream which is perhaps the most powerful sea-current in the world.

It is obvious, that to the mariner currents must be of great importance. From Portugal, for instance, ships have sailed to the Bights of Benin, on the Guinea coast, being 150 leagues, in two days, though they could not return in less than seven weeks. It is also common for vessels to descend to the latitude of the Canary Islands, in order to get into the tropical current across the Atlantic, which carries them to America in a comparatively short time; it was by this current that Columbus was carried so smoothly on in his first voyage to the new continent. The Pacific, it is said, can be crossed in this way in about ten weeks, being at the rate of 1000 miles per week; and some mariners have expressed an opinion, that China might be reached by this route in less time than by the shorter course round the Cape of Good Hope.

For the same reason that the sea flows from east to west, the air has a tendency, when not counteracted by other causes, to move in the same direction. The earth in its motion leaves the air, like the sea, a little behind it; in other words, does not carry it so fast forward: hence what are called the trade-winds, which, operating in the same direction with the sea-currents, increase the facility of navigation to the westward in a very great degree. It is impossible to avoid remarking, that these natural phenomena, which, it is to be supposed, might have been counteracted or neutralized from the beginning, must have been designed for some end useful and necessary in the economy of the world. Perhaps, like the diffusive powers given to the seeds of certain plants, they were intended to aid in the dispersion of the human race over the globe. It is well known that population exists in many places, which appear cut off from all connection with others, by seas that must have been impassable by navigators in the early ages of their art. Men could only be drifted to such places in early ages by the currents of the sea and air; and thus the cultivation of large and important regions must have commenced much earlier than would have otherwise been the case.

Besides the grand equatorial or tropical current, there is one of a less decided character from the poles to the equator. The sea under the tropics evaporates to a greater extent than elsewhere, by the influence of a vertical sun. The vapours are apt to proceed towards the north and south, where they descend in rain. A surplus of water is thus produced in the high latitudes, which naturally flows back towards the equator. Hence a constant but comparatively slight flow from the north and south towards that warmer region of the earth. Under the influence of this stream, large masses of ice are constantly becoming detached from the polar stores, and drifted to the tropics. In some of the bays on the north side of Iceland, this frigid substance comes in vast quantities, insomuch as to choke them up to the depth of 500 feet. What is still more strange, these masses of ice are sometimes mixed up with trees, some of which are known to be the produce of the torrid zone in America; this is accounted for by the action of the northern division of the great current which parts at Cape St. Augustine. That northern division, after rushing into and out of the Gulf of Mexico, proceeds northward to Newfoundland, and thence at a high latitude returns athwart the Atlantic, finally sweeping along the western coasts of Europe, and rejoining the current which gave it its first impulse. By this current, it is supposed, American timber may easily be carried to the northern shores of Iceland.

The operation of the tides is less observable in the great currents we have alluded to than in those which prevail in the more secluded seas. The abstraction of water from a secluded sea by the recess of the tide, and the rush inwards produced by its flow, are sufficient of themselves to cause very impetuous currents, more particularly in the narrow channels by which the inland seas are connected with the ocean. We find it stated, in a pamphlet respecting the condition of the Orkney islands, that the Pentland Firth, which separates the continent of Great Britain from Orkney, "has no fewer than four-and-twenty contrary currents of the tide at the flood of spring, besides numerous sets and eddies, which, under the local names of *wells*, *swelches*, and *roosts*, boil more madly on the Orcadian shore than ever did witch's caldron on the kindred coast of Norway, if we may believe old tradition and Bishop Pontoppidan. 'The Boar of Papa,' at the opposite extreme of Orkney, is another terrible tide; when he gets a vessel in his tusks, he shakes the masts out—an operation which, in the country phrase, goes by the name of *hackling*." The contrariety of influences which are sometimes brought into play by polar and equatorial currents, and those produced by the tides, occasion many phenomena extremely perplexing, and sometimes very dangerous, to the navigator. In the Cattegat, by which the Baltic is connected with the German Ocean, one current always goes in by the side next Jutland, while another issues forth by that nearest to Sweden. In like manner, a current seems to proceed along the eastern coast of Britain towards the south, while another, flowing in an opposite direction, advances along the coast of Holland. What is still more curious, under-currents are sometimes found going in a contrary direction to those upon the surface. At the Straits of Gibraltar, it is said there is always a surface current going in, as if to supply a want in the Mediterranean, while, at a certain depth, there is another going out. So strong and so steady is this contrariety in the Caribbean Sea, that a boat may be moored by dropping a heavy substance to a certain depth; the upper current impels the boat one way, while the under one draws the sunk object another, and between the two the boat is steadied.

Two currents of equal force, but of different directions, meeting in a narrow passage or gut, will cause a whirlpool, a phenomenon which has ignorantly been said to be produced by subterranean rivers, gulfs, chasms, &c., but essentially is only an eddy, produced by the contact of two currents meeting on a centre. The whirlpool named the Euripides, near the coast of Greece, alternately absorbs and rejects the water seven times in twenty-four hours. Charybdis, in the Straits of Sicily, absorbs and rejects the water thrice in twenty-four hours; and the Maelstroem, on the coast of Normandy, which is considerably the largest, absorbs, every six hours, water, ships, whales, in short, every thing that approaches its malignant influence, and the next six hours is employed in casting them up again. These eddies are sometimes augmented by the force of contending tides, or by the action of the winds. They draw vessels along, dash them upon rocks, or engulf them in their furious vortices, the wreck not appearing until some time after.

WATERSPOUTS.

Marine waterspouts are caused by the action of atmospheric currents, and are as dangerous in their effects as they are wonderful in appearance. Malte-Brun thus describes them:—"Underneath a dense cloud, the sea becomes agitated with violent commotions; the waves dart rapidly towards the centre of the agitated mass of water, on arriving at which they are dispersed into aqueous vapours, and rise whirling round in a spiral direction towards the cloud. This conical ascending column is met by another descending column, which leans towards the water, and joins with it. In many cases the marine column is from fifty to eighty toises (fathoms) in diameter near its base. Both columns, however, diminish towards the middle, where they unite; so that here they are not more than three or four feet in diameter. The entire column presents itself in the shape of a hollow cylinder or tube of glass, empty within. It glides over the sea without any wind being felt; indeed, several have been seen at once following different directions. When the cloud and the marine base of the waterspout move with unequal velocities, the lower cone is often seen to incline sideways, or even to bend, and finally to burst in pieces. A noise is then heard like the noise of a cataract falling in a deep valley. Lightning frequently issues from the very bosom of the waterspout, particularly when it breaks; but no thunder is ever heard."

Sailors, to prevent the imminent danger which their vessels would be exposed to by coming in contact with these tremendous columns, discharge upon them a cannon ball, which, passing through them, causes them invariably to burst, and, consequently, removes all chance of injury connected with them. This phenomenon is accounted for in the following manner:—Two winds meet—a vortex ensues: any cloud which happens to lie between them is condensed into a conical form, and turned round with great velocity: this whirling motion drives from the centre of the cloud all the particles contained in it; a vacuum is thereby produced, and water or any other body lying beneath this vacuum is carried into it upon the usual and well-known principle. The cannon ball, breaking this cylinder, which is always partly hollow, causes it to fall to pieces, in the same manner as a touch upon the surface of a soap-ball reduces the resplendent mass to a drop of common water.

TEMPERATURE OF THE SEA.

The temperature of the sea, like that of the air, is liable to be affected by the latitude and the season of the year, but not to nearly so great an extent as the air Within the tropics, where the season has hardly any influence, it is generally found at about 80 or 81 of Fahrenheit's thermometer, being somewhat more, in general, than the warmth of the neighbouring air, which is deprived to a certain extent of its heat, in order to carry on the process of evaporation. Taking the month of March as one of those during which the heat of the sun must be equally determined in both directions by latitude, we find that in that month the sea has been found, at 11° 32′ south, of 80·6 Fahrenheit; at 31° 34′ south, of 75·7; at 40° 30′ south, of 59·9; though in some instances it has been found several degrees more or less at the same season, and under nearly the same latitude. The chief cause of the variation is the perpetual flow of water from the poles to the equator, which has been already explained. It has been pretty nearly ascertained, that, in the tropical seas, it ranges about 9 degrees of Fahrenheit; in the middle of the temperate zone about 12; and after that, decreases with a more rapid and more equable gradation. The temperature of the sea is also affected by its depth. In deep seas between the tropics, the heat diminishes towards the bottom; while, in more frigid latitudes, it is sometimes observed to become warmer. The sea is a bad conductor of heat; the solar rays can only penetrate about three hundred feet below the surface, nor does the light descend any farther. A small difference is discovered between the observations on temperature in the two hemispheres. For the first 25° towards the south, the decrease of heat is slower, and after that more rapid, than towards the north.

It must be evident to every one who considers the great mass of waters composing the ocean, and the interchange of position which must always be taking place, to a greater or less extent, between the upper and warmer parts and the lower and colder, that this comparative equability of temperature is unavoidable, even if there were no other causes to account for it. The uses of that equability are still more obvious, and must add greatly to the wonder we always experience when the economy of nature is minutely traced. By this equability, the natural result of high latitude is mor[illegible] less corrected, for the advantage of the human be[illegible] who happen to be so placed. A milder air breath[illegible] n the sea softens the climate all over the adjacent land, and produces a freshness which is of the greatest service to vegetation. On the other hand, in those torrid regions where both animated and vegetable nature is apt to sink beneath the vertical rays of the sun, the cooling breath of the ocean comes, generally at fixed times, reviving the parched soil, and communicating to man sensations of relief and pleasure, which are hardly to be imagined by those who have not experienced them.

SALINE PROPERTY OF THE SEA.

The saline property of the sea has never been scientifically accounted for; it baffles all human investigation. Some have alleged that it is caused by fossil or rock salt at the bottom, but for this there is neither proof nor probability. The most reasonable conclusion is, that the sea is a homogeneous salt body; that its waters were created, and have continued, and ever will continue, in this saline condition, in the same manner that the atmosphere has been created and exists as a compound body. The inquiry, therefore, why the sea is salt, is just as needless as why the atmosphere is composed of two or three gases. The two questions are equally shrouded in mystery. "The proportion which the saline matters bear to the water varies considerably. The water of the Atlantic Ocean, within the tropics, contains about one twenty-fourth of its weight of saline matters. There, from the great heat, very great evaporation must go on at the surface; and from the great mass of water, particularly far out at sea, the influence of rivers in counteracting the effect of the evaporation, by adding fresh water, must be less than usual. In the Firth of Forth, the saline matters form only one-thirtieth of the weight of the water. There less fresh-water is removed by evaporation, the climate being much colder; and the fresh water supplied by rivers is greater in proportion, so that the salt matters bear a smaller proportion to the whole. There are chiefly four matters (continues our authority*) contained in sea-water, common salt (muriate of soda), glauber salt (sulphate of soda), muriate of magnesia, and muriate of lime. Potash has been detected in sea-water; and it also contains extremely small quantities of two simple substances lately discovered, namely, iodine and bromine, in union with hydrogen. Disregarding all except the four first, the composition of the water of the Atlantic Ocean, as analysed by Dr. Marcet, may be stated as follows. The quantity examined was 500 grains

"Water,	478·420
Muriate of soda,	13·3
Sulphate of soda,	2·33
Muriate of lime,	0·995
Muriate of magnesia,	4·055
	500 grains."

Thus, it is seen that muriate of soda or common salt is the principal solid ingredient in the waters of the ocean, and that muriate of magnesia is the next in importance. Sea-water is to a certain degree more dense, or of greater specific gravity, than pure water. According to Dr. Arnot, "a ship draws less water, or swims lighter, by one thirty-fifth, in the dense salt water of the sea, than in the fresh water of a river: and for the same reason, a man swimming supports himself more easily in the sea than in a river." Sea-water freezes at 28° of Fahrenheit's thermometer. Fresh water, as is well known, expands equally in its volume, 8° above or below 40°, that is to say, it expands by an increase of temperature up to 48°, or by a diminution of temperature down to 32°, the common freezing point, when it assumes the crystallized or icy form. Thus 40° is the point of mean density, or of smallest volume, in fresh water. By the recent experiments of chemists, it is found that sea-water does not expand by a diminution of temperature down to 32°, because it is reluctant to assume the crystallized form, and when it does freeze at 28°, its ice is very imperfect, being full of pores and interstices, and composed in a great degree of thin spicular flakes, enclosing drops of a strong briny liquid which cannot be crystallized.

Sea-water, on being boiled, or exposed in small quantities to the sun's rays, evaporates, and leaves a residuum of common salt; and the manufacture of this article, by means of pans and furnaces, is carried on upon the shores of almost every civilized country. Innumerable have been the attempts to render sea-water useful as an element of food or drink, in cases of great scarcity of fresh water on shipboard, but in no case has a perfectly pure or sweet water been procured. Filtration has no effect, because the saline matters in the water are chemically united with it, and cannot be removed by means merely mechanical. The process of purifying the water to the best advantage consists in distilling it, the vapour being gathered and condensed into a liquid. But this liquid is not entirely fresh or sweet, in consequence of its containing certain gaseous matters: and therefore, after distillation, the liquid should for a length of time be exposed to the action of the atmosphere, so as to allow the escape as far as possible of the gases with which it is charged. A small quantity of potash or soap put into the water previous to distillation, is said to be useful in purifying it and rendering it more palatable. The following plan for procuring fresh water at sea, in a case of emergency, was pursued by a Captain Chapman, when sailing off the north coast of Finland. By accident he lost nearly all his water; and while thus circumstanced, a gale of wind arose, which blew hard for three weeks, and drove him far out to sea. The Captain was in great anxiety. The water in the ship would last but a short time, and he had no still on board. But necessity, the mother of invention, aided him in contriving one. By means of an old pitch-pot, with a wooden cover, and a pipe made of a pewter plate, and a cask for a receiver, he commenced operations. He put seven quarts of sea-water and an ounce of soap into the pot, and placed it on the fire. As soon as the pot boiled, the condensed vapour began to flow through the pipe into the receiver. In half an hour he obtained a quart of fresh water. This water, though not very palatable, answered for all necessary purposes. He kept the still constantly at work, and got a gallon of water every two hours. And thus the crew was saved from great suffering, if not from actual death.

PHOSPHORESCENCE OF THE SEA.

Every one who has been at sea, and observed the action of the waters at night, must have less or more remarked certain luminous appearances in the waves. Accounts of the phosphorescence of the sea may be found in the narrative of almost every voyager. The following description is given by Mr. Stewart, in his Journal of a Residence in the Sandwich Islands:—"The exhibitions of the day have been followed at night by a phosphoretic scene of unrivalled splendour and sublimity. We had often before observed luminous points, like sparks of fire, floating here and there in the furrow of our vessel, but now the whole ocean was literally bespangled with them. Notwithstanding the smoothness of the surface, there is a considerable swell of the sea; and sparkling as it did on every part as with fire, the mighty heavings of its bosom were indescribably magnificent. It seemed as if the sky had fallen to a level with the ship, and all its stars, in tenfold numbers and brilliancy, were rolling about with the undulations of the billows.

"The horizon in every direction presented a line of uninterrupted light, while the wide space intervening was one extent of apparent fire. The sides of our vessel appeared kindling to a blaze, and as our bows occasionally dashed against a wave, the flash of the concussion gleamed half way up the rigging, and illuminated every object along the whole length of the ship. By throwing any article overboard, a display of light and colours took place, surpassing in brilliancy and beauty the finest exhibition of fire-works. A charming effect was produced by a line coiled to some length, and then cast into the water at a distance, and also by a bucket of water dashed from the side of a vessel. The rudder, too, by its motions, created splendid coruscations at the stern, and a flood of light, by which our track was marked far behind us. The smaller fish were distinctly traceable by running lines showing their rapid course, while now and then broad gleamings, extending many yards in every direction, made known the movements of some monster of the deep. But minuteness will only weary without conveying any adequate impression of the scene: it would have been wise, perhaps, only to have said that it was among the most sublime nature herself ever presents.

"The cause of this phenomenon was long a subject of speculation among men of science, but is now satisfactorily ascertained to be a sea animalcule of the luminous tribe, particularly the species *Medusa*. The *Medusa*

*Chemistry of Nature, by Hugo Reid. Edinburgh, 1837.

pellucens of Sir Joseph Banks, and the *Medusa scintillans* of Mr. Macartney, emit the most splendid light. The degree and brilliancy of the exhibition are supposed to depend on the state of the atmosphere and sea. A more grand display than that which we have witnessed probably seldom if ever takes place."

This phenomenon has been ascribed to various causes, but the explanation presented by Mr. Stewart is the one now most generally admitted. The little animal by which this light is produced is sometimes called *the glow-worm of the sea*. This animal is exceedingly small, thin, and transparent, and, like the fire-fly, with which we are well acquainted, emits a brilliant light. The sea contains many animals of this nature, of different species. The *Medusa* have little antennæ or horns, from which they dart a strong light, while the rest of their body remains in obscurity. All the zoophytes appear to be in a greater or less degree phosphorescent. Some accurate observers have also thought, that in addition to this *glow-worm* light, there is a luminous appearance originating from the decomposition of vegetable and animal substances, similar to the phosphorescence of rotten wood.

THE COLOUR OF THE SEA.

The water of the sea is colourless when examined in small quantities, but when viewed in the mass in the wide ocean, it appears to be of an azure or blue tint. The cause of this generally blue colour of the deep sea has not been as yet clearly explained; but it seems to be in some degree accounted for by reference to certain principles connected with the science of optics. Probably most are aware that light consists of the set of colours which we see so beautifully displayed in the rainbow. Now, it is a law of light, that when it enters any body, and is either reflected or transmitted to the eye, a certain portion of it, consisting of more or less of its colours, is lost in the body. The remainder, being reflected, strikes our visual sense, and whatever colour that may be, the object seems of that colour. Now, it chances that the portion of light most apt to be reflected from masses of transparent fluid is the blue; and hence it is, or supposed to be, that the air and sea both appear of this colour.

While there can be no doubt that the ocean is generally of a blue colour, it is equally certain that there are many portions of sea in which a different hue appears. The causes of these exceptions from the rule seem to be of various kinds. Frequently, the ordinary colour of the sea is affected by the admixture of foreign substances, these being sometimes of a living and organic nature, and sometimes the reverse. The most simple example of the latter class of cases is the common flooding of any stream, when quantities of mud and earthy particles are introduced into the river, and emptied into the sea. What is thus strikingly seen on every coast, on a small scale, will readily be conceived to be of infinitely wider extent in the mighty rivers of the principal continents of the globe. Some seas are coloured *yellow* from a similar cause. Vegetable matter is known to have a colouring effect; but more usually the peculiar tint of the sea results from an infusion of animals of the infusoria tribes. Another class of cases in which the ocean appears to be tinged with a peculiar colour, is referable to the reflection of rays of light from the bed or bottom; and hence, in shallow and clear seas, the colour of the ground is a main cause for any particular tint which the water assumes to the eye.

WINDS—TRADE-WINDS.

A change in the temperature, a diminution of the vapour, or any other cause that may occasion a portion of the surrounding atmosphere to contract or expand, will give rise to the aërial currents denominated winds which, indeed, bear a strong analogy to the currents which occur in the ocean. When the air by which we are surrounded becomes heated, it expands, and becomes specifically lighter, in consequence of which it mounts upwards, and the colder and denser air which surrounds the mass thus rarified rushes in to supply its place. When, also, a condensation of vapour in the atmosphere suddenly takes place, giving rise to clouds which speedily dissolve in rain, the temperature of the surrounding air is sensibly altered, and the colder rushing in upon the warmer, gives rise to a sudden gust of wind. For this reason, a cold heavy shower passing over head, with a hasty fall of snow or hail, is often attended with a violent and sudden gust of wind, which ceases when the cloud disappears, but is renewed when another cloud, sweeping along in the same direction, brings with it a fresh blast. Accordingly, a whistling, or howling, or noise of the wind, is universally considered to be a prognostic of rain, because it indicates that a change is taking place in the temperature of the atmosphere, owing to the vapour in its higher regions being condensed into rain-clouds.—(See article METEOROLOGY.)

The most remarkable winds are those which traverse the ocean steadily in one direction, and are called "trade-winds," from their use in mercantile navigation. An explanation of their cause is given in the article METEOROLOGY. The external limits of the trade-winds are 30 degrees north and 30 degrees south of the equator; but each limit diminishes as the sun advances to the opposite tropic. The larger the expanse of ocean over which they sweep, the more steadily do they blow; accordingly, they are more steady in the Pacific than in the Atlantic, and in the South than in the North Atlantic Ocean.

Sea and Land Breezes.—In most countries near the shores of the sea, but particularly in tropical climates, there are periodical winds called sea and land breezes, of which the navigator takes advantage. The cause of the occurrence of these winds is described in the article METEOROLOGY.

Hurricanes.—The most dangerous winds to the navigator are those which occur in sudden gusts, or squalls, and for the approach of which the sharpest outlook is required. When the squall is in the form of a violent tempest, accompanied by rain, lightning, and thunder, it receives the name of a hurricane. Hurricanes occur most frequently and with the greatest violence in tropical climates; because, in consequence of the very great heat which there prevails, the rarefaction of the air, and also the condensation of the vapour it contains into rain-drops, take place more suddenly and completely than in more temperate regions. By this means the electricity of the atmosphere—that subtle fluid which seems to pervade all bodies, and which universally seeks its own equilibrium—is disturbed, and no longer maintains an equal distribution through the aërial vapour. It accumulates in vast quantities in one mass of vapour or cloud, while in another it is deficient; and consequently, to regain its equilibrium, it flashes in the form of lightning from the surcharged cloud to the cloud that is undercharged, or to the earth itself. Hence hurricanes are always attended with electrical manifestations, which add greatly to the horrors of the spectacle. Hurricanes commence in various ways: sometimes from a single and small cloud, which suddenly expands, overspreading, as with a dense shroud, the whole heavens; and sometimes from a slowly gathering mass of clouds which appear to be irradiated with electric fire. The West Indies, the Isle of France, and the kingdoms of Siam and China, are the countries which are most subjected to the ravages of hurricanes. In the West Indies they most frequently occur in the month of

August, and the Indians, from their experience, originally taught our planters the signs by which their approach may be prognosticated. All ordinary signs, however, may prove delusive; and the best of all prognosticators of storms is the marine barometer, an instrument whose services are of incalculable value.

Calms—Breezes.—"After a storm comes a calm," is an old proverbial expression. The fury of the tempest expends itself, and in all likelihood there shortly after ensues a state of tranquillity, though several days may elapse before the "swell," or heaving agitation of the sea, subsides. When both the atmosphere and the waters are tranquil, the surface of the ocean is beautifully calm, and almost as smooth as the glassy surface of a lake. But a perfect or dead calm, if of any continuance, is almost as disagreeable to the navigator as a driving tempest. The ship makes no progress in its course; the sails are useless; and there are no means of removing from the dull and distressing scene. Fortunately, dead calms are not generally of that continuance which leads to any serious result. A gentle breeze begins to steal upon the extended face of the deep, and the hitherto unruffled surface of the waters begins to show a slight tremulous ruffling, technically called the *crow's foot*. Sailors have a superstitious, and of course foolish belief, that whistling in a calm will bring up a breeze, and this they do with a drawling and beseeching intonation on some prominent part of the vessel.

THE ARCTIC SEAS.

The seas within the arctic circle, at the north or south pole, exhibit some remarkable appearances. In the coldest season, the air deposits its moisture in the form of a fog, which freezes into a fine gossamer netting, or slender icicles, dispersed through the atmosphere, and so extremely minute that they seem to pierce and excoriate the skin. The hoar-frost settles profusely in fantastic clusters on every prominence. The whole surface of the sea steams like a lime-kiln, an appearance called the *frost-smoke*, caused, as in other instances of the production of vapours, by the waters being still relatively warmer than the incumbent air. At length the dispersion of the mist, and the consequent clearness of the atmosphere, announce that the upper stratum of the sea itself has become cooled to the same standard; a sheet of ice quickly spreads, and often gains the thickness of an inch in a single night.

The most appalling phenomenon of these dreary regions is the floating of huge masses of ice, called icebergs, which are formed from the water of the melted snow on the nearest coasts; little by little the incrustations on the shores and cliffs increase to the size of mountains, and these being torn from their fastenings by winds or their own great weight, are swept off into the ocean, where they accumulate by the falling of snow, and finally resemble great islands. These float southwards, and are the terror of navigators. Not unfrequently do the regular packets from Liverpool to the United States fall in with these floating islands, and vessels in the night have been dashed to pieces by driving against them. They are carried towards the Atlantic by the current, which generally flows from the north-east; and after they reach the warmer water of the lower latitudes, they rapidly dissolve, and finally disappear probably in the space of a few months.

WAVES.

The waves of the ocean are various in figure and dimensions, according to the force and direction of the winds, contending currents, and other causes. The best account we have of the theory of waves, is that given by the learned Dr. Arnot, in his work, "The Elements of Physics," from which we may quote a few passages. "The common cause of waves is the friction of the wind upon the surface of the water. Little ridges or elevations first appear, which, by continuance of the force, gradually increase, until they become the rolling mountains seen where the winds sweep over a great extent of water. In rounding the Cape of Good Hope, waves are met with, or rather a swell, so vast, that a few ridges and a few depressions occupy the extent of a mile. But these are not so dangerous to ships as a *shorter* sea, as it is termed, with more perpendicular waves. The slope in the former is so gentle, that the rising and falling are scarcely felt; while the latter, by the sudden tossing of the vessel, is often destructive. When a ship is sailing before the wind, and riding over the *long swell*, she advances as if by leaps; for while each wave passes, she is first descending headlong on its front, acquiring a velocity so wild that she can scarcely be steered; and soon after, when the wave has glided under her, she is climbing on its back, and her motion is slackened almost to rest before the following wave arrives.

"The velocity of waves has relation to their magnitude. The large waves, just spoken of, proceed at the rate of from thirty to forty miles an hour. It is a vulgar belief that the water itself advances with the speed of the wave, but in fact the *form* only advances, while the *substance*, except a little spray above, remains rising and falling in the same place, with the regularity of a pendulum. A wave of water, in this respect, is exactly imitated by the wave running along a stretched rope when one end is shaken; or by the mimic waves of our theatres, which are generally undulations of long pieces of carpet, moved by attendants. But when a wave reaches a shallow bank or beach, the water becomes really progressive, for then, as it cannot sink directly downwards, it falls over and forwards, seeking the level. So awful is the spectacle of a storm at sea, that it is generally viewed through a medium which biasses the judgment; and lofty as waves really are, imagination pictures them loftier still. Now, no wave rises more than ten feet above the ordinary sea-level, which, with the ten feet that its surface afterwards descends below this, give twenty feet for the whole height, from the bottom of any water-valley to an adjoining summit."

SHIPS.

Ships are vessels of a certain size adapted for sailing on the ocean, and the ingenuity of their construction is one of the proudest triumphs of human skill. Of the early history of ship architecture little can be said of any importance. The buoyant property of water, particularly that of the sea, must have been soon observed by mankind; and, therefore, beginning with rude skiffs and canoes, they would in time acquire sufficient experience and skill to form vessels of a larger size, and to guide them in the required direction by means of rudder and sails. The cultivated nations of antiquity, Egyptians, Carthaginians, Phœnicians, and others, possessed ships for commerce and war, some of which were of large dimensions, and moved either by rowers or by the action of the wind on the sails. But of these early ships it is unnecessary here to speak, and we proceed to notice the construction and character of vessels formed according to the principles of modern and improved science.

The nicest and most difficult operation in ship-building consists in first forming a draught or model of the proposed vessel, or, as we may call it, the *plan*, which, the mechanics are to adopt and follow out. In forming this plan, the designer is governed by a consideration of the precise object to be attained. There are two classes of vessels—ships of war and merchantmen—and each must possess certain qualifications. In a ship of war the great object is speed, with ease of movements, and capacity to accommodate her crew, and carry a sufficient weight of guns, stores, and provisions. One point, moreover, is especially to be looked to; this is, that the ship float high enough above water to run no risk of receiving waves or seas in her lower ports during action, when these holes must be necessarily open. In order to be secure of this, the constructor makes an estimate of the whole weight of the ship, including body, spars, armament, men, and munitions, and must so model the bottom that it will have displaced an equal weight of water when arrived at the desired depth. In the case of merchantmen, the primary consideration is to attain the greatest capacity to carry cargo, combined, as far as possible, with safe and easy movements and rapid sailing.

The English excel in ship-building, but in some respects they are outdone by the Americans, whose packet ships carry enormous weights, while they are noted for their extreme speed. Among the admitted and well-established principles of construction is the leading one, that the greatest breadth must always be before the centre, and consequently the bow or front be more blunt than the stern or hinder part. Abstractly, it would seem most important that the bow should be the sharpest, so as to cleave the water with the least possible resistance; but experience has proved that it is far more essential to facilitate the escape of the displaced water along the side of the vessel; for when once a passage is opened for the ship, the fluid tends to reunite behind the point of greatest breadth, where, instead of offering resistance, it presses the ship forward, and fills up the space constantly opening behind her. The principle is evident in the form of the duck and other aquatic animals, which are uniformly broadest in front, and gradually diminish to the tail. As it is, then, less essential that a ship should be sharp forward than aft, there is a further advantage in having the bow full towards the edge, that it may check her in descending into the waves, not abruptly, but gently; pitching, or rising and falling endwise, being the most dangerous to hull and spars of all a vessel's movements. Though sharpness towards the stern-post is vitally essential to fast sailing, yet care must be taken to leave the buttock full towards the surface, in order to check the stern gently in descending, and when scudding before a gale, to lift it in timely season, on the arrival of a sea. To hit the exact mean in these respects, so as not to retard the sailing on the one hand, nor to endanger the ship on the other, requires all the skill of the architect.

There must likewise be a due correspondence between the general bulk of the vessel and its length and breadth; the whole must be properly proportioned. If unduly long, speed may be gained, but there is a difficulty of turning, and also of rising to escape the breakings of the sea; long ships, therefore, are apt to roll and go through waves instead of breasting them, by which their safety is perilled. When a ship is unduly short for its general bulk, it is apt to pitch, which is equally dangerous, and hence the greatest care is required to proportion the various dimensions.

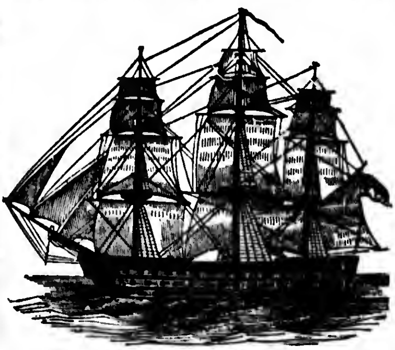
All essential preliminaries being settled, the ship is begun to be constructed; and this is always done in the yard of a ship-builder, close by the water's edge. The wood considered to be best adapted for ship-building is oak, pine, teak, elm, or beech, and whichever is employed, it requires to be strong, well-seasoned, and dry; the greater part, likewise, should be bent or crooked, to suit the curves and angularities in the structure; and for this end growing timber is often constrained to assume particular forms. The keel, which is the lowest part of the vessel, and corresponds to the back-bone of an animal, from which the ribs spring, is formed and laid first on a slip and blocks set for the purpose. As the framework proceeds, all parts are firmly bolted and riveted together, and the whole is finally covered with the planking in even lines from bow to stern. When it is necessary to bend a plank for either the bow or stern, it is heated by steam, and then forced into its place by screws and levers. The planks are fastened to the ribs by wooden pins, and the plan is followed of allowing a seam or space between each plank, which is filled up or calked with oakum, and the whole is smeared with pitch. In some instances, the bottom is further secured by sheathing it in sheets of copper. Meanwhile, the interior beams and partitions have been placed; and when duly prepared, the vessel is *launched*, or shot by an easy movement down the inclined plane on which it rests into the water. After launching, the rudder, or helm, is shipped. The rudder is a wooden apparatus placed at the stern of the ship, a large portion being in the water, and by means of it the vessel is steered and turned about at pleasure; the steering part of the apparatus is on deck, and consists of a wheel placed perpendicularly and connecting chains and pulleys. The principle on which the rudder acts is very simple: the object is to turn the vessel, and to whatever side the inclination is to be made, the rudder is caused to present an obstacle to the water in that direction. The masts of the vessel are now set; and the spars, comprehending the bowsprit and yards, and also the rigging are attached. The spars of a ship are not abandoned to their own unsupported strength, but are sustained by what is called the *standing rigging*. Besides this, there is the *running rigging*, which consists of the tacks and sheets that serve to spread the sails, the halyards, traces, lifts, clewlines, and all other ropes used in making, taking in, or manœuvring the sails.

The sails of a ship are square sheets of canvas bent to the yards, and fore and aft sails traversing on stays or bent to gaffs. Let us proceed to describe an entire suit of sails, beginning forward. On the extremity of the bowsprit is the flying-jib, a three-cornered sail, which goes from the end of its boom upward along its stay, leading to the fore-topgallant-mast-head, and confined to the stay by rings of wood or iron, called the *hanks*. It is hoisted by means of the halyard; hauled down by a downhaul; and when up, is trimmed to hold the wind by a sheet or rope leading to the forecastle. The jib, which leads from its boom to the fore-top-mast-head, is of similar form, and so is the fore-top-mast-stay-sail, running from the bowsprit end towards the mast-head. On the foremast we have the fore-sail, bent to the foreyard, and spread at the foot by means of tacks and sheets; Above it, the fore-top-sail, bent to the top-sail-yard, by means of which it is hoisted aloft, while its lower corners are spread to the extremities of the fore-yard; next, the topgallant-sail, bent to its yard, and sheeting home to the top-sail-yard; and so with the royal and sky sail. All these sails are turned at pleasure, to be presented to the wind, by means of braces attached to their yard-arm, and leading to the main-mast. The main-mast is furnished with a similar suit of sails, somewhat larger; the mizzen-mast, also, though smaller than either, instead of a square-sail on the lower part of the mast, has a gaff sail, hoisting up or down abaft the mast. Some ships have similar gaff-sails on the fore and main-masts, which are found of great use in gales of wind, as a substitute for storm stay-sails. Most carry, also, light stay-sails between the masts; but they are very troublesome. Studding-sails, spread beyond the square sails like wings, are found useful when going before the wind. The perfection of equipping a ship with spars, rigging, and sails consists in so disposing them, that, in a whole-sail breeze the centre of effort of all the sails will be in the same line with the ship's centre of rotation; or that the efforts of the forward and after-sails to turn the ship will be exactly balanced, as not to require any continued assistance from the rudder in either direction.

The retarding apparatus of the vessel consists of heavy iron instruments called anchors, of which each vessel has usually more than one. Large ships carry the following suite of anchors:—1. The *sheet* anchor, which is the largest, and only used in the case of violent storms. 2. Two bower anchors, namely, the *best bower* and *small bower*, so called from their situation at the bows. 3. The *stream* anchor, the *kedge*, and *grappling*, or *grapnel*. The three last are often used for moving the ship from place to place in a harbour or river. Each anchor is let down by a strong cable of iron or rope, and is lifted by means of the windlass placed on deck. To the cable, when in the water, a *buoy* or floating object may be attached, to show where the anchor has been let down; and to save time, or in an emergency, the anchor and cable are sometimes left, while the vessel proceeds, the buoy serving to point out where the anchor may be recovered. The anchor is said to be *a-peak* when the cable is perpendicular between the hawse and the anchor; it is said to *come home* when it does not hold the ship; it is said to be *foul* when the cable gets hitched about the flukes. *Riding at anchor* is the state of the vessel when moored or fixed by the anchor. *Dropping* or *casting anchor* is letting it down into the sea. *Weighing anchor* is raising it from the bottom. We shall proceed now to notice the principal kinds of vessels.

War Vessels.

At the head of the list stands the ship proper, a vessel with three masts, called the fore, the main, and mizzen-masts, and which is square-rigged, or carrying large square sails. The largest ships are vessels of war, named line-of-battle ships, having three complete decks, and carrying 120 guns. A representation is given of such a magnificent floating apparatus in the accompanying figure. The decks are equivalent to different floors. On the first or



First-rate war-vessel.

uppermost, extending on each side of the fore-mast, is the *forecastle*, and next to it, between the fore-mast and the main-mast, are the *waist* and *gangway*; between the main and mizzen masts is the *quarter-deck*; and next to it, towards the stern, is an elevated part called the *poop*. A narrow passage on each side of the vessel, communicating from the quarter-deck to the forecastle, is called the *gangway*, and in nettings above it the seamen's hammocks are stowed as a protection during action.

The forecastle is appropriated to the best or able-bodied seamen, the quarter-deck is the proper situation for the officers, and in the poop are stationed the marines. The quarter-deck is a privileged spot, and as, by a fiction, the sovereign is supposed to be present, every one who enters this deck must salute it by touching his hat, and all present return the compliment by touching their hats likewise. Beneath the poop are the apartments of the captain, and some others. Descending from the upper range of decks, we arrive at the *main-deck*, at the fore part of which is the sick-ward, and next to it the *galley* or cook's room; at the after part, beneath the captain's cabin, is the admiral's cabin. The next, or third range of deck is the *middle-deck*, at the fore part of which is the *ward-room*, or general apartment for the officers. The fourth range is the *lower-deck*, where the sailors sleep and mess, and on which, also, is the *gun-room*, for inferior officers. On all the decks mentioned, cannon or large guns are ranged, each having its appropriate port-hole; and by these holes, on which temporary windows are fastened, light is admitted to the interior. We now descend to a floor beneath the surface of the water, which is called the *orlop-deck*, on which, between the main and mizzen-masts, is the cock-pit, or surgeon's room; the purser's, boatswain's, and carpenter's berths, and midshipman's mess-room. Beneath the orlop-deck is the *hold*, a species of cellar in divisions, containing the boatswain's and carpenter's stores, the powder magazine, shot, the water-casks, and provision stores.

War vessels receive their designations from the number of their decks, or of the guns which they carry. Line-of-battle ships are of various *rates*. The *first*-rates include all carrying 100 guns and upwards, with a company of 850 men and upwards; *second*-rates carry 90 to 100 guns, and from 650 to 700 men; and *third*-rates carry from 60 to 80 guns, and from 600 to 650 men. The rates thus diminish in bulk and complement of men down to sixth-rates. A common rate is a 74 gun-ship, which carries 600 men. The following is a list of the titles and number of the crew of a first-rate ship, classed in the order of their amount of pay:

Captain,	1	Brought forward,	106
Lieutenants,	8	Coxswain of Pinnace,	1
Master,	1	Sailmaker's Mate,	1
Chaplain,	1	Caulker's Mate,	1
Surgeon,	1	Armourer's Mates,	2
Purser,	1	Cooper,	1
Second Master,	1	Volunteers	12
Assistant Surgeons,	3	Gunner's Crew,	25
Gunner,	1	Carpenter's ditto,	12
Boatswain,	1	Sailmaker's ditto,	2
Carpenter,	1	Cooper's ditto,	2
Mate,	1	Yeoman of Store-room,	1
Midshipmen,	23	Able Seamen, Ordinary ditto,	478
Master's Assistants,	6		
Schoolmaster,	1	Cooks' Mate,	1
Clerk,	1	Barber,	1
Master-at-Arms,	1	Purser's Steward,	1
Ship's Corporals	2	Captain's ditto,	1
Captain's Coxswain,	1	Captain's Cook,	1
Launch ditto,	1	Wardroom ditto,	1
Quartermasters,	12	Wardroom Steward,	1
Gunner's Mates,	5	Steward's Mate,	1
Boatswain's Mates,	8	Landsman,	1
Captains of Forecastle,	3	Boys,	31
Captain of Hold,	1		
Ship's Cook,	1	Total Seamen,	690
Sail Maker,	1		
Rope Maker,	1	Captain of Marines,	1
Carpenter's Mates,	2	Lieutenants,	3
Caulker,	1	Serjeants,	4
Armourer,	1	Corporals,	4
Captains of Maintop,	3	Drummers,	2
Captains of Foretop,	3	Privates,	146
Captains of Mast,	3		
Captains of After-Guard,	3	Total war complement of officers, seamen, and marines,	850
Yeoman of Signals,	1		
	106		

A number of the above officers and subalterns are not appointed to third or inferior rates. Latterly, engineers have been added to the list of men in the royal navy, intended for service in the steam marine; they take rank below carpenters.

The burden of a first-rate is from 2700 to 2800 tons; the length of the lower gun-deck is 205 feet 6 inches, and length of keel for tonnage 170 feet 6 inches, the upper decks being longer in proportion; the height from keel to midships from 50 to 60 feet. The guns are generally distributed as follows:—Forecastle, two 18-pounders and two 34 carronades; quarter-deck, two 18-pounders and fourteen 32 carronades; main-deck, thirty-four 32-pounders; middle-deck, thirty-four 32-pounders;

and lower deck, thirty 32-pounders and two 68 carronades. Total, 120 guns.

Ships of less than 44 guns are termed *frigates*. A frigate, of which the following engraving is a sketch, has

Frigate.

only one gun-deck beneath the quarter-deck, and beneath that lighted and ventilated partly by skylights and partly by small holes in the sides, is a deck appropriated to the men, officers, &c.

The following account of the organization and arrangements on board of war-vessels is abridged from a work entitled, "Two Years and a Half in the American Navy," by E. C. Wines, 1833. Though strictly applying to an American frigate, it is generally applicable to a similar vessel in the British navy. "Time on shipboard is divided into watches, and reckoned by bells. Hence you never hear the question, 'What's o'clock? but 'How many bells is it?' The twenty-four hours are divided into six equal portions, called watches. At the end of the first half hour of one of these portions, the bell is struck one; at the end of the second, two; and so on, till the series reaches eight, when it commences again. In the ship's journals, the dates are put down according to the common mode of reckoning time. The division of time into watches differs somewhat at sea and in port.

"Order is the first great rule on board a man-of-war, and that to which all others must bend. From day to day, from week to week, from month to month, and from year to year, the same stroke of the bell is followed by the same whistle, the same call, and the recurrence of the same duties. Every thing has its place, too, and must be kept in it. So true is this, that a person acquainted with the details of a ship, can lay his hand on a given object in any part of her as well in the dark as if a thousand suns were shining on it. To the same grand principle—ORDER—are to be attributed the numerous divisions and subdivisions of the officers and crew.

"At the head of the list of officers stands the captain, whose will is supreme; and from his decisions, for the time being, there is no appeal. He has a general superintendence over the affairs of the ship, and every order of a general nature must originate in him. No important alteration can be made without his knowledge and consent. It is his duty to take a general oversight of the officers' conduct; to see that they are guilty of no improprieties, and to punish such as are. He is responsible for the safety of the ship, both at sea and in port. If any business of a public nature is to be transacted with a foreign power, it falls of course into his hands. These are his duties in time of peace; in war he has still higher responsibilities.

"Next in rank come the wardroom officers, consisting, on board of a frigate, of six lieutenants, a purser, surgeon, chaplain, sailing-master, and lieutenant of marines. The first lieutenant is next in power to the captain; and though his station is less responsible, his duties are more laborious. He has a general supervision over the ship, and is to see that she is kept clean and in proper order. To this end he is obliged to inspect every part of her at least once a day, and report her condition to the captain. When the ship is put in commission, it devolves chiefly upon him to station the men, a business of the most laborious and difficult nature, requiring great patience, a discriminating judgment, and deep insight into the human heart. It is his duty to have the men frequently exercised at the guns; to regulate the expenditures of certain public stores; to take care that the men keep themselves clean and decently clad; to superintend the watering and victualing of the ship; and, in short, to see that all her multifarious and complicated concerns move on regularly and harmoniously. In coming to an anchor and getting under weigh, and when all hands are called to reef topsails, or for other purposes, he takes the trumpet. On him, more than on the captain himself, depends the comfort of the officers. In port, it belongs to him to grant or withhold permission to go ashore; and there are a thousand other ways in which, if he is a man of capricious or malignant disposition, he can gratify his whims or his spleen at the expense of the comfort and feelings of his fellow-officers.

"The other lieutenants are divided into watches, and take turns in performing the duties belonging to their station. The lieutenant on duty is styled in writing the officer of the watch, but is familiarly called the officer of the deck. Some of his duties are common at sea and in port, and others are peculiar to each of these situations. In both he is responsible for the deck while he has charge of it, and has also to take a general oversight of the ship. He must see that the men's rations are properly cooked, and that they have their meals at proper hours. The serving of the grog is also under his control. At sea, his duty is to sail the ship, keeping her on the course given her by the captain, and reporting to him any change in the wind, the discovery of land or strange sails, and any extraordinary occurrences. At night, he has the captain waked at stated periods, and the state of the weather reported to him. On receiving the trumpet, the first thing the officer of the deck does is to glance at the compass, the sails, the dog-vane, the sky, and the water, to discover the state of the ship, the wind, and the weather; and at the end of the watch, he must have a general account of the weather, and other matters which he may deem proper, inserted in the ship's log-book. The duty of the officer of the deck in port is to receive any supplies of water or provisions which may come alongside, to regulate the sending away of boats, to keep a look-out as to what is going on in the harbour, to report the arrival of ships, and any important occurrences to the captain, &c. The lieutenants are also officers of divisions, and frequently have to exercise the men at the guns, besides superintending the monthly issues of slops to their respective divisions.

"Next in rank to the lieutenants comes the sailing-master, whose duties are more comprehensive and arduous than those of any other officer. His supervision and responsibility extends to almost all the public stores in the ship, but particularly to the water, spirits, cables, and anchors. He reports the daily expenditures of water to the captain. It is his business to keep the ship's place, and report it at least twice a day to the commander, together with the bearings and distance of the port to which she is bound, or the nearest land desired to be made. Some commanders leave this entirely to their sailing-masters.

"There is no berth on board a man-of-war more comfortable than that of purser. He holds the keys of the strong-box; and though his regular salary is not much, his emoluments, arising from other sources, are considerable. All the provisions on board are committed to his charge, and the ship's accounts are all kept by him. His respon sibilities are very great, and heavy bonds are therefore justly exacted from him.

"The surgeon and his two assistants form the medical staff of a frigate. The assistant-surgeons form a distinct class of officers, ranking between the wardroom officers and midshipmen. In frigates and ships of the line they mess in the cockpit, but in all other public vessels in the steerage. The business of the staff is of course to take care of the sick, and perform such surgical operations as may be necessary. A daily journal is kept of the names, rank, diseases, and constitutional habits of all the sick on board, and also of the medicines administered to them. From the journal a report is made out and signed by the surgeon every morning, stating the names, rank, and diseases of the sick, and the number added to and taken from the list. This is handed to the captain. Another list, containing only the names, is placed in the binnacle for the use of the officer of the deck. Nothing will excuse either an officer or a man from duty, but the fact of his being registered on the sick list. A general review of the sick takes place every morning after breakfast. One of the assistant-surgeons inspects the ship's coppers every day, to see that no verdigris is allowed to collect upon them. It is the duty of the surgeon not only to attend to the sick, but also to recommend and enforce such precautionary measures as will have a tendency to prevent disease, and thus secure the general health of the officers and crew. On board of every war-vessel there is a chaplain, who conducts the Sunday services, and administers spiritual consolation to the dying. Of late, a schoolmaster has been added to the list of functionaries.

"The midshipmen may be called apprentice officers, and they require to learn certain duties of seamen. They are also useful by carrying messages from the officer of the deck to the captain, and in port one of them takes charge of every boat that leaves the ship. Towards noon, while at sea, they are obliged to go on deck with their quadrants, and take an observation. They have to work out the last day's run, and report the course, distance made good, and ship's place at noon each day, to the captain. They muster the crew when the watch is called at night. They are also required to keep a journal of the cruise, which is, however, only a copy of the ship's log. This is examined every few weeks by the commanding officer; and if it happens not to be written up when called for, the delinquent is generally punished by a curtailment of some of his indulgences. Five of the oldest midshipmen are master's mates; and their duties are more important and responsible than those of the others.

"The boatswain, gunner, carpenter, and sailmaker, form a distinct class of officers, called warrant-officers. The boatswain is charged with the rigging of the ship, and in port attends to squaring the yards. You may know him by his silver whistle, rattan cane, and, above all, by the ruddy hues of his countenance, and the odious vapours that issue from his mouth. The gunner has charge of the military stores, and, when all hands are called, of the main rigging. The carpenter is responsible for the stores belonging to his department, and superintends the caulking of the ship, and other work performed by his subalterns. The sailmaker is charged with the sails, hammocks, and generally all the canvas in the ship. At sea, he is obliged to go aloft on each of the three masts, examine the condition of the sails, and report it to the first lieutenant every morning before breakfast.

"The grand divisions of the crew are into petty officers, seamen, ordinary seamen, landsmen, and boys. This division has reference to rank; but there are others, into which considerations of this kind do not enter. Such are the military divisions, and the divisions into larboard and starboard-watches, into forecastlemen, fore, main and mizzentopmen, afterguard, waisters, &c.

"The petty or warrant officers are appointed by the commander, and may be degraded by him without the formalities of a court-martial. They are selected from among the most experienced and trustworthy of the seamen. They consist, on board of a frigate, of a master-at-arms, eight quarter-masters, four boatswain's mates, eight quarter-gunners, a boatswain's and gunner's yeoman, a carpenter and sailmaker's mate, an armourer, a cooper, cook, and cockswain.

"The highest and most responsible of the petty officers is the master-at-arms, who may be called the principal police-officer of the ship. He has charge of all the prisoners, and every morning makes out and hands to the commander a list of their names, with a specification of the crime for which each is confined, and the time when he was put in confinement. He has charge also of the berth-deck, and it is his duty to see that it is kept in good order. All property that falls in his way for which he cannot find an owner, is thrown into the 'lucky-bag,' the contents of which, if not finally claimed, are sold at auction.

"The office of quartermaster is one of some dignity and considerable importance. It is his duty to keep a look-out with his spy-glass for signals from other ships, and to report them to the officer of the deck and also to report to him all boats that come along-side, and all other movements and occurrences in the harbour, which he may deem of sufficient importance. One quarter-master is stationed at the wheel to steer the ship, and the others keep a look-out, as in port. When the log is thrown, they hold the minute-glass. All the colours and signals are under their charge.

"Boatswain's mates are an indispensable class of men on board of a man-of-war, but their office is the most invidious and least desirable of all. They have to perform all the flogging, and the men accordingly hold them in some degree of detestation. Each of the boatswain's mates has a silver whistle suspended from his neck, with which he echoes the orders of his superiors. The armourer is the ship's blacksmith. The cooper opens the provision barrels when their contents are wanted, and performs other matters in his line of business, when necessary. The duties of the cook are somewhat arduous, and it requires a good deal of patience and care to perform them acceptably to the crew. The meals must always be reported 'ready,' morning, noon, and night. At noon, when dinner is reported ready, the cook takes a specimen to the officer of the deck, who inspects it, to see that it is properly cooked.

"The above are the principal petty officers; and we now come to the rest of the crew, or seamen, who are of different classes. The first class consists of seamen, or able-bodied men, who are expected to be finished sailors; the next class are ordinary seamen; and after these are boys, who perform various useful offices, but chiefly as servants. The boys, and all others on shipboard, who do not keep watch, are called *idlers*.

"On board of a frigate there are six military divisions, one on the quarterdeck, one on the forecastle, three on the gundeck, and one on the berthdeck. The last is commander by the purser, and each of the others by a lieutenant. It is the business of those who compose the purser's division to pass up powder to the combatants. Every officer and man is included in one or the other of these divisions, and is stationed in a particular part of the ship. These are the stations for action, and are called general quarters. The crew is mustered and inspected at quarters always once, and on board many of our ships twice a day. There are ten or twelve men to each of the guns in a broadside, called first and second captains, spungers, loaders, powder-boys, &c. On the intimation being given, the boarders run for their caps, and every man seizes a cutlass. At the first tap of the drum, there is a general rush throughout the ship, and before the music has ceased, you may hear the midshipmen of the divisions calling over the names, George Bell—first captain, sir—James Anderson—second captain, sir—William Stokes—powder-boy, sir—and so on. Having called the names, the midshipmen report to the officers of their divisions, the officers of the divisions to the first lieutenant, and he again to the captain. Should the order be given to retire, another rush takes place, the cutlasses and boarding-caps are returned to their places, and the men, as the case may be, proceed to their daily labours or their evening diversions. All this is but the work of a moment. Sometimes the call to quarters is beaten in the dead of night, and then the men are obliged to get up, lash their hammocks, take them on deck, and stow them in the nettings, and be ready to answer to their names in the space of about eight or ten minutes. The midshipmen have to do the same.

"In addition to their general quarters, the men are also stationed for getting under way, and coming to an anchor, for tacking and veering, and for other general evolutions. I have sometimes been astonished to see how quick, in the darkest night, it is discovered that a man is missing from his post, and how speedily he is searched out and brought to it. But not only does every man know his station; he has a specific duty to perform at every order, and a failure on his part might disconcert the whole operation. Thus, it will be seen that, notwithstanding the complicated nature of naval evolutions, and the apparent confusion which must necessarily prevail when all hands are called, there is in fact the greatest possible order, efficiency, and harmony of action."

The marines act as a body of soldiers, and do duty both as sentries at different parts of the vessel, and as marksmen, both below and aloft, during action. Being in some respects an armed police over the sailors, there is often a feeling of jealousy between the marines and other members of the crew.

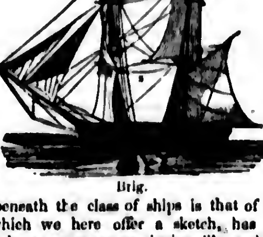
The following is the gradation of officers in connection with the royal navy:—Midshipman; lieutenant; master and commander (usually called captain); post-captain; rear admiral (of which there are several gradations, styled red, white, and blue); and admiral. The senior captain of a squadron, which consists of a few vessels sent upon an expedition, is styled commodore, and he is the general commander for the time being. A fleet is a large number of vessels commanded by an admiral. The affairs of the royal navy are managed by a department of government called the Admiralty, whence the commissions of the officers are issued. Latterly, the condition of both officers and men in the royal navy has been greatly improved, and rendered much more comfortable than formerly.

Merchant Vessels.

Vessels employed in trade, or merchantmen, are of innumerable sizes. The largest is of the ship-proper,

Merchant Ship

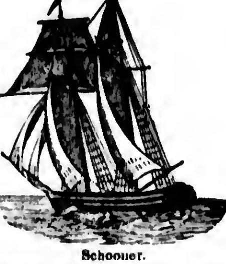
as represented in the preceding figure, with three masts and square sails, but having only an upper deck, the sides of which are usually pierced to carry guns. Vessels of this kind possess holds of very large dimensions for stowing goods, and their burden is from 1000 to 1500 tons.



Brig.

Next beneath the class of ships is that of *brigs*. A brig, of which we here offer a sketch, has only two masts, but it possesses square rigging, like a ship. Brigs are handsome and roomy vessels, carrying from 700 to 800 tons.

With brigs, square rigging terminates, and we now come to classes of vessels in which the rigging is of a



Schooner.

different character. At the head of these stands the *schooner*, a vessel with two masts, and capable of carrying a large press of canvas, but their rigging is various.

Vessels possessing only one mast, are either *sloops* or *cutters*, both distinguished by their tall mast and ex-

Sloop.

tremely large mainsail, which projects towards the stern. Sloops are chiefly engaged as coasting traders, and are of all burdens, from 100 to 600 tons. The class of sloops employed to carry goods and passengers between London and Leith are ordinarily styled *smacks*. There are schooners and sloops of war carrying from ten to twenty guns; they are generally employed in the custom-house service, and adapted for quick sailing.

A *lugger* is a small kind of vessel, but carrying three masts and a running bowsprit, with sails of the form called lug-sails. A *brigantine* is a brig which can be either sailed or rowed. A *xebec* is a light swift-sailing vessel, of three masts, and a long prow, peculiar to the ports of the Mediterranean. A *galley* is another vessel peculiar to the ports of the Mediterranean; it is low built, and carries two masts, but depends chiefly on being rowed with oars; condemned criminals are often sent as a punishment to row these galleys. A *yacht* is a small vessel designed either for state or pleasure. All the preceding classes of vessels possess decks. Small open vessels, not possessing the accommodation of a deck, are of the class of *boats*, of which there are many varieties—as the long-boat, pinnace, wherry, gig, barge, and so forth. Boats are mostly built with the side planks lapping over one another; and this, which is called being *clinker built*, gives them greater buoyancy and strength than if built in the manner of ships.

In every class of merchant vessels, the prime object is to accommodate as large a quantity of goods as possible, and therefore comparatively little space is occupied with accommodation for either the captain or his crew. If the cargo be light, such as cotton, *ballast* is required to be put on board; this consists of sand or any other heavy material, which is placed lowest in the hold, in order to balance the vessel, and give it due hold of the water. In stowing cargo, care is taken to preserve the trim of the vessel—that is, to keep it upright, and also equally balanced fore and aft.

Latterly, vessels propelled by steam power have been introduced and largely employed in the commercial marine, also in the royal navy. Steam vessels carry only a limited quantity of rigging and canvas, the propulsion by the paddles being sufficient in all ordinary circumstances. Much sail, in the case of stiff breezes, would drive the vessel faster than the steam, and thereby cause the paddles to drag through the water: as this would retard the motion, sails are mounted only to give a small addition to the impetus, and to steady the vessel. (See Article CONVEYANCE.)

NAVIGATION.

Navigation is the art of conducting vessels at sea in the direction in which they are designed to proceed: the term is derived from the Latin word *navis*, a ship, and *ago*, to manage or govern. From *navis*, also, is derived the term *navy*, which signifies a collection of ships. The terms *marine*, *maritime*, and *mariner*, are likewise from a Latin root, to wit, *mare*, the sea.

Vessels advance in their course by means of tides, currents, and winds; the winds are in most instances the principal moving agent, and the art of the mariner consists in rendering almost every breath of wind which blows subservient to the purpose of the intended voyage. The winds most favourable for propelling the vessel are those which blow on the *quarter*, or slantingly on the ship's course. The reason for this is very obvious: when the wind blows directly astern, it can affect one or perhaps two sails with commensurate force; but when it comes obliquely, every sail may be trimmed to meet it, and receive a share of the impulsive force. The variety in the rigging of vessels causes much difference in sailing powers: some will sail close to the wind, as it is called, or with a very small angle to the direction of the breeze, while others require winds much more fair. When the wind becomes too powerful, certain sails are taken in, and others are *reefed*, a portion being bound to their respective yards, so as to reduce the surface of canvas. Reefing and bracing the yards are among the nicest points of seamanship.

Ships are navigated, as nearly as possible, by the path which is the shortest distance between the port whence they depart and that for which they are destined; but from contrary winds and intervening land, it is generally necessary to sail in a track of a zig-zag form. When a vessel is obliged to sail to the right or left of the direction of the intended port, it is said to *tack*; when the ship is tacking towards the left, and the wind consequently on the right, it is said to be on the *starboard* tack; and when it is tacking towards the right, it is said to be on the *larboard* tack. A ship does not sail exactly in the direction of her keel, but deviates towards the side that is opposite to the wind; and the angle contained between the apparent and real direction is called *lee-way*.

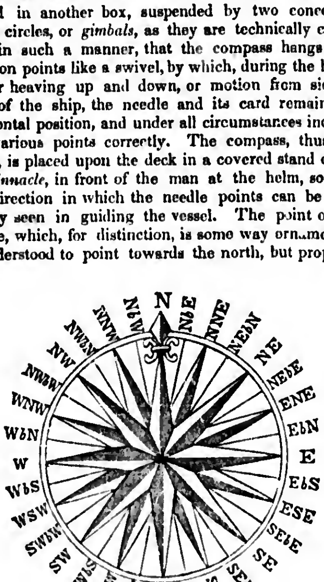
The tacking or changing of directions, in order to present the sails at a proper angle to the wind, is a process requiring considerable seamanship. The ship being already close to the wind, the helm is gradually eased down, so that the rudder may not exert its full force until she begins to turn, nor act suddenly to check the headway, so essential to the success of the evolution; at the same time the head sheets are flown, so as to cause the sails before the centre of rotation to shake, and lose their power of balancing the after ones. As the ship approaches the wind, the spanker is drawn gradually from the lee side towards the centre, that it may keep full, and, by its action so near the stern, continue promoting the rotation. As soon as the sails reach the direction of the wind, and cease to draw, the corners of the courses are drawn up, and the tacks and sheets overhauled, ready to swing the yards. After a while, the sails catch aback, and the fore-sails, soon masking the after ones, act with a powerful lever to turn the bow. At length, having come head to wind, without loss of headway, and the evolution being certain, the after yards are swung round, ready to receive the wind on the opposite side; which operation is then more easily performed, from the sails being becalmed by the fore ones. Lastly, when the after sails are filled by the wind, the head yards are also braced round to receive its impulse, and the ship at once recovers headway, and proceeds on her new tack.

Thus easily is a ship manœuvred in fine weather. Not unfrequently, however, a gale comes to disturb the peaceful course of the mariner, and call forth all his exertions. Let us suppose that, whilst our ship is contending against the head wind, the misfortune is augmented by its gradual increase. Shortening sail becomes necessary, and it is determined by two leading considerations—the stability of the ship, and the strength of her masts; it is to diminish the careening of the one, and avoid endangering the other, that the surface spread to the wind is reduced. In shortening sail, we always begin with the highest and lightest sails, descending gradually, and keeping pace, with an inverse ratio, with the increase of wind. The sails do not, however, come in uniformly in the direction of the length; but the after sails most rapidly; because, as the wind increases, the energy which it exerts in a forward direction upon the masts tends, with a powerful lever, to depress the bow and raise the stern; hence the latter drifts more easily to leeward, thereby bringing the bow towards the wind; this effort is also promoted by the action of the sails passing farther to leeward, and by the ship ceasing to sail on an even keel. From all these reasons, the more the wind increases, the more she tends to come to; so, to avoid a constant recurrence to the action of the rudder, it becomes necessary to shorten sail faster aft than forward, taking in the mizzen-topgallant-sail, and even the spanker, before the fore and main-topgallant-sails; for the same reason, when it becomes necessary to reef, it is not unusual to begin with the mizzen-topsail. Reefing consists in binding a portion of the sails to their respective yards, so as to reduce the surface; and in the case of a heavy gale, it becomes necessary to reef or take in the whole from stem to stern; the helm being at the same time kept constantly hard down, the vessel is said to *lie to.* Should the gale abate, the reefs are shaken out, sail is added, and the vessel bounds actively on its course.

THE COMPASS.

The most important instrument for the guidance of the mariner is the compass. There are different kinds of compasses, to suit peculiar purposes; but that which is commonly in use on shipboard is of the following construction:—The most essential part is a magnetized bar of steel, called the needle, which is supported horizontally on a central pivot, round which it is free to move and to point in any direction. The pivot of the needle rises from a circular *card*, resembling the dial-plate of a time-piece, and round the circumference of which are marked thirty-two points. The adjoining figure represents the card of a compass. North, South, East, and West, are the main or cardinal points, and are indicated by their initial letters respectively, while the subordinate points are also marked by letters, as NbE for north-by-east, NNE north-north-east, and so on. To be able to recite the various points is said to "box the compass." The north is usually indicated by an ornamented figure, or arrow head, as in the sketch of a compass card here presented.

The card and needle are fixed in a round box, enclosed by a sheet of glass, to secure it both from the agitation of the atmosphere, as well as to exclude dust, moisture, and other things which might interfere with the correctness of the indications. The whole is enclosed in another box, suspended by two concentric brass circles, or *gimbals*, as they are technically called, and in such a manner, that the compass hangs as it were on points like a swivel, by which, during the lurching or heaving up and down, or motion from side to side, of the ship, the needle and its card remain in a horizontal position, and under all circumstances indicate the various points correctly. The compass, thus encased, is placed upon the deck in a covered stand called the *binnacle*, in front of the man at the helm, so that the direction in which the needle points can be constantly seen in guiding the vessel. The point of the needle, which, for distinction, is some way ornamented, is understood to point towards the north, but properly,



it points a little to the west of due north; and this, as well as other variations to which it is subject in certain latitudes, must be thoroughly understood by the navigator. In the whole of the northern hemisphere of the globe, the point or northern pole of the needle is the active agent in pointing the direction of the compass. In the southern hemisphere, the southern pole of the needle assumes the active management of the instrument; and, by pointing towards the south pole of the earth, keeps the point of the needle pointing towards the north as before. Practically, it is of no consequence to the mariner which point of the needle is most affected by the polarity of the earth, for in all places and conditions (slight variations excepted) the needle keeps its northern ornamented point towards the north pole of the globe.

The needle being liable to be affected by the proximity of iron, no piece of that metal is used in the construction of the binnacle, or is allowed to be near it. In the case of iron ships, or ships having much iron on board, means are adopted to counteract the tendency which the needle has to point in a wrong direction. From want of attention to this important point, serious disasters at sea have ensued.

THE LOG—SEXTANT.

Provided with a compass, the next object of importance is the *log*, an instrument for measuring the rate at which the vessel proceeds through the water, in a given space of time. The log is a very simple contrivance. It consists of a long cord, having a piece of wood attached to one end, and called the *chip*. This is of a quadrantal form, and being slung at the corners with line, and loaded at the circumference, when thrown overboard it remains erect and stationary, and drags the line off as fast as the ship passes through the water. The line is divided into knots and half knots, representing miles and half miles, or minutes of a degree, to which they bear the same proportion as the log-glass does to an hour. Thus the log-glass being filled with sand to run through in 30″, the length of a knot must be 51 feet, the first being the same proportion of an hour that the last is of a mile. As, however, the log is found to come home a little in the effort to draw the line out, it is customary to mark the knot a foot or two less than the true length. The mode of heaving the log to measure a ship's rate is as follows: The log-reel, upon which the line is wound, being held by one of the sailors, the officer places himself on the rail to leeward, and a third person holding the glass, he proceeds to prepare the chip, so that the peg of one of the lines holding the chip in a perpendicular direction will draw out, by the force of the water, when the wheel is stopped, and allow it to haul in easily. Then, having gathered a sufficient quantity of line into his hand, he throws it far to leeward, that it may not be affected by the eddies which follow in the wake. The stray line, which allows the chip to get astern, now runs of, and the instant that the white rag, which marks its termination, passes through the hand of the officer, he cries "Turn!" and continues to veer out line until the glass runs out, and the person holding it cries "Stop!" Then the line is grasped, and the number of knots that have passed off mark the speed of the ship. When this exceeds five miles, it is usual to use a glass of 15 instead of 30″, counting the knots double. The rate of sailing, per hour, multiplied by the hours, thus gives the mariner the measure of his run.

In addition to these essential instruments for directing the course and ascertaining the distance, the navigator must be provided with octants of double reflection, to measure the altitude of the heavenly bodies, and a circle, or sextant, more nicely graduated, to measure distances between the moon and stars. He should also have with him a book containing the logarithms of numbers, sines, tangents, and secants, to facilitate trigonometrical calculations; tables for correcting altitudes for dip, parallax, and refraction; also lists of latitudes and longitudes for every part of the world; and of tune of high water at every port, at the period of full and change of the moon, from which, at all times, to be able to find the tide; and a variety of tables to facilitate the various problems of navigation. He should also have with him the Nautical Almanac, containing the places and declinations of the fixed stars and planets, and especially the distances of the moon from the sun and other stars, and all that relates to that body, with a view to calculate the longitude by observation. Finally, he must be provided with the general and local charts applicable to his contemplated voyage. Thus furnished, the mariner may set sail with confidence; many do so with no other aids than their compass, log, quadrant, a single chart, and book of navigation, and arrive in safety. But it is less our business to show with how little care a ship may be navigated, than to show how she may be carried from port to port with the greatest possible certainty. Having taken leave of the port, and, when the last land is about to disappear from view, either from the growing distance or the intervention of night, the mariner selects some conspicuous headland, of which the latitude and longitude are noted in his tables, and placing a compass in some elevated position, remote from any iron object to disturb its polarity, proceeds to determine its bearing, and estimate his distance from it, either by the progress made from it, or by the ready estimate of a practised eye. Or, taking the simultaneous bearings of two distinct points of coast, he has still surer data for deducing his position. This is called *taking the departure*, and is carefully noted on the log-slate, with the time of making the observation. Thenceforth the log is thrown every hour, and the course and distance are entered upon the slate, to be copied into the log-book at the end of the day.

WORKING A RECKONING.

At the first noon succeeding the time of taking his departure, the mariner works up his reckoning. Noon is an epoch fixed by nature, being determined by the passage of the sun over the meridian, and is therefore well chosen as the beginning of the day. The log-slate being marked, he copies the courses and distances, if from head-winds or other causes they have been various; the departure from the land is also converted into a course, as is also the current, if there be any known one. He next proceeds to find the difference of latitude and departure from the meridian corresponding to each course, either by geometrical calculation, or, more expeditiously, by reference to tables; then he adds the several differences of latitude and departure, and, if they be of different names, as some north and some south, some east and others west, deducts the less from the greater. With the remaining difference of latitude and departure, he not only finds the course and distance made good, but also the latitude and longitude in; the difference of latitude being applied to the latitude left, by adding or subtracting, in sailing from or towards the equator, at once gives the latitude of the ship. But before the departure can be thus applied to find the longitude, it is necessary to reduce it for the converging of the meridians towards the poles; for, though all degrees of longitude are divided, like those of latitude, into 60 minutes or miles, yet they decrease in length, from being equal to a degree of latitude at the equator, until they become nothing at the poles. There are many ways, more or less accurate, of deducing the difference of longitude from the departure, the latitude being known; they are founded upon this principle: the circumference of the earth at the equator is to its circumference at any given parallel of latitude, as the departure is to the difference of longitude. The most easy and correct way of obtaining the difference of longitude, on an oblique course, is by the aid of a table of meridional parts; for, having taken out the meridional difference of latitude, the mariner has this simple proportion: the proper difference of latitude is to the meridional difference of latitude, as the departure to the difference of longitude. The difference of longitude thus obtained, is applied to the longitude left, adding or subtracting, in sailing to or from the first meridian, and the result will be the ship's longitude; which, with the latitude previously ascertained, determines her position on the chart. The method of navigating thus described is called *dead reckoning*. It is far from infallible, and leaves much to desire. It will, indeed, do pretty well in short runs; but as errors daily creep in from many causes escaping calculation, such as bad steerage, leeway, heave of the sea, unknown currents, and as these accumulate, and become considerable at the end of long voyage, it becomes necessary for the mariner, removed from all reference to terrestrial objects, to resort to the immovable guides in the heavens. All the heavenly bodies are, by the revolution of the earth, daily brought to the meridian, at which time, if their altitude is measured, their declination or distance from the equinox being known, the latitude is readily deduced; it may also be deduced from single or double altitudes of bodies not in the meridian, the times being accurately known. But the meridian altitude of the sun is what furnishes at once the easiest and most correct method of finding the latitude. So great, indeed, are the advantages offered by the meridian altitude of the sun, that no other means of finding the latitude are used, except when these have failed from a clouded atmosphere, or when the momentary expectation of making the land quickens the mariner's anxiety. We shall, therefore, now explain the method of deducing the latitude from the sun's meridian altitude.

TAKING AN OBSERVATION.

Furnished with a sextant, circle, or octant of reflection, the observer goes upon deck, and having examined the adjustment of his instrument, proceeds to bring down the image of the sun reflected by its mirror, until the lower limb just sweeps the horizon. He continues to follow and measure its ascent, until it ceases to rise; the moment that it begins to fall, and the lower limb dips in the horizon, the sun has passed the meridian. The altitude marked by the index being read of, it is next corrected. And first, the observer adds the semi-diameter, in order to make the altitude apply to the centre of the object; next, he subtracts the dip, to meet the error caused by the extension of the horizon, in consequence of the rotundity of the earth, and the elevation of his eye above its surface; also the refraction of the atmosphere, by which the object, when not vertical, is made to appear higher than its true place; lastly, he adds the parallax (a small correction, inconsiderable from the sun's distance), in order to reduce the calculation for the centre of the earth; from which point all calculations are made, and which is ever supposed to be the station of an observer. Having made all these corrections, which many mariners despatch summarily, by an addition of 12 minutes, he has the true meridian altitude of the sun. Taking this from a quadrant, or 90°, gives its zenith distance, or distance from that point in the heavens which is immediately over the observer, and would be met by a straight line passing from the centre of the earth through his position. Now, if the sun were for ever on the equinoctial, the zenith distance would always be the latitude; for, whilst the zenith is the observer's position, referred to the heavens, the equator is there, in like manner, represented by the equinoctial and we have already seen that latitude is the distance from the equator. But as the sun is only twice a year upon the equinoctial, and as his distance from it at times increases to more than 20°, it becomes necessary to take this distance (called his *declination*) into the estimate. The sun's declination is given in the almanac, for the noon of each day; by correcting it for the time anticipated or elapsed, according as the sun comes first to him or to the first meridian, by his position east or west of east of it, the observer obtains the declination for noon at his own position. This declination applied to the zenith distance, by adding when the sun is on the same side of the equator, by subtracting when on the opposite side, gives the true latitude. A daily and accurate knowledge of his latitude is, then, to the mariner of our day, a desideratum of easy attainment. By its aid, nothing is easier than to sail clear of any rock or shoal that crosses his track, either by a watchful look-out at the moment of passing its latitude, or else by avoiding its parallel entirely, until it be surely passed. Moreover, this is his best and surest guide in aiming at his destined port; for he has but to attain the exact latitude it lies in, and then sail directly upon it, east or west, to be sure of success. And here nature is again his friend: by a singular coincidence, discoverable in glancing at the map of the world, most coasts and continents lie in a northern and southern direction. Hence the value attached by seamen to an accurate knowledge of the latitude; and hence the saying of "Latitude, lead, and look-out."

TO FIND THE LONGITUDE.

Various ways have been devised to find the longitude, in all of which the great element is time. The earth performs her diurnal revolution in 24 hours, or, in other words, each part of the circumference of the globe, which is divided into 360 degrees, is brought under the sun once a day. Hence, each part of the circumference (reckoning from east to west) has its own peculiar time of day. When it is noon at one place, it is one o'clock afternoon at another place, two at another, and so on; the time differs all round the globe. Dividing the 360 degrees by 24, we find that 15 is the result; for every 15 degrees, therefore, along the circumference, going westward, there is an hour of difference, in advance; and, going eastwards, an hour behind. If it be noon at Greenwich, it will be one o'clock at a point 15 degrees east from it (that is, the sun has passed over it an hour ago), and eleven o'clock forenoon at a point 15 degrees west from it (that is, the sun will be an hour in getting up to it.) Dividing the 60 minutes of an hour by 15, the result is 4; the earth, therefore, moves under the sun at the rate of a degree, or 60 geographical miles in four minutes, or 15 miles in the minute, or one mile in the four seconds, or a quarter of a mile in the second. Here, then, the element of time is brought at once, and in the most satisfactory manner, to bear upon the distance of any given place, east or west from any other given place. The measuring of such a distance is called finding the longitude. Different places on the globe have been established as starting points in making these measurements. The French reckon from Paris, and the English from Greenwich, a village near London, where an astronomical observatory has been long established and supported at the public expense. In all English works of geography, the longitude is reckoned from Greenwich, although not expressly mentioned. Navigators determine their longitude by watches or chronometers, whose movements are as exact as can possibly be obtained from mechanism. In setting out on a voyage, the chronometer is set to London time, and kept going at that time. At the hour of noon of each day, as determined by an observation with the sextant, the difference is estimated between that hour and the hour indicated by the chronometer, and that difference is the longitude east or west of Greenwich, as the case may be. Some mariners, for security, take several chronometers to sea with them, as one only is by no means a safe guide. In general, however, the masters of coasting traders, or those who pursue short voyages by regular lines of route, depend on books containing lists of longitudes as well as of latitudes.

MARINE BAROMETERS—LOG-BOOK.

The last great requisite in navigation is a good barometer to indicate the approach of foul weather. The most delicate instrument of this kind is the sympesometer of Adie, by which the earliest and most certain indications are presented of coming storms. In treating of the nature and value of instruments of this nature, Dr. Arnott makes the following observations:—"The watchful captain of the present day, trusting to this extraordinary monitor, is frequently enabled to take in sail and to make ready for the storm, when in former times the dreadful visitation would have fallen upon him unprepared. The marine barometer has not been in general use for many years, and the author was one of a numerous crew who probably owed their preservation to its almost miraculous warning. It was in a southern latitude. The sun had just set with placid appearance, closing a beautiful afternoon, and the usual mirth of the evening watch was proceeding, when the captain's order came to prepare with all haste for a storm. The barometer had begun to fall with appalling rapidity. As yet, the oldest sailors had not perceived even a threatening in the sky, and were surprised at the extent and hurry of the preparations: but the required measures were not completed, when a more awful hurricane burst upon them than the most experienced had ever braved. Nothing could withstand it; the sails, already furled and closely bound to the yards, were riven away in tatters; even the bare yards and masts were in great part disabled; and at one time the whole rigging had nearly fallen by the board. Such, for a few hours, was the mingled roar of the hurricane above, of the waves around, and of the incessant peals of thunder, that no human voice could be heard, and amidst the general consternation even the trumpet sounded in vain. In that awful night, but for the little tube of mercury which had given the warning, neither the strength of the noble ship, nor the skill and energies of the commander, could have saved one man to tell the tale. On the following morning the wind was again at rest, but the ship lay upon the yet heaving waves an unsightly wreck."

A journal of events and observations on board ship is usually kept in what is called the log-board, and transferred thence into the log-book. The log-board consists of two boards shutting together like a book, and divided into several columns, containing the hours of the day and night, the direction of the winds, and the course of the ship, with all the material occurrences that happen during the twenty-four hours, or from noon to noon, together with the latitude of observation. From this table, which is written in chalk, and daily effaced, the officers work the ship's way, and compile their journals. From it, also, entries are carried to the log-book, in an expanded form, with any observations and additional particulars supposed to be necessary. The log-book is thus the journal of the ship, and is preserved with great care for exhibition, if required, at the termination of the voyage.*

Thus, then, by the use of various instruments and practical experience in navigation, a ship is conducted from port to port, dangers avoided, and difficulties overcome. Though they who traverse the vast ocean leave no tract for the guidance of those who follow, it is thus converted into a plain and convenient highway, extending to the extremities of the earth.

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* For much of the matter in the present sheet on ships and navigation, we have been indebted to several articles in the "Encyclopædia Americana" (Conversations Lexicon).

MARITIME DISCOVERY.

No people of antiquity possessed the courage or skill to navigate their vessels out of sight of land, or, at least, to push into the open Atlantic or other great oceans. Maritime intercourse, for the sake of traffic, was carried on only along the shores of the Mediterranean, or down the Red Sea, and along the coast to India, or along the western shore of Europe to Britain. The Romans thought they performed a wonderful feat when they sailed a ship as far as the northern islands of Scotland. In these times there was no other known guide, with respect to the cardinal points, than the stars by night and the sun by day; and, therefore, when clouds covered the visible horizon, or when total darkness ensued at night, the ship was necessarily brought to a pause, or placed in the most imminent danger of being wrecked on some unknown shore. This, however, was not the only difficulty. The nations of antiquity, with all their learning, were utterly ignorant of the form and size of the globe. They believed that the world was a great flat plain, with the habitable earth placed in the midst of the ocean; that this ocean was of interminable breadth; and that, at a certain distance from land, the waters were shrouded in eternal darkness. With such notions prevailing among mankind for thousands of years, it is not surprising that they should have made so slow advances in the art of navigation, or done so little for maritime discovery.

During the middle ages (fourth to the fourteenth century), ship-building was considerably improved by the Italians, who then conducted a large maritime traffic on the Mediterranean; but the art of navigation, in the proper sense of the term, was still in its infancy, and its history cannot be said to commence till the beginning of the fourteenth century, when that wonderful instrument, the mariner's compass, was discovered, or came first into observation in Europe. Of the polarity of the magnet, or its tendency to point to the poles, a sufficient explanation is given in the article Electricity and Magnetism; and it is here only necessary to describe how this polarity is rendered subservient to the purposes of the navigator. The mariner's compass, which consists of a magnetized slip of metal, or needle, as it is called, poised on its centre, and free to point to the poles, was first made known, as far as it can be ascertained, by one Flavio Gioja, an Italian, in the year 1302. As with all great discoveries, its advantages were not at once recognised—it had to contend against a variety of prejudices; but these in time vanished, and about the middle of the fourteenth century its important uses were allowed and established.

Navigation now assumed a much bolder character than formerly. The English, Portuguese, Italians, and Spaniards, pushed their vessels into districts of ocean never previously traversed, and thus the way was fairly opened for maritime discovery. The first great discoverer who made use of the compass, and partly improved its construction, was Prince Henry, a son of the king of Portugal, and who is known in history by the name of *Henry the Navigator.* This intelligent and enterprising prince (born 1394, died 1461), with the concurrence of the Portuguese government, set on foot a series of maritime enterprises, with the view of discovering a route to India by way of the Atlantic. These voyages ultimately proved successful; the islands of Puerto Santo, Madeira, and the Canaries, were successively discovered, and annexed to the crown of Portugal. In 1433, the Portuguese navigators penetrated beyond Cape Bojador, on the coast of Africa, which was considered an extraordinary performance; another expedition afterwards went as far as Cape Blanco, and discovered the island of Arguin and the Cape de Verd Isles; and in 1448, the Azores were reached and made known. Henry the Navigator thus struck a spark which kindled to a flame all over Europe. Not long after his death, the Guinea coast was added to the Portuguese discoveries. In 1484, the Congo was reached by Diego Cam; in 1487, the Cape of Good Hope was doubled by Bartholomew Diaz; and in 1498, Vasco de Gama touched the shores of Hindostan. The Portuguese having received an assignment from the pope of all lands that could be discovered on the African coasts, the Spanish government, burning with anxiety to emulate the late proceedings of its neighbours, was compelled to seek out new countries in a different direction. Ferdinand and Isabella, the sovereigns of Spain, listened, therefore, to the speculations of Columbus regarding a route to India across the Atlantic, and sent him off on a mission. In this his bold attempt to reach Hindostan by pursuing a direction across the Atlantic, he landed on one of the American islands, now called the Bahamas, on the 12th October, 1492. About the year 1499, Amerigo Vespuccii, under an appointment from the Spanish government, discovered the coast of the South American continent, and hence the name of *America* was given to the New World, although, as is well known, Columbus had previously discovered and landed on South America, without being aware that it was the continent which he had reached.

Several subsequent voyages by Spanish navigators disclosed the extent of the east coast of South America; and in 1513, Nunez de Balboa crossed the isthmus of Panama with an exploring party of his sailors, and made the discovery of the Pacific Ocean on the west coast of that continent. It was now seen that America was not, as had been at first believed, a portion of Asia or India, but was a separate territory of vast extent lying between the Atlantic and Pacific. There was yet a doubt with respect to the southern extremity of America, but in 1520, Megellan made the passage from the Atlantic to the Pacific by the straits which separate America from the island of Terra del Fuego, at about the 53d degree of south latitude, and so removed all doubt upon the subject. This navigator extended his voyage across the Pacific to the Philippine islands, where, unfortunately, he was killed; but his companions proceeded in the route homewards by the Cape of Good Hope, and thus, by circumnavigating the globe, settled the long-disputed problem with respect to the sphericity of our planet. This most important voyage was made between the years 1520 and 1523.

In the meanwhile, several maritime discoveries were made by the English nation. In 1495, John Cabot, a Venetian pilot, settled at Bristol, obtained from Henry VIII. letters patent, empowering him and his three sons, Lewis, Sebastian, and Sanctius, to discover unknown lands, and conquer and settle them. In consequence of this permission, the king supplied one ship, and the merchants of London and Bristol a few smaller ones, and in 1496, John and Sebastian sailed to the north-west. In July of the same year, they discovered Newfoundland, and explored it up to latitude 67°. In a subsequent voyage, the father and son sailed as far as Cape Florida, and are believed to have been the first who saw the main land of America. By these and succeeding voyages of discovery in the reigns of Henry VIII., Edward VI., and Elizabeth, the English became possessed of the eastern coast of North America and some of its islands. Between the years 1740 and 1744, Anson was employed in circumnavigating the globe, and visiting different parts of the Pacific, but this extensive and protracted voyage added little to the existing knowledge of geography. At a later period, in the reign of George III., Cook explored the groups of islands in the Pacific, making various interesting discoveries, in which was included a survey of the eastern coasts of Australia and Van Diemen's Land, also a visit to the New Zealand islands. After the voyages of this enterprising navigator, little was left to perform in the way of maritime discovery, except in exploring the northern extremities of the American continent. A series of voyages for this purpose was begun in 1818, conducted by Ross, Parry, and others, and which lately terminated by establishing the fact, that a passage for ships exists between the Atlantic and Pacific, round the northern promontories of America, but that, from the blocking of ice, such a passage can only on rare occasions be open to navigators, and is therefore of no practical value.

The great maritime discoveries made in the course of the fifteenth century, which at once opened up a new view of the globe, led to various improvements in navigation. The *log*, for measuring the ship's progress, also charts on Mercator's projection, were introduced. In 1614, Napier discovered the calculation of numerical quantities by logarithms; and about the year 1620, Gunter invented a scale, by the help of which, and a pair of compasses, every question in trigonometry might easily be calculated by the mariner. In 1731, the art of navigation was greatly advanced by the invention, or rather improvement, by Hadley, of the quadrant, an instrument for ascertaining, by an observation of the sun, the true latitude of a ship at sea. Till nearly this period, an instrument called an *astrolabe*, a species of sun ring, had been employed for this purpose, and was very imperfect in its operation. Between the years 1765 and 1774, Harrison invented a chronometer, or time measurer, by which the longitude could be ascertained at sea with nearly perfect accuracy; and thus the art of navigation may be said to have been completed. In the course of the eighteenth century, the true figure of the earth was fully made known by the voyages of Anson, Cook, and others; and, at the same time, discoveries were made of almost every accessible island and tract of land over the globe. Thus, in the short space of four centuries from the time when the first impulse was given by the Portuguese, the civilized part of mankind had acquired a nearly complete knowledge of the features of our globe, as well as of its true figure and dimensions.

DOMINION OF THE SEAS.

It is a common law of nations that the ocean is a free and universal highway, which no state can appropriate to its own special use. While this exists as a principle generally recognised by all civilized powers, Great Britain has for a considerable period of time claimed *the dominion of the seas*, as a right acquired by its extensive conquests, and the skill and valour of its seamen. By this claim, it is not assumed that Great Britain possesses a legal right of property in the waters of the ocean, or the lands which they may cover. The claim resolves itself into what is termed in law "a military sovereignty," which it would be exceedingly difficult to define, and is practically an empty and vain-glorious boast. Within the last twenty years, during which a large maritime force has grown up in France, Russia, and the United States of America, the claim of the British to the dominion of the seas has been little heard of, and is perhaps now a dead letter in maritime law, as it is in fact. Each nation retains a judicial control over its vessels and their crews, in whatever part of the ocean they may be; all crimes and misdemeanours committed on board of a ship are punishable by law, as soon as the vessel reaches the country to which it belongs.

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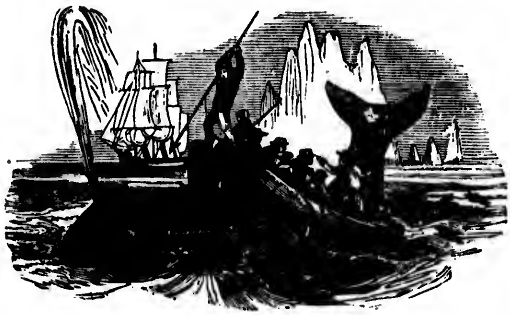
[BOOKS ON THE OCEAN, MARITIME DISCOVERY, AND NAVIGATION.

The *Encyclopædia of Geography* by Murray, already referred to, contains an excellent treatise on the Ocean, in its introduction. Malte-Brun has another in his Geography. The subject of Maritime Discovery has seldom been treated in a general way; but there is a multitude of books in illustration of it. Among these are, Tytler's "*Discoveries on the Northern Coasts of America*," "*Circumnavigation of the Globe*," from Magellan to Cook; Ellis's "*Polynesian Researches*," Leslie's "*Discoveries and Adventures in Polar Seas*," "*Cook's Voyages round the World*," "*Lives and Voyages of Drake, Cavendish, and Dampier*," Humboldt's "*Travels*," "*Lives of the Early Navigators*," St. John's "*Lives of Celebrated Travellers*." These are comprehensive works, not being confined to the explorations of single travellers. Dr. Robertson's "*History of the Discovery and Conquest of America*" is full of information, and has the additional advantage of his delightful and faultless style of writing. His "*History of India*" is not less interesting and valuable. Mr. Wheaton's "*History of the Northmen*," and Crichton and Wheaton's "*History of Norway, Sweden, and Denmark*," abound with information respecting the bold, extensive, and successful enterprises of the early Scandinavian voyagers. One of the books in Lardner's Cabinet Cyclopædia, entitled "*Maritime and Inland Discovery*," is, on the whole, the most general and systematic work on this subject, which has been published in a cheap form.

The best and most comprehensive work on Navigation is Dr. Bowditch's "*Practical Navigator*." Although it was written expressly for the use of mariners, it is rendered perfectly intelligible to the general reader, and it is so full and complete that it fully answers the purpose of making the reader as familiar with "all the ropes in the ship" as it is possible to become by the use of books alone. For the purpose of learning the history of the progress of marine architecture, the French have a highly embellished popular compend, entitled "*La Marine*," by M. Eugene Pacini. The same species of information may be obtained by consulting the several chapters in the Pictorial History of England, in which the useful arts are treated. —*Am. Ed.*]

THE WHALE, AND WHALE FISHERIES.



DESCRIPTION OF THE WHALE.

The cetaceous order of animals, of which the whale is the most remarkable and important member, is distinguished by various peculiarities which render it a link, as it were, between the creature of the land and the sea. While living in part or wholly in the ocean, and so formed as to make their way through its waters with ease and velocity, the cetacea differ from the true fish-tribes in being *mammalian* or suck-giving animals, in being warm-blooded, and in having organs for respiring the atmospheric air, like the ordinary inhabitants of the land. These striking distinctive features would be sufficient in themselves to render this order of animals an object of interesting study, but the cetacea have also strong claims upon attention, as being of very great consequence to the wants and comforts of man. This is especially the case as regards the whale and its varieties, which will form the subject of notice in the present section. In the general account given of the animal kingdom, the dolphin, porpoise, and others of the cetacea, are individually described.

The whale, or *balæna*, as naturalists term it, is the largest of all known animals. The polar seas, if not its exclusive dwelling-place, are at all events the region which it peculiarly frequents, and where it herds in the greatest numbers. There, also, are found the varieties which attain to the greatest bulk. The three principal of these are the *balæna mysticetus*, the common Greenland whale, and what British sailors call the "right" one, from its being the most valued and valuable object of their pursuit; the *balæna physalis*, or the great northern rorqual, a variety which exceeds all others in bulk, and is termed the "razorback" or "finner," by fishers; and, thirdly, the *cachalot*, or spermaceti whale. With the exception of some few points, which will be noticed afterwards, the characters of the Greenland whale are identical with those of the whole tribe, and by calling attention to the peculiarities of structure in this species, in the first instance, much repetition may ultimately be spared.

The size of the common whale was the subject of very exaggerated notions, until within a very recent period. About fifty years ago, a standard writer in natural history asserted that whales were frequently "to be seen above an hundred and sixty feet long;" and that, even at this standard, the animal was much smaller than it had been before man began to disturb and destroy the race. That whales "two hundred and fifty feet in length" were often seen previously, is represented as a thing beyond all question. Mr. Scoresby, however, a very high authority on the subject, declares that the common whale seldom or never exceeds seventy feet in length, and is much more frequently under sixty. Out of three hundred and twenty-two whales which he had personally aided in capturing, *not one* exceeded fifty-eight feet; and the largest ever taken, of which he knew the reported measurement to be authentic, came up only to sixty-seven feet. The body of a large individual of this family measures from thirty to forty feet round the body at the thickest point, or a short way behind the head, which is of great proportionate size, and occupies about one-third of the whole extent from snout to tail. When the mouth is open, it is sufficiently large and long to admit a whaler's jolly-boat with its full compliment of men. The bulk of the head, which is somewhat conical in form, and has a sort of round eminence above and posteriorly, renders the aspect of the mysticetus clumsy and unshapely. A very slight diminution of the circumference indicates the position of the neck, and behind this, the body swells to its greatest calibre, whence it tapers sharply away again towards the tail. The animal has no back or dorsal fin. The two side or pectoral fins are placed about two feet behind the angles of the mouth, and are nearly five feet broad by nine feet in length. The tail is something in the shape of a crescent, with an indentation in the middle of the concavity, the convex side being united to the body. This appendage is placed horizontally, and is about twenty-four feet broad. It is an instrument of immense power, and the whale has sometimes given a stroke with it which has sent large boats high into the air in a thousand splinters. The colour of the body is mainly a velvety black; the under part of the head and abdomen, and the junction of the tail, being partly white and partly of a freckled gray. In old whales, much more of the body assumes the latter tint, and the streaks sometimes resemble a beautiful landscape of trees. On the tail, in one instance, noticed by Ray, nature, in a freakish mood, had set down the number 122, in large and very distinct characters. The eyes of the whale are about a foot behind the angle of the mouth, and are not much larger than those of the ox. The iris is of a white colour, and the organs are guarded by lids and lashes as in quadrupeds. The two blow-holes of the whale, situated on the summit of the head, and descending perpendicularly through it for a length of twelve inches or so into the top of the windpipe, are the only other features worthy of notice in the exterior aspect of the Greenland whale.

The mouth of the common whale is an organ of very wonderful construction. In a large specimen of the race, it may measure, when fully opened, about sixteen feet long, twelve feet high, and ten feet wide—an apartment, in truth, of very goodly dimensions. It conta[illegible] teeth and enormous as the bulk of the creature is, its throat is so narrow that it would choke upon a morsel fitted for the deglutition of an ox. An inch and a half is stated to be the diameter of the gullet in the very largest whales. From this peculiarity of formation, it may be anticipated that the food of the animal is of a very minute nature, notwithstanding the vastness of the cavity which is prepared for its primary reception. The animal is indeed supported upon a multitude of smaller inhabitants of the deep, and, to permit this, its mouth is provided with a remarkable apparatus, composed of what is called the *baleen*, or the well-known *whalebone* of commerce. The baleen is arranged into two rows of laminæ or thin plates, projecting literally from a line in the centre of the arch of the palate, somewhat like the laminæ of a feather. Towards the point of origin, they are comparatively few in number and strong, while towards the lips they divide and taper away into mere bristles, forming a loose hanging fringe or border. There are about three hundred of these plates on each side, and, when dried, they weigh usually above a ton. In the rorqual whale they are more numerous, and we find from the description given by Mr. Frederick J. Knox, of the skeleton prepared and exhibited at Edinburgh, that three hundred and fourteen external plates were counted on each side in the mouth of that animal. The whole number of plates which *could* be counted, not including the more minute bristly terminations, was 3768. The longest plate of baleen, which is always placed about the centre of the series on each side, measured two feet two inches in length by fifteen inches in breadth. "The substance when recent (says Mr. Knox) is highly elastic."

The use of these plates, with their pendulous extremities and fringes, is to retain, as in a net, the multitude of small animals which are floated into the mouth of the whale whenever it is opened. Were it not for such a drainer, formed by these fringes with the aid of the tongue, which is merely a great mass of fat tied down to the lower jaw, the emission of the water would be attended by the escape of all the objects which entered with it. As it is, the most minute matters are retained; and shrimps, sea-snails, small crabs, medusæ, &c., are thus entrapped to support the great monster of the deep.

The remaining features in the structure of the whale need not be individually described at the same length. The skin consists, first of the scarf-skin, or epidermis, which is moistened by an oily fluid, enabling it to resist the action of water; secondly, of the *rete mucosum*, a layer usually held to contain the colouring matter of all animal surfaces; and, thirdly, of the true skin, which, for particular purposes, is open in texture, so as to contain oil, or blubber as it is called, in great quantities. This mass of oil, surrounding the whole animal, and sometimes weighing more than thirty tons in all, serves the important end of keeping the animal warm by its weak conducting powers, amid the coldest recesses of the polar ocean, and is also calculated to resist the enormous pressure to which the body of the creature must be subjected at the depths to which it often descends. Whales have been known to take a line perpendicularly down to the full extent of a mile; and had not this ample layer of fat, between one and two feet thick, been wrapped around them, possessing a resisting power like that of caoutchouc, it is difficult to imagine how, in such a case, they could endure the immense weight of superincumbent water. Moreover, being inferior in specific gravity to the water, it is obvious that all this body of oil must be of incalculable use in augmenting the buoyancy of the animal's frame. Below the skin are situated the muscles or flesh, and the character of this structure is much the same in the whale as in the ox or horse. With the exception of the tail, the arrangement of the various muscles of the whale does not differ very much from that of quadrupeds; and the same remark applies to the osseous structure. The fins are merely rudimental arms, containing nearly the same bones as in man, and the chest strongly resembles that of ordinary quadrupeds. The vertebral column of the rorqual whale contains sixty-three bones, those of the Greenland whale are not quite so numerous. The skull consists of the crown-bone, from which the facial bones and upper jaw project forward, while the lower jaw is composed of two long curved bones, that meet at the point or fore-part of the mouth. These are often put up over gates, and make a handsome archway. The whole of these bones are hard and porous, and some of them, as the lower jaw-bones, contain oil, but they are said to have no proper medulla or marrow. The total weight of Dr. Knox's rorqual skeleton, was twenty-eight tons.

The organs of respiration in the whale are formed upon the same principle as those of land animals, but with modifications to suit the peculiar element in which the creature lives. It is plain that some provision was required to permit the whale to breathe without the risk of having the lungs filled with water. This is accomplished by the extension of the top of the windpipe into the nostrils or blowholes, or rather into the passage which terminates in these in the common whale. By this contrivance, the creature can inhale air while it is feeding or has its mouth full of water. As with terrestrial animals, the air gives a red colour to the blood, or, in other words, oxygenates it, and sustains the animal heat. The whale has frequently to come to the surface, accordingly, to get its air; but this operation is rendered less frequently necessary by the provision of a reservoir of oxygenated blood, which can be drawn upon when required. This is the cause why the animal has such a vast proportionate quantity of blood in its frame. The brain of the whale is held by Cuvier to be large in relation to the animal, but no determinate conclusions have been reached on the subject. The arrangements of the whole nervous system are equally little understood. It is known that whales possess pretty acute vision, but there is a doubt whether or not they have any external ear. Their sense of smell seems to lie in the blowholes, yet the strongest reason for ascribing such a faculty to them at all is founded upon the half-traditionary notion of sailors, that if certain strong-smelling substances are thrown overboard, whales will fly from the spot at once. The mammæ or dugs of the common whale are two in number, and attached to the abdomen; in the case of some other varieties, they are placed on the breast. In both cases they are situated inferiorly. The milk of the animal is said to be rich and creamy.

Such are the general characters of structure in the whale tribe, and, on regarding them attentively, one cannot but feel amazed at the seeming simplicity of the whole supplementary contrivances by which a mammalian animal, so thoroughly terrestrial, one would say, in its general formation, is fitted to live in the deep. The Greenland whale, or mysticetus, to which, more particularly, the preceding description applies, is said by Scoresby *never* to be found beyond the limits of the Arctic seas. There is an excellent reason for this localization. Within the polar latitudes, vast pasture-fields are spread out for the animal which warmer climes have never been known to provide. These feeding grounds, if they may be called so, consist of large tracts of *green water*, covering in all not less than twenty thousand square miles of the Greenland seas. This *green water* is of a deep olive hue, and remarkably opaque. Mr. Scoresby discovered its peculiar appearance to arise from the presence of innumerable animalcules of the medusa family, one common species of which is known by the name of sea-blubber. To give some idea of the numbers of these creatures, Mr. Scoresby calculated that two square miles would contain 23,888,000,000,000,000; and that 80,000 persons must have entered on the task at the creation of man in order to complete the enumeration at the present time. These creatures, many of which are visible only through the microscope, do not all directly serve as aliment to the whale, but they feed myriads of the smaller fishes upon which the whale does live. When feeding, it swims with open mouth under the water, and all the objects that lie in the way of that vast moving cavern are caught by the baleen, and make their egress no more. "This is the simple food (says an old writer) of the great Greenland whale; it pursues no other animal, leads an inoffensive life in its element, and is harmless in proportion to its strength to do mischief." It is gregarious in its habits, being found in shoals, and migrating in this manner (according to most writers) from one ocean to another. When a herd of large ones is seen gambolling together, the sight is as magnificent as the range of nature presents. One whale of sixty feet in length, and seventy tons weight (nearly equal to that of three hundred fat oxen), is a grand enough object of itself, and how much more so must a great herd be when seen sporting in their native element! Let the reader imagine what an effect on the eye must be produced by the sight of one of these enormous living masses leaping right into the air, clear altogether out of the water. This is a feat which they frequently perform, to the high admiration of all who are at a safe distance. They effect it by means of their tail, which is the great instrument of motion, and which derives its prodigious power from the termination and concentration in it of all the muscles and tendons of the spinal column. In some of the larger species, the tail comprises a surface of not less than from eighty to one hundred square feet. Sometimes a whale will turn its head downwards, and, moving its tremendous tail high in the air, will lash the water with violence, raising a cloud of vapour, and sending a loud report to the distance of two or three miles. This is called "lob-tailing" by the mariners. With the aid of the same great instrument, they can travel through the water, horizontally or downwards, at the rate of eight miles an hour; but their usual mode of travelling does not exceed four miles in that space. Considering their bulk, their ease of motion and buoyancy are altogether wonderful, and must be mainly ascribed to the masses of oil they contain.

When the Greenland whale ascends to the surface, which it does usually once in ten minutes, or at the most in twenty, it breathes nine or ten times, and a loud noise accompanies the act, along with an emission of light vapour, in a straight column. This is called the *blowing* or *spouting* of the whale. When alarmed, it snorts much more loudly than usual. It is believed that some whales have other vocal organs, but the mysticetus seems to have no power of making noise but by the blow-holes. The spoutings of the whale consist of the ejection of jets of water to the height of twenty or thirty feet through the same apertures, in such a manner that the act is both seen and heard at the distance of several miles. There is a doubt among naturalists, whether this be an ejection of mucus secreted in the blow-holes, or of water merely from the mouth. The quantity emitted would lead one at once to say that it must be water, were there not a doubt as to the possibility of water entering the blow-holes in this way. The most probable explanation is, that the animal, acting beneath the water, forces up the fluid by means of the air from the lungs. However this may be, the spouting phenomenon is a beautiful one, according to the accounts of all observers.

No point relative to the habits of the Greenland whale affects one so much as the creature's love and care for its offspring. The period of gestation is supposed to be about ten months, and scarcely any dam has ever been observed to have more than one young one in attendance. In suckling, the mother throws herself on her side for the convenience of her offspring, and this usually takes place on the surface of the water, to permit, no doubt, of free breathing. At birth, the young whale measures from ten to fifteen feet, and continues a nurseling for about a year. It attains to its full growth very slowly; not sooner, according to most naturalists, than in twenty years. The whale-fishers turn the strong affection of the whale for its offspring to most fatal account. They try to strike the young one with the harpoon, and if they effect this, are sure of the old one, for she will not leave it. Mr. Scoresby mentions a case where a young whale was struck beside its dam. She seized it and darted off, but the fatal line was fixed in its body. Regardless of all that could be done to her, she remained beside her dying offspring, without moving, until she was struck again and again, and finally perished. Sometimes, however, she becomes furious on these occasions, and extremely dangerous. A naval officer gives the following account of a case which he witnessed in the Atlantic. Being out with fishing boats, "we saw (says he) a whale, with her calf, playing around the coral rocks; the attention which the dam showed to its young, and the care which she took to warn it of danger, were truly affecting. She led it away from the boats, swam round it, and sometimes she would embrace it with her fins, and roll over with it in the waves. We contrived to get the 'vantage ground' by going to seaward of her, and by that means drove her into shoal water among the rocks. Aware of the danger and impending fate of her inexperienced offspring, she swam rapidly round it, in decreasing circles, evincing the utmost uneasiness and anxiety; but her parental admonitions were unheeded, and it met its fate." The young one was struck and killed, and a harpoon fixed in the mother. Roused to reckless fury, she flew upon one of the boats, and made "her tail descend (says the writer) with irresistible force upon the very centre of our boat, cutting it in two, and killing two of the men; the survivors took to swimming for their lives in all directions." Her subsequent motions were alarmingly furious, but, subsequently, "exhausted by the fountain of black blood which she threw up, she drew near to her calf, and died by its side, evidently, in her last moments, more occupied with the preservation of her young than of herself."

The Greenland whale is captured, it is scarcely necessary to say, chiefly for its oil, about thirty tons of which are procured from the body of a large individual, being nearly the half of its whole weight. The flesh and blubber, also, when recently procured, and pickled and boiled, are not unpalatable, and the Esquimaux, in particular, hold them to be superb feeding. But it is for the oil that mariners from all quarters of the civilized world expose themselves to the dangers and privations attending the pursuit of the animal in the Polar seas. If recent statements be correct, however, these sufferings and risks may be greatly diminished, by the adoption of new fishing routes. Scoresby, as has been mentioned, says that the Greenland whale is to be found only within the Arctic circle, but other observers aver, that the mysticetus, as well as other varieties, migrate southwards every year, and in reality make an annual tour round Cape Horn, beginning their travel about March or April. Many persons represent themselves as having been eye-witnesses of their course; and, among others, the naval officer lately quoted, declares that he has repeatedly seen them passing Bermuda in shoals. The main objection to this statement is, that the *green water* exists only near the poles, and that, at the very time when these journeyings are said to be in progress, our fishers are finding and killing whales by hundreds in the north. At the same time, it is undeniable that the whale is migratory in its habits, and the matter is worthy of a thorough investigation, as the establishment of fishing stations in warm latitudes would prevent much suffering at present endured in the North Sea fishing. The female alone, however, is said to take the circuit mentioned, and the reason is understood to be the instinctive desire of the animal to give strength to her young by taking them to a genial clime.

Being by far the most valuable and frequent object of the fisheries, the Greenland whale has received much more attention here than it is necessary to bestow on the great rorqual, though that variety exceeds all others in magnitude, and is indeed the largest of all the living creatures of the earth. Two specimens have been observed which measured the enormous length of one hundred and five feet. One of these, it is stated by Scoresby, was found floating lifeless in Davis's Straits, and the skeleton of the other was observed by Captain Clarke on Columbia River. This last individual, when alive, must have measured nearly one hundred and twelve feet, allowing six or seven for the tail, and it may therefore be regarded as the largest creature of which we have the authentic measurement. Other specimens have measured a hundred, and others from ninety to eighty feet. The rorqual cast ashore at North Berwick, and preserved by Dr. Knox, was eighty-three feet in length. The colour of the rorqual is a pale bluish black, with the abdominal regions of a grayish tint. In shape, the body is not nearly so cylindrical as that of the mysticetus, but is compressed on the sides, and angular on the back. Hence the common name of "razorback;" and from the dorsal fin, which is low down, and of a small size, springs the equally familiar name of "finner." The blubber of the rorqual is less abundant than that of the Greenland whale, and is seldom more than half a foot in depth, and eight or ten tons in weight; while its baleen, also, is much shorter, coarser, and every way less valuable. This latter circumstance arises partly from the upper jaw being less arched than in the common whale. There is another cause for the inferior fineness of the baleen in the rorqual, which is the greater size of the objects which it employs as food. In the stomach of one individual, six hundred great cod, and immense quantities of other large fish, were found. The gullet, accordingly, is much wider than in the mysticetus. Another striking feature in the rorqual, and the one from which the name is derived, is an immense sort of fold or pouch along the under jaw. This was thought to be an air-bag or swimming bladder, till the observations of Dr. Knox satisfied every one that it was merely a great water-reservoir, for augmenting the capacity of the mouth, otherwise so much diminished in this creature by the want of curve in the upper jaw.

The great rorqual has two blow-holes, through which it blows violently and very loudly; and it swims with much speed, its rate of motion varying from five to twelve miles an hour. The species is very numerous in the Arctic seas, and particularly about Spitzbergen and Nova Zembla. It is a much bolder animal than the mysticetus, and having so little oil in its frame, fishers seldom meddle with it, and dislike, indeed, to see it, as it is supposed to be avoided by the more valuable varieties of its race. If struck by the harpoon, it is excited to most dangerous energy; and on one occasion, an individual drew a whole whaling-vessel, with its crew, with such violence on a bank of ice, that every man on board perished. A rorqual struck by Mr. Scoresby dived with so much velocity, that it ran out 2880 feet of line in one minute, and ultimately snapped the cord. Though thus dangerous, however, as well as comparatively valueless, the Laplanders and Greenlanders seize every occasion of attacking it in their small boats. They usually send as many harpoons into it as possible, and get out of the way, leaving it to die alone, as it usually does, and is then cast or hauled ashore.

A lesser species of the rorqual is found in the Greenland seas, having, like the greater one, a dorsal fin, and measuring usually between twenty and thirty feet in length. That this was a distinct species of rorqual was proved by Dr. Knox, who got possession of a specimen that was cast ashore at Queensferry, and found it to have only forty-eight bones in the vertebral column, whereas the other had sixty-three. This was decisive of its individuality as a genus. It has a fine blue tint in the skin, and its oil is considered as highly delicate and medicinal by the Icelanders, but otherwise the species is one of no general importance.

Not so with the cachalot, physeter macrocephalus, or spermaceti whale, of which there are several varieties. All of them are distinguished by teeth in the lower jaw, by one blow-hole, and by the want of baleen. The leading distinctions between the various kinds of the sperm whale lie in the possession of two fins or three fins; of a spout in the neck or in the snout; of flatted teeth or sharp teeth; and finally of a black, a blue, or a whitish back. But, generally speaking, the characters now to be noticed are proper to all. The sperm whale attains to a great size, varying between sixty and eighty feet. The head is enormous in bulk, being fully more than a third of the whole body, and it ends like an abrupt and steep promontory in front. On the upper part of the snout is placed the blow-hole, often verging a little to one side; and it is a remarkable fact, that this is but one of the various deformities, whether congenital or acquired in the terrible battles waged by the creatures with one another, which are commonly found in the body of this whale. Its eyes are unequal, and the left frequently useless. The back has a greenish-gray tint, and below, much of the creature is white. On the back, there are in most of the species one or two small fins, with large protuberances; the side fins are also of small size, but the tail is an instrument of amazing power. The teeth are usually about forty-two in number, and fit into depressions in the upper jaw. In this whale the gullet is wide enough to admit a man, and the animal feeds on large fish. A molluscous animal (sepia octopus), called *squid* by the sailors, is its chief food in deep seas.

The size of head in the sperm whale has a very extraordinary purpose to serve. To assist in floating the animal, a great cavity in the interior of the skull is filled with a fine oil, which becomes concrete on cooling, and forms the spermaceti of commerce. Some of this oil is also found along the vertebral column; and in a bag in the intestines another valuable substance lies, the ambergris of traders. Some authors, it is proper to state, assert that the ambergris is merely the animal's fæces. These are the principal objects of the sperm whale fishery, the blubber procured from this variety of the cetacea not being nearly so abundant as in the case of the mysticetus. At the same time, the blubber of the sperm whale is valuable, and is usually called sperm oil. The sailors know this whale at a great distance by the act of blowing, which it performs with great regularity, at intervals of ten minutes or so. The spout sent up is visible at the distance of two or three miles, and has the appearance of a misty cloud or bush. Having thus blown, or expired, sixty or seventy times, and made inspirations as often, the animal descends, and can remain under water more than an hour, subsisting on the store of blood which it has oxygenated, and keeps in the reservoirs already described. This alternation of appearances and disappearances is gone through by the animal with undeviating regularity, unless it be disturbed. The sperm whale is timid before man, yet it fights fiercely with those of its own race. Fights usually take place when male whales, or "bulls," as they are called, and one or two of which always attend a particular herd of females, meet with rivals desirous of entering their company. They lock jaws with one another, and exert a dreadful degree of power at one another's cost. When alarmed, or harpooned, they sometimes roll over and over on the surface of the water in an amazing manner. Still they are not furious or dangerous towards the mariner, but are commonly killed with ease. The sailors call a herd a "school, and the old bulls the "schoolmasters." The females are said to be smaller than the males by a fourth. They are, like the mysticetus, very fond of their young and also of one another; so much so, that, by cautious management, a whole herd may be destroyed, as they will scarcely quit a wounded companion.

It has been noticed, however, by the sperm-whalers, that the males do not exhibit any such affectionateness of temperament, but, on the contrary, make an immediate and ungallant retreat on the approach of danger, leaving the females to shift for themselves, and to show the gentler constitution of their nature by helping and guarding their wounded companions. Though exposing themselves to risk on these occasions with so much simplicity, the sperm whales are nevertheless very cautious, and careful to avoid peril in the first instance. They have the power of raising their heads perpendicularly out of the water to a very considerable height, and when in this attitude, which seems to be assumed for the purpose of viewing the surrounding expanse, they present the appearance of huge black rocks. They are said to have the ability, also, on noticing any object, to communicate the intelligence to their companions, though the manner in which this is done remains a secret. Mr. Beale, from whose excellent work on the Pacific whale-fishery we shall immediately make some interesting citations, gives it as his opinion that the sperm-whale can communicate signals to a distance of four, five, and even seven miles. This cannot be effected by sounds, for, above water at least, the animal utters no noise whatever, if we except the hissing sound accompanying the act of respiration. Baron Cuvier and others aver, indeed, that the cachalot sends forth loud groans when struggling in the mortal agony, but this statement is contradicted by all practical whalers. With regard to its other habits, the sperm-whale much resembles the Greenland whale. It is often seen, like its northern congener, to leap directly out of the water, or to *breach*, as the sailors call the action. Its purpose is to get rid of various sucking-fish and crabs, which are fond of effecting a lodgment upon its mountainous body, and which often remain there till plucked from off the captured animal by the whalers. The sperm-whale has been erroneously represented by many writers as a voracious creature, pursuing and destroying all the lesser fishes that come in its way. Leaving out of sight the impracticability of such a thing, arising from its unwieldy bulk, the truth of the matter really is, that the great whale of the South Seas is peculiarly harmless and inoffensive with regard to the smaller tribes of the deep. As in the case of the elephant, nature seems to have gifted this mighty creature with a degree of gentleness proportioned to its size and strength, with a benevolent view to the comforts of other oceanic races. Indeed, the sperm-whale is more sinned against in this way than sinning. The sword-fish and other animals have been observed to attack it with the utmost audacity, and to throw it into a state of prodigious alarm.

It has been mentioned that the principal food of the cachalot is the sepia octopus, or sea-squid. This is an animal of so curious an order as to merit a word of special notice. The common sepia is well known by the name of the cuttle-fish. The principal peculiarity of this molluscous tribe is the possession of powerful tentacula, or arms, ranged round the mouth, and provided with suckers which give them the power of adhering to rocks or any other substances with surprising tenacity. Some of the tribe attain to a great size, and, large as the whale is, will furnish it with no contemptible mouthful. In the gullet of one spermaceti whale, an arm or tentaculum of a sea-squid was found, measuring nearly twenty-seven feet long The native divers of the South Seas have a mortal dread of these squids, and no wonder, seeing that the strength of man is totally inefficient to tear away their tentacula when they are once fixed. A naval captain, we are informed by Sir Grenville Temple, once came in contact with a large sepia when bathing. The animal attached itself to one foot; he felt this, and strove to disengage the creature with the other foot, but it fixed upon that too. He seemed then to have made an attempt to free himself with his hands. These also were firmly grasped, and the poor man was soon after found bound hand and foot, and drowned past recovery! Mr. Beale relates an adventure which he himself had with one of these creatures. He saw it near the surf on one of the Bonin islands, and made some half sportive attempts to capture it, not anticipating any possible harm from a creature which had a blubbery body not above the size of a clenched fist, though its tentacles appeared about two feet in length. He took hold of one of them, and was endeavouring to pull the creature from the rock, when suddenly it turned round and sprang upon his arm, which had been bared for the purpose of seeking shells. It fastened its cold slimy body upon him so firmly that he was in great alarm, especially as it endeavoured to fix its mouth next. He ran to the boat to his friends, and the animal was disengaged, but only by cutting it in pieces. These squids are very numerous in the Pacific seas, and the sperm-whale has abundant feeding upon them and other small fishes.

The cachalot is seldom or never seen in the Greenland seas, at least by modern navigators. It is spread, however, over an immense expanse of the ocean, having been captured, at some time or other, almost everywhere between the latitude of 60° south and 60° north. The coasts of New Guinea and the adjacent archipelagoes, the shores of New Holland, Mitchell's Group, New Zealand, Navigator Isles, Ellis's Group, the shores of Peru, Chili, California, Japan, the Persian Gulf, the Chinese seas, the Moluccas, and many other parts of the ocean, abound more or less with this valuable cetaceous tribe.

In the Naturalist's Library, an able periodical, under the conduct of Sir William Jardine, we find the following minor genera of whales enumerated, after a description of the mysticetus, the rorquals, and the cachalot, the three varieties of greatest use to man. 1st, the nar whal, or sea-unicorn, an animal from sixteen to twenty feet long, and provided with a straight tusk or horn (sometimes two), about four or five feet in length, and projecting from the snout. The animal has a spotted, grayish body, handsomely rounded off, and containing usually near a ton of oil, much prized by the Greenlanders, on whose coasts the narwhal is often seen. The horn yields beautiful ivory, and is greatly sought on that account. 2d, The diodons, or two-teethed whales. These are of a size similar to the preceding, and are a variety of little or no value. 3d, The hyperoodons, animals of a dark colour, about twenty feet long, and distinguished by knobs in place of teeth. 4th and 5th, The aodons and the ziphins, two classes of small toothless whales. 6th, The beluga, or white whale, a creature of pure white colour, exceedingly rounded and symmetrical in form, and from twelve to twenty feet long. It abounds on the northern coasts of Asia and America. In 1815, a beautiful specimen of the race haunted the Forth for three months, and was finally killed, and placed in the Edinburgh Museum. 7th, The delphinapterus, a South-sea whale, is about six feet long, and remarkable only for being beaked somewhat like a bird. 8th, The deductor is an Arctic animal, black in colour, and twenty or twenty-four feet long. It has scarcely any snout, and is most noted for its power of uttering loud cries when in distress, which circumstance has obtained for it the name of the *calling* (calling) whale. Whether other species can cry or not

was already noticed as a matter of doubt. These are the most important of those minor varieties of the cetaceous family, which are ranked among the whales. The dolphin, porpoise, and grampus, on the other hand, have been isolated by naturalists, and are usually considered by themselves.

THE WHALE FISHERY.

Whale-fishing is a practice of long standing in the world. It is natural to suppose that those nations dwelling on the shores of the Arctic seas would be the parties earliest engaged in such pursuits; and accordingly we find, that not only did the Norwegians and other Northmen precede all the other nations of Europe in this perilous but profitable line of enterprise, but they also were the first introducers of it among the southern nations. The shores of the Bay of Biscay, where the Normans formed early settlements, became famous through them for the whale-fishing there carried on. In the same region was it first made a regular commercial pursuit, and as whales then visited the Bay in great quantities, the traffic was convenient and easy. The Biscayans maintained it with great vigour and success in the twelfth, thirteenth, and fourteenth centuries. We find from the work of Noel, "Upon the Antiquity of Whale-fishing," that, in 1261, a tithe was laid upon the tongues of whales imported into Bayonne, they being then a highly esteemed species of food. In 1338, Edward III. relinquished to Peter de Puyanne a duty of £6 sterling each whale, laid on those brought into the port of Biarritz, to indemnify him for the extraordinary expenses he had incurred in fitting out a fleet for the service of his majesty. The Biscayans, however, soon gave up the whale-fishing, from the want of fish, which ceased to come southward, no longer leaving the icy seas. The voyages of the Dutch and English to the Northern Ocean, in order to discover a passage through it to India, though they failed in their primary object, laid open the remote haunts of the whale. The British Muscovy Company obtained a royal charter prohibiting all vessels but theirs from fishing in the seas round Spitzbergen, under pretence that it was discovered by Sir Hugh Willoughby. The fact, however, was, that Barentz, a merchant-seaman of Amsterdam, had discovered it in 1596; and neither Dutch, Spaniards, nor Frenchmen, were at all disposed to admit the justice or propriety of the claim made by the English. An extraordinary scene succeeded in the northern seas. The Muscovy company sent out six or seven strongly armed vessels, which took up a position near Spitzbergen, and commenced an attack on all foreign ships that refused either to quit the region at once, or pay the very moderate toll of one-half the proceeds of their fishing. The English succeeded so far as to annoy everybody else, and to prevent themselves from taking almost a single fish, so busy were they in looking after others. All the nations of Europe remonstrated loudly through their envoys against these proceedings, but the Dutch, ever fearless at sea, sent out a strong fleet, which effectually guarded their own fishing. At length, in 1618, a general engagement took place, in which the English were worsted. Hitherto, the two governments had allowed the fishing adventurers to fight out their own battles; but in consequence of the event mentioned, it was considered prudent to divide the Spitzbergen bay and seas into fishing stations, where the companies might not trouble each other. After this period, the Dutch quickly gained a superiority over their rivals. While the English prosecuted the trade sluggishly and with incompetent means, the Dutch turned their fisheries to great account, and in 1680 had about 260 ships and 14,000 sailors employed in them.

Though there have been, in English history, one or two magnificent instances of the success of great companies, possessed of monopolies and exclusive privileges, there can be little doubt that the attempt to prosecute the whale-fishing at this era failed from its not being opened up to private enterprise. After the cessation of the Muscovy Company, a Greenland Company, with an actual capital of £45,000, entered on the trade, and in nine years came to a ruinous close. In 1725, the South Sea Company took up the adventure, and in eight years, after the outlay of a vast amount of money, they also were compelled to submit to a dead loss of their capital, and throw up the attempt.

The legislature now tried a new scheme, being sincerely desirous to encourage and establish the trade, as well as to make it a nursery for seamen. In 1732, a bounty of 30s. a ton was granted to every ship of 200 tons burden that engaged in the fishing. In 1749, it was thought necessary to raise the bounty to 40s., when, as Mr. M'Culloch observes, as many ships seem to have been fitted out for catching the bounty as for catching fish. But a trade supported on any other principle than that of direct benefit received from it by the parties engaged therein, can never be of an enduring nature, and this truth soon appeared in the present case. In 1777, the bounty was reduced to 30s., the consequence of which was, that during the next five years the number of ships employed in the trade was reduced from 105 to thirty-nine! In 1781, the bounty was raised again to its old level, and an inducement was thus held out for the revival of the spirit of trade. But, after all, what a million and a half of money, expended in successive donations under the name of bounty, was totally inefficient to do, the spirit of private enterprise, once fairly awakened, speedily accomplished. The British whale-fisheries throve rapidly between 1781 and 1795, and the legislature found themselves justified in reducing the bounty, at intervals, from 40s. to 20s. The long continental troubles consequent on the French revolution put a complete period almost to the Dutch fishing, while in the same space of time the British fisheries were continually improving, the conduct of them being left entirely to the private spirit of the nation. A small bounty, indeed, was given even down till 1824, but it was uninfluential, and was then withdrawn altogether. Of the change which has of late years come over the whaling traffic of Britain, a few words will be said before bringing the general subject to a close.

No species of fishery, prosecuted anywhere on the face of the ocean, can compare in intensity of interest with the whale-fishery. The magnitude of the object of the chase, and the perilous character of the seas which it peculiarly frequents, are features which prominently distinguish the profession of the whale-fisher from all similar pursuits, and which invest the details of its history with the strong charm inseparable from pictures of stirring exertion, privation, and danger. Such being the case, we shall present, chiefly from the writings of Captain Scoresby, the highest authority on the subject, a full description of the proceedings connected with the British whale-fishery. Long a whaleman himself, Captain Scoresby had ample opportunities of personal observation, and he was gifted, fortunately, with such powers as enabled him to describe the scenes which fell under his notice with clearness, accuracy, and force.

The ships designed for the whale-fishery are usually from 300 to 400 tons in burden, and require to be very substantially built, in order to resist the pressure of the ice. With the view of increasing their strength, most of them have additional planks and timbers, and often, also, iron-plates and stancheons, introduced into their structure, both internally and externally. Such appurtenances and provisions are technically known by the names of *doublings*, *treblings*, *fortifyings*, *pointers*, *ca* ings, &c. Of course, the whale-ship is also furnished with an ample stock of the apparatus and instruments used in the fishing, as well as with the peculiar boats which are employed in capture and pursuit.

The whale-boat is from twenty to twenty-eight feet in length, and provided with from four to six pair of oars. It should float lightly on the water, and be so formed as to move with speed, and to turn easily round. They are "carver-built," as it is called, and the best made ones are composed of straight oak planks, suppled and bent to the required shape, by which means their elasticity is greatly increased. The rapid and dangerous movements of the whale render these various qualities indispensable. The principal weapons with which whale-fishers are supplied, are the *harpoon* and the *lance*. The harpoon is an iron instrument about three feet long, and consists of three conjoined parts, the "socket," "shank," and "withers" or barbs. The socket is about six inches in length; the shank, which is between the withers and socket, is nearly eighteen inches long; and the withers are eight inches long by six in breadth. The united withers are triangular in shape, and the shank is fixed between them. The shank of the harpoon is the most important part of the weapon. It is formed of the most pliable iron, old horse-shoe nails being usually preferred for the purpose; and it is not more than four-sixteenths of an inch in diameter. Much attention is paid to the manufacture of the shank, because on its flexibility the retention of a harpooned whale depends. If the shank should break during the plunges of the whale, the animal is lost to the fishers. Unless the shank will bear to be wound round an inch bar of iron, in the form of a close spiral, and to be again unwound, it is held to be of imperfect materials. The socket is hollow and strong, and swells, from the point of its junction with the shank, to a diameter of two inches. It is only necessary to add to this description of the harpoon, that each of the withers has at its point a smaller and reversed barb, like the beard of a fish-hook. The use of this provision is obvious.

The lance is a more simple instrument. It is nearly ten feet long, and consists of a hollow socket into which a fir stock is inserted, of a shank of iron about half an inch in diameter, and of a sharp, flat point or tongue of steel, seven inches long by two in breadth. This instrument and the harpoon, together with lines and boats, are all the apparatus absolutely necessary for capturing the whale. Some ships have a harpoon-gun, or a gun which projects the harpoon; but this weapon has been found extremely uncertain when put to use.

The ships destined for the Greenland fishery put to sea in March, or during the first days of April. The crew of one of these vessels usually consists of from forty to fifty men, comprising various classes of inferior officers, such as harpooners, boat-steerers, line-managers, carpenters, landsmen, and others. Steering from the direction of Shetland, on a course to the east of north, the whalers commonly reach and pass the west side of Spitzbergen in the end of the month of May. From this point they continue their course till they arrive at the latitude of 78° or 78½° (the best parallel for fish), or till they meet with whales. There is a remarkable indentation in the ice, lying between longitude 5° and 10°, which the whalers for the most part strive to enter; but their course must be regulated greatly by the state of the ice. On reaching a fishing station where whales are seen, preparations are immediately made for commencing the business of capture. Two or three boats at the least are always kept suspended from cranes by the side of the ship, in such a position that they can be lowered into the water, with their complements of men, and the whole necessary apparatus, in the space of one minute. Previously to this time, the harpoons and lines have been got in order. The socket of the harpoon has been furnished with a stock or handle, six or seven feet long, and fastened in its place by means of a splice of strong rope, called a *foreganger*, the eye of which is kept firmly fixed to the iron of the harpoon by the *swelling* of the socket. To the loose end of the foreganger are attached five or six fathoms of line, called the stray line, and this again is connected with the other lines of the boat. In each boat there are about 4320 feet of rope, neatly though loosely coiled up in six separate portions, and laid down in places appointed for the purpose. The line or rope is made of the best hemp, and is about 2½ inches in circumference. An axe, to cut the lines if necessary, a bucket to lave the lines and keep them from being overheated by friction, and a few other articles, are also laid down in the boats for use.

MODE OF FISHING.

Whenever there is a probability of seeing whales, the master, or some experienced officer, keeps a close look-out from the *crow's-nest*, a station at the mast-head so called. With the assistance of a telescope he scans the surface of the waters around, ready, at the first glimpse of a fish, to give notice to the watch on deck. In fine weather, a boat is kept afloat, manned, and engaged also in the look-out. The short time during which whales usually remain above water to breathe (being only two minutes), renders the discovery of them less easy than might be anticipated from their great bulk. Besides, while below water, the animal frequently traverses a space of half a mile in the ten or fifteen minutes intervening between the respirations; and hence the spot at which it may again rise, after being once seen and again disappearing, is left in a great measure a subject of conjecture. The previous direction of the whale's movements, and occasionally a sort of eddy on the surface, are the only guides to the boatmen in this particular. When the whale does come up within reach of a harpoon-cast, and lies unconscious of the approach of its enemies, "then (says Captain Scoresby) the hardy fisher rows directly upon it, and an instant before the boat touches it, buries his harpoon in its back. But if, while the boat is yet at a little distance, the whale should indicate his intention of diving, by lifting his head above the common level, and then plunging it under water, and raising its body until it appear like the large segment of a sphere, the harpoon is thrown from the hand, or fired from a gun, the former of which, when skilfully practised, is efficient at the distance of eight or ten yards, and the latter at the distance of thirty yards or upwards. The wounded whale, in the surprise and agony of the moment, makes a convulsive effort to escape. Then is the moment of danger. The boat is subjected to the most violent blows from its head or its fins, but particularly from its ponderous tail, which sometimes sweeps the air with such tremendous fury, that both boat and men are exposed to one common destruction.

"The head of the whale is avoided, because it cannot be penetrated with the harpoon; but any part of the body between the head and tail will admit of the full length of the instrument, without danger of obstruction. The harpoon, therefore, is always struck into the back, and generally well forward towards the fins, thus affording the chance, when it happens to drag and plough along the back, of retaining its hold during a longer time than when struck in closer to the tail.

"The moment that the wounded whale disappears, or leaves the boat, a jack or flag, elevated on a staff, is displayed, on sight of which, those on watch in the ship give the alarm, by stamping on the deck, accompanied by a simultaneous and continued shout of 'a fall!'*

"* The word 'fall,' as well as many others used in the fishery, is derived from the Dutch language. In the original it is written *val*, implying jump, drop, fall, and is considered expressive of the conduct of the sailors when manning the boats on an occasion requiring extreme despatch.

the sleeping crew, roused by the sound, jump from their beds, rush upon deck, with their clothes tied by a string in their hands, and crowd into the boats, at a temperature of zero. They generally contrive to dress themselves, in part at least, as the boats are lowered down; but sometimes they push off in the state in which they rise from their beds, row away towards the 'fast boat,' that is, the boat attached by its harpoon and line, to the whale, and have no opportunity to clothe themselves for a length of time afterwards. The alarm of 'a fall' has a singular effect on the feelings of a sleeping person, unaccustomed to the whale-fishing business. It has often been mistaken for a cry of distress. A landsman in a Hull ship, seeing the crew, on the occasion of a fall, rush upon deck, with their clothes in their hands, when there was no appearance of danger, thought the men were all mad. But with another individual the effect was totally different. Alarmed with the extraordinary noise, and still more so, when he reached the deck, with the appearance of all the crew seated in the boats in their shirts, he imagined the ship was sinking. He therefore endeavoured to get into a boat himself, but every one of them being fully manned, he was always repulsed. After several fruitless endeavours to gain a place among his comrades, he cried out, with feelings of evident distress, 'What shall I do?—will none of you take me in?'

"The first effort of a 'fast fish,' or whale that has been struck, is to escape from the boat, by sinking under water. After this, it pursues its course directly downwards, or reappears at a little distance, and swims with great celerity, near the surface of the water, towards any neighbouring ice, among which it may attain an imaginary shelter; or it returns instantly to the surface, and gives evidence of its agony by the most convulsive throes, in which its fins and tail are alternately displayed in the air, and dashed into the water with tremendous violence. The former behaviour, however, that is, to dive towards the bottom of the sea, is so frequent in comparison of any other, that it may be considered as the general conduct of a fast fish.

"A whale struck near the edge of any large sheet of ice, and passing underneath it, will sometimes run the whole of the lines out of the boat, in the space of eight or ten minutes of time. This being the case, when the 'fast boat' is at a distance, both from the ship and from any other boat, it frequently happens that the lines are all withdrawn before assistance arrives, and, with the fish, entirely lost. In some cases, however, they are recovered. To retard, therefore, as much as possible, the flight of the whale, it is usual for the harpooner who strikes it, to cast, one, two, or more turns of line round a kind of post, called a ballard, which is fixed within ten or twelve inches of the stern of the boat for the purpose. Such is the friction of the line, when running round the ballard, that it frequently envelopes the harpooner in smoke; and if the wood were not repeatedly wetted, would probably set fire to the boat. During the capture of one whale, a groove is sometimes cut in the ballard, near an inch in depth; and were it not for a plate of brass, iron, or a block of lignum vitæ, which covers the top of the stem where the line passes over, it is apprehended that the action of the line on the material of the boat would cut it down to the water's edge, in the course of one season of successful fishing. The approaching distress of a boat, for want of line, is indicated by the elevation of an oar, in the way of a mast, to which is added a second, a third, or even a fourth, in proportion to the nature of the exigency. The utmost care and attention are requisite, on the part of every person in the boat, when the lines are running out: fatal consequences having been sometimes produced by the most trifling neglect. When the line happens 'to run foul,' and cannot be cleared on the instant, it sometimes draws the boat under water; on which, if no auxiliary boat or convenient piece of ice be at hand, the crew are plunged into the sea, and are obliged to trust to the buoyancy of their oars, or to their skill in swimming, for supporting themselves on the surface. To provide against such an accident, as well as to be ready to furnish an additional supply of lines, it is usual, when boats are sent in pursuit, for two to go out in company, and when a whale has been struck, for the first assisting boat which approaches to join the fast boat, and to stay by it until the fish reappears. The other boats, likewise, make towards the one carrying a flag, and surround it at various distances, awaiting the appearance of the wounded whale.

"On my first voyage to the whale fishery, such an accident, as above alluded to, occurred. A thousand fathoms of line were already out, and the fast boat was forcibly pressed against the side of a piece of ice. The harpooner, in his anxiety to retard the flight of the whale, applied too many turns to the line round the ballard, which, getting entangled, drew the boat beneath the ice. Another boat, providentially, was at hand, into which the crew, including myself, who happened to be present, had just time to escape.

"The whale, with nearly two miles' length of line, was in consequence of the accident lost, but the boat was recovered. On a subsequent occasion I underwent a similar misadventure, but with a happier result; we escaped with a little wetting into an accompanying boat, and the whale was afterwards captured, and the boat with its lines recovered.

"When fish have been struck by myself, I have on different occasions estimated their rate of descent. For the first 300 fathoms, the average velocity was usually after the rate of eight to ten miles per hour. In one instance, the third line of 120 fathoms was run out in sixty-one seconds; that is, at the rate of eight and one-sixth English miles, or seven and one-eighth nautical miles, per hour. By the motions of the fast boat, the simultaneous movements of the whale are estimated. The auxiliary boats, accordingly, take their stations about the situation where the whale, from these motions, may reasonably be expected to appear.

"The average stay under water of a wounded whale, which steadily descends after being struck, according to the most usual conduct of the animal, is about thirty minutes. The longest I ever observed was fifty-six minutes; but in shallow water, I have been informed, it has sometimes been known to remain an hour and a half at the bottom after being struck, and yet has returned to the surface alive. The greater the velocity, the more considerable the distance to which it descends, and the longer the time it remains under water, so much greater in proportion is the extent of its exhaustion and the consequent facility of accomplishing its capture. Immediately on its reappearing, the assisting boats make for the place with their utmost speed, and as they reach it, each harpooner plunges his harpoon into its back, to the amount of three, four, or more, according to the size of the whale and the nature of the situation. Most frequently, however, it descends for a few minutes after receiving the first harpoon, and obliges the other boats to await its return to the surface, before any further attack can be made. It is afterwards actively plied with lances, which are thrust into its body, aiming at its vitals. At length, when exhausted by numerous wounds and the loss of blood which flows from the huge animal in copious streams, it indicates the approach of its dissolution by discharging from its 'blowholes' a mixture of blood along with the air and mucus which it usually expires, and finally jets of blood alone. The sea, to a great extent around, is dyed with its blood, and the ice, boats, and men, are sometimes drenched with the same. Its track is likewise made by a b oad pellicle of oil, which exudes from its wounds, still appears on the surface of the sea.

"Its final capture is sometimes preceded by a convulsive struggle, in which its tail, reared, whirled, and violently jerked in the air, resounds to the distance of miles. In dying, it turns on its back or on its side, which joyful circumstance is announced by the capturers with the striking of their flags, accompanied by three lively huzzas!"

The writer of this animated description points out how remarkably nature seems to assist man in the capture of the whale. By no efforts of its human assailants could the strength of the creature be so far reduced as to permit of its destruction, were it not that its descent, through fright, to a depth of 700 or 800 fathoms, must subject its body to the exhausting pressure of more than 200,000 tons of superincumbent water! It is through this cause rather than from the wounds the whale has received, that it comes to the surface in so helpless a state of exhaustion. The space of time in which different individuals are captured and killed, varies considerably, and, in part, for the same reason. Large whales have been sometimes killed in twenty minutes, while in other instances, the animal costs his assailants a struggle of sixteen hours' duration, and in some cases more, and may escape from them after all. The average time, under favourable circumstances, is one hour, but two or three hours are no uncommon period for the contest to last, even in favourable circumstances. Two harpoons usually despatch a whale of middling size, and its movements may commonly be restrained within the limits of 600 fathoms of line. On the career or flight of a first-size whale, no check can be placed, until its own exertions exhaust its powers.

The ease with which some whales are subdued, and the slightness of the entanglement by which they are taken, have often been the cause of agreeable surprise to fishers. The following case would almost incline one to accuse the whale of a degree of stupidity unknown among the lowest of the brute creation:—"A whale was struck from one of the boats of the ship Nautilus in Davis' Straits. It was killed, and, as is usual after the capture, it was disentangled of the line connected with the first 'fast-boat,' by dividing it within eight or nine yards of the harpoon. The crew of the boat from which the fish was first struck, in the mean time, were employed in heaving in the lines, by means of a crank fixed in the boat for the purpose, which they progressively effected for some time. On a sudden, however, to their great astonishment, the lines were pulled away from them, with the same force and violence as by a whale when first struck. They repeated their signal, indicative of a whale being struck; their shipmates flocked towards them; and while every one expressed a similar degree of astonishment with themselves, they all agreed that a fish was fast to the line. In a few minutes they were agreeably confirmed in their opinion, and relieved from suspense, by the rising of a large whale close by them, exhausted with fatigue, and having every appearance of a fast-fish. It permitted itself to be struck by several harpoons at once, and was speedily killed. On examining it after death, to discover the cause of such an interesting accident, they found the line belonging to the above-mentioned boat in its mouth, where it was still firmly fixed by the compression of its lips. The occasion of this happy and puzzling accident was therefore solved. The end of the line, after being cut from the whale first killed, was in the act of sinking in the water; the fish in question, engaged in feeding, was advancing with its mouth wide open, and accidentally caught the line between its extended jaws—a sensation so utterly unusual as that produced by the line, had induced it to shut its mouth and grasp the line, which was the cause of its alarm, so firmly between its lips, as to produce the effect just stated. This circumstance took place many years ago, but a similar one occurred in the year 1814."

Another case of easy capture, though one not quite so disparaging to the intellect of the whale, has been recorded by Scoresby:—"A harpooner, belonging to the Prince of Brazil, of Hull, had struck a small fish. It descended, and remained for some time quiet, and at length appeared to be drowned. The strain on the line being then considerable, it was taken to the ship, with a view of heaving the fish up. The force requisite for performing this operation was extremely various; sometimes the line came with ease, at others, a quantity was withdrawn with great force and rapidity. As such, it appeared evident that the fish was yet alive. The heaving, however, was persisted in, and after the greater part of the lines had been drawn on board, a dead fish appeared at the surface, secured by several turns of the line round its body. It was disentangled with difficulty, and was confidently believed to be the whale they had struck. But when the line was cleared from the fish, it proved to be merely the 'bight,' for the end still hung perpendicularly downward. What was, then, their surprise to find that it was still pulled away with considerable force! The capstan was again resorted to, and shortly afterwards they hove up, also dead, the fish originally struck, with the harpoon still fast. Hence it appeared, that the fish first drawn up had got accidentally entangled with the line, and in its struggles to escape had still farther involved itself, by winding the line repeatedly round its body. The first fish entangled, as was suspected, had long been dead; and it was this lucky interloper that occasioned the jerks and other singular effects observed on the line."

The whale-fishing is apt to be impeded, as may readily be imagined, by the great masses of ice everywhere abounding in the northern seas. The usual course of proceedings in open water has been described; in different circumstances, different plans must be adopted. *Pack-fishing* is the name given to the chase of the whale on the borders of close packs of drift-ice. The animal loves to shelter his vast bulk under the lee of these frozen masses, and, when struck, usually flies to them for refuge, thus endangering the lines and lives of the whalemen. The common method of providing against such contingencies, is either to strike the fish with two harpoons from different boats at the same moment, or to affix the line of a second boat to that of the one from which the whale has been harpooned, so that the strength of two lines is brought into play against the fish. Sometimes, when the fish gets entangled in the drift-ice, the adventurous seamen climb over it, and lance the animal from that perilous station. Altogether, pack-fishing is troublesome and dangerous, and were it not that the largest whales often resort to such situations, whalers would seldom attempt to fish there.

On the other hand, *field-fishing*, as it is called, or fishing on the edges of those wide connected plains of ice termed fields, is one of the most productive of all the modes of fishing prosecuted in the Greenland seas. When the weather is tolerably mild, it is also a pretty secure mode. The most marked of the advantages held out by field-fishing, is the curtailment of the range of the whale's movements. When harpooned, it commonly descends obliquely beneath the field, and, being unable to rise through the ice, is forced to return to the edge, or nearly to the spot where it made the plunge. Thus, the ship's boats, if stationed along the margin of the field, can at once harpoon it a second time, and despatch it. In open water, the whale, by rising at a spot far apart from where it dived, gains time to breathe freely and recruit its strength, and so either breaks away altogether, or greatly protracts the struggle. For this reason, six boats at a field will do the work of twelve in open sea. Two or more fish are frequently taken at a field at one time, and on r particular occasion six fish were actually captured at once by the seven boats of a single ship. Even in such weather as renders fishing impracticable elsewhere, field-fishing can be prosecuted with success. But there are disadvantages also attendant on this mode. The movements of fields of ice are so rapid, various, and unaccountable, and their powers of doing mischief so unlimited, that the utmost prudence and skill cannot entirely secure vessels lying in their vicinity from the risk of severe damage or total destruction. Small fields or floes are especially dangerous, particularly if they contain small cracks or holes in the centre of them. The chance of a sudden movement in such floes is much greater that in the case of the large fields, and, moreover, after being struck, the whale generally makes for the apertures in the ice, and there breathes freely, rendering it necessary for the men to cross the field on foot, and despatch their prey with the lance. Even when they succeed in doing this, there is no way of getting out the whale but by sinking it, and dragging it from below the ice, at the great risk of pulling out the harpoon altogether; or by cutting the blubber away, and transporting it over the surface of the floe, piece by piece. These operations are attended with vast labour and loss of time. "As connected with this subject (says Captain Scoresby), I cannot pass over a circumstance which occurred within my own observation, and which excited my highest admiration. On the 8th of July, 1813, the ship Esk lay by the edge of a sheet of ice, in which were several thin parts, and some holes. Here a fish being heard blowing, a harpoon, with a line connected to it, was conveyed across the ice from a boat on guard, and the harpooner succeeded in striking the whale at a distance of 350 yards from the verge. It dragged out ten lines (2400 yards), and was supposed to be seen blowing in different holes in the ice. After some time it happened to make its appearance on the exterior, when a harpoon was struck at the moment it was proceeding again beneath. About 100 yards from the edge, it broke the ice where it was a foot in thickness with its crown, and respired through the opening. It then determinately pushed forward, breaking the ice as it advanced, in spite of the lances constantly directed against it. It reached, at length, a kind of basin in the field, where it floated on the surface of the water without any encumbrance from ice. Its back being fairly exposed, the harpoon, struck from the boat on the outside, was observed to be so slightly entangled that it was ready to drop out. Some of the officers lamented this circumstance, and expressed a wish that the harpoon were better fast; observing, at the same time, that if it should slip out, the whale would either be lost or they would be under the necessity of cutting it up where it lay, and of dragging the pieces of blubber over the ice to the ship—a kind and degree of labour which every one was anxious to avoid. No sooner was the wish expressed, and its importance made known, than one of the sailors, a smart and enterprising fellow, stepped forward and volunteered his services to strike it better in. Not at all intimidated by the surprise which was manifested in every countenance by such a bold proposal, he pulled out his pocket-knife, leaped upon the back of the living whale, and immediately cut the harpoon out. Stimulated by this courageous example, one of his companions proceeded to his assistance. While one of them hauled upon the line and held it in his hands, the other set his shoulder against the extremity of the harpoon, and though it was without a stock, he contrived to strike it again into the fish more effectually than it was at first; the fish was in motion before they finished. After they got off its back, it advanced a considerable distance, breaking the ice all the way, and survived this uncommon treatment ten or fifteen minutes. This admirable act was an essential benefit. The fish fortunately sank spontaneously after being killed, on which it was hauled out to the edge of the ice by the line, and secured without further trouble. It proved a stout whale, and an acceptable prize."

If whalers could choose their own ground for fishing, many of them would probably prefer a position among open, navigable drift-ice, where the force of the sea is broken, and heavy swells prevented from affecting the vessel. This kind of fishing is called *open pack-fishing*, and is held to be advantageous for the capture of whales. Where the ice is crowded, however, and affords room for boats to pass through it, the chase becomes difficult and hazardous. Still, as the fishers must take the seas as they find them, fishing is often conducted in this situation of things. Success depends on the boats being spread widely, on the incessant watchfulness of the harpooners, and on their occasionally taking the benefit of a mass of ice, from the elevation of which the fish may sometimes be seen blowing in the interspaces. Celerity in rowing, and the highest degree of activity in all the proceedings, can alone give a chance of success in open pack-fishing.

Whalers must also be prepared to meet and combat all the difficulties attending the prosecution of their employment in *storms* and *fogs*. When a gale occurs during a chase, and after a fish has been harpooned, fishers are often obliged to cut the lines and let the prize go. Sometimes this takes place even when the fish is killed, and it is worthy of remark that a whale so abandoned becomes the lawful prize of the ship that first gets hold of it, though this may occur in the face of the original captors. But it is common enough for whalers during a storm to keep a fish secured by a hawser to the ship, and to retain it thus till the return of moderate weather. Few whalers venture to commence fishing while a storm exists, and it is a matter of equal difficulty and uncertainty to fish during a fog. The mist on such occasions is so thick that it is impossible to see objects, however large, above 100 or 150 yards off; and when a boat is led away by the chase to such a distance that a bell or a horn cannot be heard, its situation becomes very perilous. The only rule in these cases is to make every possible exertion for the rapid despatch of the whale, and if this be impracticable, to leave it.

Captain Scoresby gives an interesting account of the plan pursued by himself in *bay-ice fishing*. Being locked up with his ship in a field of thin bay-ice that was unfit in many places to bear a man's weight, he placed a number of boats in various openings which existed a short way from the vessel. When a whale came to these apertures to breathe, it was struck, and the men endeavoured to drown it, when it darted below the ice, by keeping a steady strain on the line. If this plan failed, Captain Scoresby planted his feet in a pair of ice-shoes, formed simply of thin deal-boards, to the centre of which the feet were tied, and then he boldly crossed the thin ice to the point where, by the direction of the line, he knew the fish would rise. In three instances he was fortunate enough to see the whale through the ice and to plunge his harpoon into its body, after which he used his lance, till in each case the fish was killed. The fish actually rose once or twice beneath the very spot where he stood, and broke through the ice with its head. He was lucky enough to escape all injury, however, though the ice in most places could not have borne the weight of a boy standing in common shoes. This kind of bay-ice fishing, though successful, will be regarded by most persons as somewhat daring and hazardous.

Of course, in all these various ways of fishing, circumstances now and then occur which set at defiance all ordinary rules. The whale, for example, when struck near the margin of a small floe, is usually held in restraint, and killed by the use of the lines from at most *two* boats. On the 25th of June, 1812, however, a harpooner belonging to the Resolution of Whitby, struck a fish close by a small floe, under which it disappeared. Assistance was quickly given, and a second boat's lines were attached to those of the fast-boat (or boat attached to the whale), after which it was left by the other boatmen, who spread out for a second stroke. But in a short time distress signals were made by the fast-boat, and before aid could be afforded, the men were seen to throw themselves into the sea. Immediately afterwards the bow of the boat sank in the water, the stern rose in the air, and the whole majestically disappeared. An accidental circumstance had prevented the cutting of the lines. The men were picked up, and a search commenced for the whale. It was ere long seen, and no less than three harpoons, each having a boat and its lines attached to it, were buried in the animal's body. Every one imagined that all was now secure beyond risk. Not so, however; the whale pushed impetuously forward, and soon the men of one boat found their lines run out, and were obliged to cut them. The harpoon of another boat was drawn out from the body of the fish, and now one boat only remained in connection with the animal. The creature still darted forward with the velocity of light, and not only pulled out the lines of the remaining boat, but made it fly along like an arrow. At length the line snapt, and the whale went off free, with a boat and 6720 yards, or about 3⅘ English miles, of line behind it. The obstruction to its progress, caused by the sunken boat, and by the lines also, which weighed 35 cwt., must have been immense, yet the whale pushed on with unabated vigour. It was pursued, and about *ten miles* from the spot where it was first struck, it was again struck by four harpoons, and yielded at length to its fate. Calculating the additional lines used at the death, this fish ran out nearly six miles of lines. The boat and 31,200 yards of line were lost. After all, the whale proved to be one but of the second or third size. But the largest are by no means the most difficult, in general, to kill.

The harpoon does not always produce a fatal loss of blood, even after the lapse of a considerable period. An Aberdeen whaler struck a fish, which got off in consequence of a storm occurring, and rendering it necessary to cut the lines. Next day the same fish was struck, and again got off; and on the third day the identical whale was a third time harpooned, and captured. A Leith whaler, in 1817, pursued a fish which survived forty hours after being first harpooned, although in the interval four other harpoons were launched into its body. This animal continued, through the greater part of the long period mentioned, to fly at great speed, dragging six boats through the water. Finding that nothing done by the boatmen could arrest its course, the lines were taken on board the ship, which had followed the boats. Strange to say, the strength of the creature was so great, even after its wounds, and its long and most exhausting run, that it dragged the ship in the teeth of a brisk wind for an hour and a half, at the rate of two knots an hour, though the sails were arranged so as to make every possible resistance, and to the best advantage. The whale proved to be of a size proportioned to the immense strength which it displayed.

Whales on being struck are sometimes able to eject the harpoon, by a sudden swelling out or heaving of the body. A curious case is on record, where a whale disengaged the harpoon in this manner, and caused it to spin high up in the air. But the poor fish did not save itself. Having got rid of the weapon, it turned suddenly over upon its back, and the falling harpoon entered the under part of its body, and sank so deeply into it as to cause its speedy capture.

Having killed a fish, the first operation performed by the sailors is to pierce two holes in its tail and to lash it to a boat. The fins are also roped to the body, and then the whole of the boats, joined in a line, unite their efforts in towing it to the ship. Here it is placed with its side parallel to that of the vessel, and is arranged for the operation of *flensing*. In consequence of its enormous weight, it cannot be raised altogether out of the water. Only about one-fifth part of its body is brought above the surface, and here it is firmly secured by ropes, with the abdomen uppermost. Men, armed with spurs on their feet to prevent slipping, then leap on the body, and begin to divide the fat and skin into separate pieces or compartments, by means of blubber knives or spades. A hook called a spec-tackle, which hangs from a capstern or winch on deck, is attached to each piece of fat, and draws it upwards as it is flayed off. Pieces weighing from half a ton to a ton are taken up at a time in this manner, and are cut on deck into smaller pieces, which are then cast down into the main hatches and stowed away. On the blubber being removed from one part, the whale is turned partially round by the ropes and windlass, and this cutting and turning are repeated until the whalebone and blubber have all been removed. The stripped carcass is then allowed to sink. Sharks and filmars often help themselves to the refuse blubber, but they not unfrequently pay for their audacity with their lives. A British whaling-crew will usually flense a common-sized whale in four or five hours. The operation is followed, when the flens-gut, or blubber-box, under hatches is filled with blubber, by another process which is termed *making-off*, from its being the finishing process. The blubber is brought on deck, separated from the skin and fibrous or muscular structure, cut into pieces of a few inches in size, and finally introduced into casks, through the bung-hole.

The instinctive fear of being enclosed in the ice during the cold seasons, and of finding no apertures for respiration, appears to be the reason for the descent of the whales into the open and more southerly seas. In the month of July, when the ice becomes broken, the cetaceous tribes again enter the Arctic waters, and are unassailable by fishers. The whalers, with a lesser or greater amount of cargo, or perhaps, if they have been very unlucky, with what is emphatically called a *clean* ship, are then obliged to return home to their respective ports, where the blubber is separated from its refuse and converted into oil by boiling, and the whalebone scraped, cleansed, and dried for sale. These operations require no special description, the names of the processes sufficiently indicating their character. The greatest cargo ever borne to the shores of Britain by a whaling vessel, was that brought from Spitzbergen by Captain Souter of the Resolution of Peterhead, in the year 1814. It consisted of 44 whales, which produced 299 tons of oil, value, reckoned at £32 per ton, the average price of that year, £9,568; and when to this sum is added the value of the whalebone, and the bounty, the freight would appear to have reached £11,000. When oil rose to £60 per ton, smaller cargoes, in several instances, amounted to an equal value. In 1813, the Scoresbys, father and son, respectively brought home cargoes which produced the sum of £11,000. Captain Scoresby, senior, in the course of 28 voyages, captured the immense number of 498 whales, the oil and whalebone of which amounted in value to above £150,000 But few single cargoes produce such sums, it must be allowed, as £11,000, and few individual men have such a career of activity to look back upon as Captain Scoresby.

PRESENT CONDITION OF THE WHALE-FISHERY.

In the years 1814, 1815, 1816, and 1817, 392 vessels sailed from England, and 194 from Scotland, for the whale-fishery. Of these, the port of Hull, which has long taken the precedence in this trade, sent out not less than 229 vessels, while London, Aberdeen, Leith, and Whitby, the next in proportion, sent out respectively 77, 55, 40, and 39. The total number of whales killed by British ships in the same years, was 5030. They yielded 54,508 tons of oil, and 2697 tons of whalebone. The average to each ship was 8.6 whales, 93 tons of oil and 4.6 tons of whalebone. By comparison with the following more recent years, the progressive condition of the trade will be seen. In 1820, 140 vessels were sent from Great Britain to the fishery. In 1821, when the number was greatest, there were 142 ships, of 44,864 tons, and with 6074 men engaged in the service; in 1824, 120 ships, of 35,194 tons, and 4867 men. In 1829, a great falling off had taken place, the ships numbering only 89, of 28,812 tons. During the years consequent upon that period, a still greater decline took place in the number of employed whale-ships. In 1832, there were only 81 engaged in the trade. In 1837, the number was reduced to 59. In 1838, Aberdeen, which, twenty years before, had sent out 55 ships, sent only five or six from its port. The decline has been similar within the last two years in other quarters of the island. This unfortunate change—for every declension in commerce, generally speaking, must be held a misfortune—merits some attention.

The decline of the British northern whale-fisheries appears to be owing to three principal causes. In the first place, the introduction of gas into universal use of late years in the Island, has materially lessened the demand for whale-oil, and the necessity for its supply. In the second place, the former fishing-fields around Spitzbergen have been greatly exhausted, and whalers have been under the necessity of venturing into more perilous latitudes for the objects of their pursuit. The third cause is in a measure a corollary of the preceding one. In consequence of entering the broken ice of Davis' Straits and other similar seas, a loss of life and property has taken place of late years, so extensive and alarming, that mercantile men have become unwilling to risk their capital, and seamen their existence, in such ill-fated expeditions. The great increase of danger is shown by the fate of the fishing-vessels during the last few years, as compared with the results of former ones. Of 586 ships sent out in 1814, 15, 16, 17, only 8 were lost. In 1819, out of 63 ships sent to *Davis' Straits*, 10 were lost; in 1821, out of 79, 11 were lost; in 1822, out of 60, 7 were lost; and in 1830, not less than 18 out of 87 were lost. The mischief has progressively increased. In 1837, the Davis' Straits whale-fleet lost several of its number, and many vessels were locked up in the ice through the winter, to the loss of the greater part of their crews, and at the cost of almost unparalleled sufferings to the petty remnants of them which escaped with life. And while the perils of the trade have thus largely increased, the profits, owing to the greater difficulty of finding whales, have suffered a corresponding decrease. In 1830, 24 out of the 87 vessels sent out to Davis' Straits, returned *clean*. Not a fish was taken by them. In the most of the years that have followed, the majority of the whalers have returned with comparatively paltry freights, and many without a pound of blubber.

The declension, and apparent approaching extinction of the northern whale-fishing, which has so long been an important pillar of our commercial greatness, could not but excite uneasiness and regret in the minds of many persons who have opportunities of making observations on the subject. Accordingly, we find that various plans have been proposed for the revival of this branch of the trade of Britain. Although we conceive that the substitution of gas for oil is one important cause of the decreased ardour for whaling enterprises, and a cause, besides, neither to be deplored nor capable of remedy, and although it also appears to us that the exhaustion of the old whaling fields is another source of the evils complained of, and one only to be affected by time, yet there might, we believe, be plans adopted which would help at once to restore the lucrative character of the whale-fishery, and to alleviate or entirely prevent the misfortunes which have attended its prosecution of late years. The most rational scheme which we have yet chanced to see proposed, is contained in the following extract from the Aberdeen Herald:—

"The plan is simply to establish a settlement of active and enterprising whale fishers on some favourable spot in the vicinity of Davis' Straits, and to employ only so many large vessels as may be necessary to carry out provisions to the colony, and fetch home the oil, blubber, whalebone, and other articles which may be thought worth importing. From all the information that we at present possess, we should think that the most eligible position for the settlement would be at Pond's Bay, or somewhere between that and Lancaster Sound, on the west coast of Baffin's Bay. There are some situations on the north-east shore (Prince Regent's Bay, for example) that might be found suitable; but of late years, the fishers assert that the whales have been most plentiful towards the other shore."

The practicability of carrying such a plan into effect, and the advantages likely to result from it, are the only two points that fall to be noticed here. The testimony of recent travellers, as well as of seamen who have been compelled to winter in the high latitudes, goes to prove the practicability of establishing and maintaining an efficient colony, even as far north as the place we have pointed out. Captain Ross's remark, that 'the temperature of sensation is more relative than is imagined, the body soon contriving to find a new and much lower scale of comfortable or endurable heat,' has been completely verified by all who have visited the Polar regions. The attention now paid to the quality of ship provisions, and the improved methods of preserving them, have not only put a stop to the inroads of scurvy, but have tended materially to increase the comfort of those who choose to lengthen their stay in cold countries. In East Greenland there are several Danish settlements. Holsteinberg, within the Arctic circle, is a small town, with a church and a clergyman; and still higher up, at Lievely, in Disco Island, the chief Danish governor resides. With an ample store of food and clothing, and materials for constructing houses, there can be no doubt that a colony of hardy whalers would contrive to pass the winter agreeably and in comfort. Nor would they be dependent altogether on the supplies carried with them, or procured from the mother country. The musk ox, the reindeer, the white bear, the hare, and a number of other quadrupeds, would afford them at once sport and a valuable addition to their means of sustenance. Birds, too, and fresh fish of various kinds, would not be wanting to give variety to their repasts; while lobsters, mussels, and other shell-fish, could be had as abundantly as at home. To avoid all risks of famine, it would be proper to have always in the settlement provisions for two years; although it could hardly ever happen that the settlers would be so completely shut up as to be inaccessible during the whole of the summer months.

The advantages of having a numerous body of fishers on the spot, instead of sending them out annually, can easily be made apparent. 1st, There would be a saving of outlaid capital. For some time past, the ships sent from Great Britain to Davis' Straits may have averaged 100 each year; and we believe we speak within limits when we assert, that the oil and whalebone which they have brought home might easily have been carried by one-fifth of the number. Suppose a permanent colony of 4000 fishers were established at Davis' Straits, and 20 of the 100 vessels employed in the carrying trade, the other 80 vessels might at once be withdrawn, making a saving of outlaid capital to the extent of at least £320,000. In this calculation, we take merely the cost of the ships, as the boats, harpoons, casks, and other apparatus, and the provisions included in the outfit, would all be required in the settlement. 2d, The fishery would have a better chance of being successful. At present a sometimes happens that vessels cannot get into the proper fishing station till the season is so far advanced that they are under the necessity of returning home without lowering their boats, and this difficulty arises not from the want of open sea within the Straits, but from accumulations of ice drifted from the north extremity of Baffin's Bay to the Labrador coast. A settlement of fishers wintering inside, would in most cases make a good fishing before the British ships had penetrated far up the straits."

SPERM-WHALE FISHERY.

It is now our purpose to devote some space to the proceedings in the sperm-whale fishery, a branch of maritime enterprise only inferior in importance to the northern fishery. There is no occasion for describing the vessels or apparatus employed, these being similar in every essential point to those already described. Timid as it is, the cachalot often causes such peril by its convulsive efforts to escape, as render its capture not less exciting than that of the mysticetus. Young bulls, in particular, frequently give a world of trouble to their pursuers, and sometimes turn upon them with unbounded fury, intent on mischief, and effecting it both with teeth and tail. The South Sea whalers, like their northern brethren, have their particular cries and watchwords in the prosecution of the chase. When a whale is seen by the man at the look-out, the cry bursts from his lips, "There she spouts!" Instantly the captain starts on deck, with the responsive exclamation, "Where away?" An answer is scarcely needed, for all on board soon perceive the huge animal, blowing regularly at intervals of ten seconds, if within a moderate distance. For a half minute the men stand gazing, and at every spout the spirited cry breaks forth from them simultaneously, "There again!" But idleness is not long the order of the day. The boats are lowered, the men rush into them, and soon are pulling towards the monster, every boat eager to reach him first. As they approach, they see him spouting more slowly. "Ah, he is going down!—he will be lost!"—is the exclamation. But one boat nears him. "One more spout (says Mr. Beale's animated narrative) is seen slowly curling forth—it is his last for this rising—his back is bent, his enormous tail is expected to appear every instant, but the boat shoots rapidly alongside of the gigantic creature. 'Peak your oars!' exclaims the mate, and directly they are flourished in the air; the glistening harpoon is seen above the head of the harpooner; in an instant it is darted with unerring force and aim, and is buried deeply in the side of the huge animal. 'It is socket up;' that is, it is buried in his flesh up to the socket, which admits the handle of the harpoon. A cheer from those in the boats, and from the seamen on board, reverberates along the still deep at the same moment." Now the pained whale plunges violently, and lashes the sea with his tail, so that the noise can be hea l for miles. Suddenly he throws up his tail in the air, and disappears. Out fly the lines, and those of another boat are attached. Eight hundred fathoms are run out, and at last the whale re-appears at the surface, somewhere in the vicinity, spouting hurriedly and agitatedly. By coiling their lines, the boatmen run rapidly up to him, and then the headsman buries his lance in the vitals of the trembling monster. "Stern all!" is at the same moment vociferated, and the boat backs away from the side of the whale. He now becomes infuriated, and rushes at the boats, often upsetting them. The lance is again driven into his sides; his motions become wild and irregular; and after what is called the mortal flurry, he turns over on his side, suffocated most commonly by the internal flux of blood from his wounds.

This is the general routine of the sperm-whale capture, but accidents occur to vary the aspect of the affair. The following whale-chase adventures are from the work of Mr. Beale:—

"On the morning of the 18th of June, 1832, while we were still fishing in the 'off-shore ground' of Japan, we fell in with an immense sperm whale, which happened to be just the sort of one we required to complete our cargo. Three boats were immediately lowered to give him chase; but the whale, from some cause or other, appeared wild in its actions long before it had seen any of our boats, although it might have been chased the day before by some other ship. It was greatly different in its actions to most other large whales, because it never went steadily upon one course. If he 'peaked his flukes,' or went down, going to the southward, we expected he would continue that course under water, but when he again rose, perhaps he was two or three miles away from the boats to the northward; in this sort of manner he dodged us about till near four P. M., at which time the men were dreadfully exhausted from their exertions in the chase, which had been conducted under a broiling sun, with the thermometer standing in the shade at 93°. About half-past four, however, Captain Swain contrived, by the most subtle management and great physical exertions, to get near the monster, when he immediately struck him with the harpoon with his own hands; and before he had time to recover from the blow, he managed, with his usual dexterity, to give him two fatal wounds with the lance, which caused the blood to flow from the blow-hole in abundance. The whale, after the last lance, immediately descended below the surface, and the captain felt certain that he was going to 'sound;' but in this he was much mistaken, for a few minutes after his descent, he again rose to the surface with great velocity, and, striking the boat with the front part of his head, threw it high into the air, with the men and every thing contained therein, fracturing it to atoms, and scattering its crew widely about. While the men were endeavouring to save themselves from drowning by clinging to their oars and pieces of the wreck of the boat, the enormous animal was seen swimming round and round them, appearing as if meditating an attack with his flukes, which, if he had thought proper to do, in return for the grievous wounds that he had himself received, a few strokes of his ponderous tail would soon have destroyed his enemies; but this was not attempted. They had now nothing to hope for but the arrival of the other boats to relieve them from their dangerous situation, rendered more so by the appearance of several large sharks, attracted by the blood which flowed from the whale, which were sometimes only a few feet from them; and also from the inability of one of the boat's crew to swim, by which three or four of his mates were much exhausted in their efforts to save him, which they succeeded in doing after having lashed two or three oars across the stern of the boat, which happened to be not much fractured, on which they placed their helpless fellow-adventurer. After they had remained in the water about three quarters of an hour, assisting them selves by clinging to pieces of the wreck, one of the other boats arrived and took them in, no doubt greatly to their relief and satisfaction. But although these brave whale-fishermen had been so defeated, they were not subdued: the moment they entered the boat which took them from the ocean, their immediate determination was for another attack upon the immense creature, which remained close by, while the other boat, which was pulling towards them with all the strength of its rowers, would still be a quarter of an hour before it could arrive.

"Captain Swain, with twelve men in one boat, therefore made another attack upon the whale with the lance, which caused it to throw up blood from the blow-hole in increased quantities. We, who were on board the ship, and had observed, from a great distance, by means of the telescope, the whole of the occurrence, were employed in beating the ship towards them, but they were far to windward, and the wind being rat er light, we had even our royal-sails set. Soon after the arrival of the third boat, the whale went into its flurry and soon died when, to the dismay of the boats' crews, who had endured so much danger and hardship in its capture, it sank, and never rose again—an occurrence which is not very unfrequent, owing of course to the greater specific gravity of the individual, perhaps from a greater development of bony and muscular structures. Such were the adventures of that day, in the evening of which the crews returned to the ship, worn out and dispirited, having lost a favourite boat with the whole of her instruments, besides the last whale wanted to complete the cargo, and worth at least £500.

"At daybreak, one fine morning in August, as our first mate was going aloft to look out for whales, he discovered no less than three ships within a mile of us; but they were situated in various directions. We soon discovered them to be whalers, who like ourselves were cruising after the spermaceti whale, and therefore their appearance only had the effect of redoubling our vigilance in the 'look-out,' so that we might, if possible, be the first to obtain the best chance if one of those creatures 'hove in sight.' And it was not long before a very large whale made his appearance right in among the ships. The water was smooth at the time, for we had but a light air of wind stirring, so that our boats were instantly lowered without the loss of time of bringing the 'ship to.' But although we managed matters as quietly and secretly as possible, we found, the moment our boats cleared the ship's side, that all the others had been as vigilant as ourselves, and had also lowered their boats after the whale. The whole of them immediately began the chase—nine boats in all, being three from each ship. They all exerted themselves to their utmost, and, as we expected, in vain; for before any of the boats had got even near him, the enormous animal lifted his widely expanded flukes, and descended perpendicularly into the depths of the ocean to feed. Those in the boat, however, having noticed his course, proceeded onwards, thinking the whale would continue to pursue the same direction under water; but as he was going slowly at the time he was up, they did not proceed more than a mile from the place at which he descended, before they separated about a hundred yards from each other, and then 'peaking' their oars, all the men in each boat stood up, looking in different directions, so as to catch the first appearance of the spout when the whale again rose to breathe: when, an hour after his descent had expired, the excitement among us who were on board the ship became wound up to its highest pitch. The captain, who had remained on board, ascended to the fore-topgallant-yard to watch the manœuvres of the boats, and for the purpose of the better ordering the signals to them, or working of the ship. All those who were down after the whale appeared as feverish with anxiety as ourselves, for every now and then they were to be seen shifting their positions a little, thinking to do so with advantage; then they would cease rowing, and stand upon the seats of the boats, and look all around over the smooth surface of the ocean with ardent gaze. But one hour and ten minutes expired before the monster of the deep thought proper to break cover; and when he did, then a rattling chase commenced with the whole of the boats, and they really flew along in fine style, some of them actually appearing to be lifted quite on the surface of the water, from the great power of the rowers; and we had the satisfaction of observing, that our boats were quite equal to the others in the speed with which they were propelled. But it was again a useless task, as the old 'schoolmaster' had outwitted those in the boats, by having gone—while under water—much farther than any of his pursuers had anticipated, and they again had the mortification of witnessing the turning of his flukes as he once more descended into the depths of his vast domain. We now knew to a minute the time that he would remain below, while the people in the boats continued to row slowly onwards the whole time. A fine breeze now sprang up, so that we were enabled to keep company with the boats, keeping a little to windward of them, as the whale was going 'on a wind,' as a seaman would say, meaning that it was blowing across him.

"When the hour and ten minutes had again nearly passed, the nine boats were nearly abreast of each other, and not much separated, so that the success of first striking the whale depended very much upon the swiftest boat, especially if the whale came up ahead. We had now all the boats on our 'lee-beam,' while the ships were all astern of us, the most distant not being more than half a mile, so that we enjoyed an excellent view of this most exciting and animated scene. True to his time, the leviathan at length arose right ahead of the boats, and at not more than a quarter of a mile distant from them. The excitement among the crews of the various boats when they saw his first spout was tremendous; they did not shout, but we could hear an agitated murmur from their united voices reverberating along the surface of the deep. They flew over the limpid waves at a rapid rate; the mates of the various boats cheered their respective crews by various urgent exclamations, 'Swing on your oars, my boys, for the honour of the Henrietta,' cried one; 'Spring away, hearties,' shouted another, and yet scarcely able to breathe from anxiety and exertion. 'It's our fish,' vociferated a third, as he passed the rest of his opponents but a trifling distance. 'Lay on, my boys, cried young Clark, our first mate, as he steered the boat with one hand, and pressed down the after oar with the other. 'She'll be ours yet; let's have a strong pull, a long pull, and a pull altogether,' he exclaimed, as he panted from his exertions at the after oar, which soon brought up his boat quite abreast of the foremost.

"But the giant of the ocean, who was only a short distance before them, now appeared rather 'gallied,' or frightened, having probably seen or heard the boats; and as he puffed up his spout to a great height, and reared his enormous head, he increased his speed, and went along quite as fast as the boats, but for only two or three minutes, when he appeared to get perfectly quiet again, while the boats gained rapidly upon him, and were soon close in his 'wake.' 'Stand up,' cried young Clark to the harpooner, who is also the bow-oarsman, while the same order was instantly given by his opponent, whose boat was abreast of our mate's, with the rest close to their sterns. The orders were instantly obeyed, for in a second of time both boat-steerers stood in the bows of their respective boats, with their harpoons held above their heads, ready for the dart; but they both panted to be a few yards nearer to the whale, to do so with success. The monster ploughed through the main quickly, but the boats gained upon him every moment, when the agitation of all parties became intense, and a general cry of 'dart! dart!' broke from the hindmost boats, who each urged their friends, fearful of delay. The uproar became excessive; and when the tumult of voices, and the working and splashing of the oars, rolled along the surface of the deep, both the harpooners darted their weapons together, which, if they had both struck the whale, would have originated a contention between them regarding their claims. But, as it happened, neither of them had that good fortune; for at the moment of their darting the harpoons, the whale descended like a shot, and avoided their infliction, leaving nothing but a white-and-green-looking vortex in the disturbed blue ocean, to mark the spot where his monstrous form so lately floated. A general huzza burst from the sternmost boats when they saw the issue of this chase, thinking now that another chance awaited them on the next rising of the whale, and they soon began to separate themselves a little, and to row onwards again in the course which they thought he had taken. Our captain, feeling irritated at the ill success of the mate, now ordered his own boat to be lowered, intending to make one in the chase himself; but just as he had parted from the ship, going down a little to leeward, a tremendous shout arose from the people in our own boats, joined with a loud murmuring from the rest of the boats' crews; for the whale, not having had all its 'spoutings out,' had now risen again to finish them, and was coming to windward at a quick rate, right towards our ship. The captain saw his favourable situation in a moment, and, passing quickly to the bows of the boat, he stood to waylay him as he came careering along, throwing his enormous head completely out of the water, for he was now quite 'gallied.' He soon came, and caught a sight of the boat just as he got within dart; the vast animal rolled itself over in an agony of fear, to alter its course; but it was too late; the harpoon was hurled with excellent aim, and was plunged deeply into his side near the fin.

"As the immense creature almost flew out of the water from the blow, throwing tons of spray high into the air, showing that he was 'fast,' a triumphant cheering arose from those in our own boats, as well as from those in the ship, accompanied by exclamations loud and deep, and not of the most favourable kind to us, from all the rest. But onwards they all came, and soon cheerfully rendered assistance to complete its destruction; but which was not done, however, without considerable difficulty, the whale continuing to descend the moment either of the boats got nearly within dart of him. But after an hour's exertion in this way, six out of the ten boats which were now engaged, got fast to him by their harpoons, but not one of them could get near enough to give him a fatal lance; he towed them all in various directions for some time, taking care to descend below the surface the moment a boat drew up over his flukes, or otherwise drew near, which rendered it almost impossible to strike him in the body, even when the lance was darted, although the after part of his 'small' was perforated in a hundred places: from these wounds the blood gushed in considerable quantities, and as the poor animal moved along, towing the boats, he left a long ensanguined stain in the ocean. At last, becoming weak from his numerous and deep wounds, he became less capable of avoiding his foes, which gave an opportunity for one of them to pierce him to the life. Dreadful was that moment the acute pain which the leviathan experienced, and which roused the dormant energies of his gigantic frame. As the life's blood gurgled thick through the nostrils, the immense creature went into his 'flurry' with excessive fury; the boats were speedily sterned-off, while he beat the water in his dying convulsions with a force that appeared to shake the firm foundation of the ocean!"

CONCLUDING ANECDOTES AND OBSERVATIONS.

Mr. Beale continues to remark, in his narrative, that "numberless stories are told of fighting whales, many of which, however, are probably much exaggerated accounts of the real occurrences. A large whale, called 'Timor Jack,' is the hero of many strange stories, such as of his destroying every boat which was sent out against him, until a contrivance was made by lashing a barrel to the end of the harpoon with which he was struck, and whilst his attention was directed and divided among several boats, means were found of giving him his death-wound.

"In the year 1804, the ship 'Adonis,' being in company with several others, struck a large whale off the coast of New Zealand, which 'stove' or destroyed nine boats before breakfast, and the chase consequently was necessarily given up. After destroying boats belonging to many ships, this whale was at last captured, and many harpoons of the various ships that had from time to time been sent out against him were found sticking in his body. This whale was called 'New Zealand Tom,' and the tradition is carefully preserved by whalers.

"Accidents of the most fearful nature have frequently occurred in this hazardous pursuit, which to enumerate would fill the space of volumes; for not only boats, but sometimes even ships, have been destroyed by these powerful creatures. It is a well authenticated fact, that an American whale-ship called the 'Essex' was destroyed in the South Pacific Ocean by an enormous sperm whale. While the greater part of the crew were away in the boats pursuing whales, the few people remaining on board saw an immense sperm whale come up close to the ship, and when very near, he appeared to go down for the purpose of avoiding the vessel, and in doing so he struck his body against some part of the keel, which was broken off by the force of the blow, and floated to the surface; the whale was then observed to rise a short distance from the ship, and come with apparently great fury towards it, striking against one of the bows with his head, and completely 'staving' it in. The ship of course immediately filled, and fell over on her side, in which dreadful position the poor fellows in the boats soon espied their only home, being distant from the nearest land many hundred miles; on returning to the wreck, they found the few who had been left on board hastily congregated in a remaining whale-boat, into which they had scarcely time to take refuge before the vessel capsized. They with much difficulty obtained a scanty supply of provisions from the wreck, their only support on the long and dreary passage before them to the coast of Peru, to which they endeavoured to make the best of their way. One boat was fortunately found by a vessel not far from the coast; in it were the only survivors of the unfortunate crew, three in number, the remainder having perished under unheard-of suffering and privation. These three men were in a state of stupefaction, allowing their boat to drift about where the winds and waves listed; one of these survivors was the master; by kind and careful attention on the part of their deliverers, they were eventually rescued from the jaws of death to relate the melancholy tale."

Not being attended with the dangers to which a northern climate exposes the hunters of the mysticetus, the sperm-whalers of Britain have greatly increased in numbers of late years, and at this day the fishing is prosecuted with great success. As in the case of the Greenland fishery, bounties were given up to 1821, when the trade was fairly left to private enterprise. In 1791, the sperm oil imported into Britain amounted to 1258 tons; in 1827, 5552 tons were imported; and in 1836, the amount was 7001 tons. One good whale will yield forty barrels of oil, and ten barrels of spermaceti are frequently taken from one head. About ten large barrels make a ton. Both sperm-oil and spermaceti bear a high price in the market, and are of great utility in various respects. There is little chance of a decline in the sperm-whale branch of our maritime traffic, not only because the fishing latitudes are comparatively free from dangers, but because the invention of gas does not trench on the use of sperm-oil as it did on that of the Greenland oil, and because spermaceti and sperm-oil are likely to be more and more employed as the country progresses in civilization.

FOREIGN WHALE-FISHERIES.

The whale-fisheries of other civilized nations have undergone as great vicissitudes as those of Britain. About the year 1680, the Dutch sent out not less than 260 ships, manned by 14,000 men, to the northern fishery. In 1828, only one whale-ship sailed from Holland! France has never prosecuted this branch of commerce with much activity or success, yet the little that was once done in this way has become still less. In 1790, 40 French ships were employed in the Greenland seas. The revolution put a stop to the fishing, and though of late years the government has made an attempt to revive it, very little success has resulted.

The people of the United States have been more active and successful in whale-fishing than almost any other nation in recent days. While dependent colonists, they embarked in it with great spirit. From 1771 to 1775, Massachusetts employed annually 183 vessels, of 13,820 tons, in the northern fishery; and 121 vessels, of 14,026 tons, in the fisheries of the south. They were the first to prosecute the trade in the southern Atlantic, on the coasts of Africa and Brazil; and they, too, led the way into the Pacific seas:—"Look at the manner," says Burke (1774), "in which the New England people carry on the whale-fishery. While we follow them among the tumbling mountains of ice, and behold them penetrating into the deepest frozen recesses of Hudson's Bay and Davis' Straits; while we are looking for them beneath the Arctic circle, we hear that they have pierced into the opposite region of polar cold; that they are at the antipodes, and engaged under the frozen serpent of the south. Falkland Island, which seems too remote and too romantic an object for the grasp of national ambition, is but a stage and resting-place for their victorious industry. Nor is the equinoctial heat more discouraging to them than the accumulated winter of both the poles. We learn that, while some of them draw the line or strike the harpoon on the coast of Africa, others run the longitude, and pursue their gigantic game along the coast of Brazil." These are the seas that are still vexed by the American fisheries, which have been pushed, however, into higher southern latitudes than had ever before been visited, and are carried on from the shores of Japan to the icy rocks of New South Shetland. They have been principally carried on from Nantucket and New Bedford, and have proved very lucrative. At present they are also prosecuted with great success from several other places. One class of ships is fitted out for the Pacific in pursuit of the spermaceti whale. These are from 300 to 500 tons burden, carrying from 25 to 30 men, and are absent about 30 to 36 months. Their number is about 170, of about 62,000 tons, and carrying nearly 5000 men. Another class sail to the coasts of Africa and Brazil, in search of the common or right whale. They average about 325 tons each, carry about 25 men, and are absent 8 to 12 months. The whole amount of tonnage of this class is about 40,000; number of seamen engaged, 3000. The quantity of sperm oil brought home in 1815, was 3944 barrels; in 1820, 34,700; in 1825, 62,240; and, in 1830, 106,800. The quantity of whale or black oil brought in in 1830, was about 115,000 barrels; of whalebone, about 120,000 pounds. The sperm oil is chiefly used at home; and 2,500,000 pounds of sperm candles are made, employing about 30 manufactories. The whale oil and whalebone are chiefly exported to Europe. From the report of the secretary of the treasury, May 4, 1832, it appears that for the year ending September 30, 1831, there were exported whale and other fish oil to the value of 554,440 dollars; spermaceti oil to the value of 53,526 dollars; whalebone to the value of 133,842 dollars; and spermaceti candles to the value of 217,830 dollars.

Of the extent of the sufferings sometimes experienced by the whalers, a single example may be given. The Dee, an Aberdeen whaler, sailed for Davis' Straits in April, 1836, and, after many difficulties, was ultimately fast locked up in the ice, in October of the same year, near the mouth of Baffin's Bay. "From this date, the peculiar sufferings of the crew of the Dee, which numbered thirty-three persons, may be said to have commenced. Their allowance remained the same, but, from the scarcity of fuel, their beds became wretchedly damp. At first, to preserve the health of the men, and to keep their shivering bodies in heat, the most praiseworthy precautions were taken. A variety of exercise was allotted to them, such as the unbending of the sails, unshipping the rudder, and other toils, of no utility now unhappily, to the ship. But the crew of the Dee had not long to resort to unprofitable labours to maintain the vital warmth of their frames. Notwithstanding the increasing hardness of the frost, the ice still remained in a loose state, and a fatal crush on the ship became the subject of continual alarm. On the 16th, the latitude was 72° 50′, wind strong, and large icebergs floating past. The ice began to press hard, and on the night of the 16th, the vessel was crushed up until it hung by the quarter, the ice squeezing all along as high as the guard-boards. At daylight, all hands were called up to get out the provisions. At 8 P. M., the wind fell off, but the ship still hung by the quarter. The ice, however, was at rest till 11 P. M., when there was another dreadful crush, which passed off with less harm than could have been anticipated. On the 18th, the ice gave way in several places, and opened up so far that a warp had to be got out to secure the Dee. The other vessels, meanwhile, lay comparatively undisturbed. On the 20th, the ice closed again, with some severe squeezes, around the Dee. To strengthen the ship, its casks were placed in a peculiar way, and ten strong beams put in aft. This was done most seasonably, for shortly after two successive shocks took place, within half an hour of each other, of such tremendous severity, that the crew fled to the ice with their bags, chests, and every thing that could be lifted, under the impression that all was over with the timbers of the Dee. The sufferings of the night that followed were awful. Without fire, or shelter from the biting elements, the crew lay on the ice, gazing on their reeling and groaning vessel, while around them were extended vast fields of ice, studded with icebergs towering to the clouds, and threatening destruction to all that came in the way of their motions. Miserable as their position was, the crew could not go on board for two days, during which time the ship experienced crushes still more severe than formerly. On the 22d, the men went on board to take out the remaining provisions, but had again to fly for their lives.' The ice, however, fell quiet on the same night, and they again took back their provisions to the ship. On the 23d, a good many lanes opened up in the water—a most discouraging prospect, for this was always the time of greatest peril. Once more the crew took to the ice, and, by cutting the nearest parts into small pieces, cleared the vessel a few feet. The men then went for a few hours to rest, but were roused by another crush—the signal that their labours had been in vain. On the 24th, the ice broke up to a considerable extent, and the crew managed to heave the Dee backwards for a hundred yards, to a point where the ice seemed to be thinner. Great difficulties were experienced in conveying the chests and other articles left in the ship, but at length every thing was again on board."

Placed upon the most scanty allowance of food, and kept in such a state of continual alarm from the ice as compelled them to spend days and nights out of the ship, notwithstanding the dreadful severity of the weather, the crew of the Dee began to suffer greatly in their health before the end of the year. "Coughs, swelled limbs, and general debility, with small red discolorations on the skin, sharp pains and stiffness, were the common symptoms, and the cold and wet to which the seamen were exposed, laid the seeds of a worse disease which now began to show its fatal power. This disease was scurvy, and it was marked chiefly by an excruciating pain in the mouth, and swelled gums, rendering eating a torture. On the 18th of December, twenty-one men were affected with scurvy. To add to their distress, the ice again gave way, and threatened to crush the miserable vessel." Before the 1st of February, six deaths had taken place, and among the victims was the lamented commander, Captain Gamblin. The following passage describes the deplorable condition of the crew of the ice in February, 1837, at which time the ship was still frozen in:—

"Though the whalers were at this time three or four degrees farther south than at first, the frost was even more severe than ever. Every liquid was frozen; and while the snow was being melted to cook the victuals, the icicles were hanging on the water-cask, at the distance of six feet from the fire. The beds were covered with solid ice—the pillows frozen in every part but where the head lay, the very hairs of which were in some cases stiff with cold—and vermin of a more rapacious kind began to swarm among the blankets: creatures that ate their way through the skin, and fed on the raw flesh. And the men all the while bowed down with mortal sickness, and incapable of defending or cleaning themselves! So scarce was fuel besides, that it could only be used for the melting of ice and cooking of victuals. Can we wonder that ere the 12th of February, six others of the crew sank under their distresses? Between the 23d and 27th, six additional deaths took place, and, by the 7th of March, other five had followed their departed mates. So many deaths as these enabled the remainder to enjoy full allowance of provisions. Six hands only were able at this time to do duty, and the ship was in great danger of a fatal squeeze from the state of the ice, which was loose, and rapidly breaking up.

"Between the 11th and 15th, three more of the Dee's crew died, and they were the last that were buried below the ice, which was now broken up in all directions. On the 16th, after being locked up for five months and eight days, the Dee entered into open water." The ship had taken on board the crew of the Thomas, a whaler wrecked during the same winter in the ice, and all the survivors of both vessels now turned their eager eyes homewards. But, alas! many of them "were destined never to see their native shores. Fortunately, light and favourable breezes attended, in general, the passage of the ship homewards, otherwise not one man of the Dee's crew could ever have reached his home. The scurvy raged so fearfully on board, that, between the 16th of March and the 22d of April, twenty more of the unfortunate men had fallen victims to it. On the 25th a fishing-boat was hailed, and it was found that the Dee was then off the Butt of Lewis. The fishermen in the boat cruelly refused to give any assistance, suspecting a case of plague, it is supposed. The barque Washington of Dundee, Barnett master, bound for New York, bore down upon the miserable whaler on the evening of the same day, and inquired if any assistance was wanted. On being informed of the state of matters, and that only three hands of the Dee were able to go aloft, Mr. Barnett instantly sent four men on board, and followed in person, carrying with him wine, porter, and other provisions. He then took the Dee in tow, and enabled her to come to anchor, on the 27th of April, in the harbour of Stromness. Every attention was here paid to the survivors of the crew; and on the 5th of May, the owners having sent effective hands, the Dee was again put to sea and carried into the harbour of Aberdeen, after an absence of thirteen months and three days. A heart-rending scene took place on the quay, which was crowded with the relatives of the deceased seamen—with weeping widows, children, and parents. Forty-six men had died on board the Dee, nine of whom belonged to the Thomas of Dundee. Fourteen men only survived of the Dee's own compliment." From this picture of the sufferings of the crew of one vessel, who endured no more than others, in the same as well as preceding seasons, the reader may form an idea of the general hardships of the modern Arctic whale-fishing. It cannot but be felt as a blessing that the progress of lighting with coal-gas is likely soon to put an end to this dangerous traffic.

[WORKS ON THE WHALE-FISHERY.

Scoresby's "*Voyage to the Northern Whale Fishery,*" and his "*Arctic Regions,*" are considered the best authority on this subject. A book published anonymously some years since, entitled "Tales of an Arctic Voyager," contains exceedingly lively and graphic sketches of the scenes which present themselves to the whale fisher. A work entitled "Incidents of a Whaling Voyage," to which are added observations on the scenery, manners and customs, and Missionary Stations of the Sandwich and Society Islands, accompanied by numerous lithographic prints, by Francis Allyn Olmsted (New York, Appleton, 1841), is full of interesting details on this subject. In the Foreign Quarterly Review, No. 14, is an article of value and authority, by J. R. M'Culloch. In the same writer's "Commercial Dictionary," is another, with full statistical details and tables. From the latter we extract the following account:—

STATE OF THE AMERICAN WHALE-FISHERY.

We borrow from a Nantucket journal the following details with respect to this fishery in 1834:—

Spermaceti Whale-Fishery.—The whole number of ships engaged in this valuable branch of the fisheries is 273, of which 257 are now absent, viz.: from

New Bedford	94	Falmouth	6
Nantucket	63	Newport	6
Fairhaven	14	Sagharbour	5
Bristol	13	Salem	3
New London	10	Newburyport	3
Hudson	9	Poughkeepsie	2
Warren	7	Portsmouth	2
Edgarton	6	Dartmouth	2

And one from each of the following ports, viz.:—Boston, Plymouth, Wareham, Rochester, Portland, Wiscasset, Fall River, Providence, Stonington, Newbury, New York, and Wilmington, Delaware. Sixteen ships only are in port, belonging as follows: to New Bedford, 7; Nantucket, 5; Fairhaven, Plymouth, Sagharbour, and Edgartown, each 1.

The aggregate tonnage of the 257 absent ships is nearly 100,000 tons. Of these, only 61 had each, at last dates, obtained 1000 brls. of oil and upwards; and about the same number are not yet reported with any oil. The number of seamen and navigators employed on board these vessels, is not far from 9000. The cost of the entire fleet, as fitted for these voyages of three years' duration, probably exceeds 6,000,000 dollars.

A document before us furnishes a very careful estimate of the spermaceti oil imported into the United States during the year 1834. Since Jan. 1, there have arrived from the Pacific Ocean 55 ships, viz.: into this port, 11; New Bedford, 25; Plymouth, 2; Fairhaven, 6; New London, 2; Edgartown, 2; Sagharbour, 2; Warren, 3; Falmouth, Bristol, and Hudson, 1 each. The cargoes of these ships, including that of the Levant and Spartan (just arrived, and presumed to amount to 5000 brls.), average little more than 2000 brls. each; being in the whole 111,881 brls. Add to this quantity 16,000 brls. estimated to have been brought from the South Atlantic Ocean, making about 128,000 brls., and we have the entire quantity of spermaceti oil imported in the course of the last year. Of this quantity, 70,577 brls. were received at New Bedford, and the residue at Nantucket and other ports.

We deduce from this valuable document one fact, which we repeat with some feeling of pride. It is, that more than half of the ships now engaged in the sperm whale-fishery are commanded by Nantucket men though less than one-fourth of the whole fleet is owned in this place. *Am. Ed.*]

CONVEYANCE—ROADS—CANALS—RAILWAYS.

PRIMITIVE MODES OF CONVEYANCE.

The means adopted in early times for the artificial transport of either person or property, were, as may be supposed, of the rudest kind, as is still the case in those countries which are little advanced in the useful arts. The most degrading species of artificial conveyance that seems to have been practised, was the employment of human labour, in bearing litters or palanquins, specimens of which, on a scale of barbarous splendour, are now seen in India, Burmah, and China.

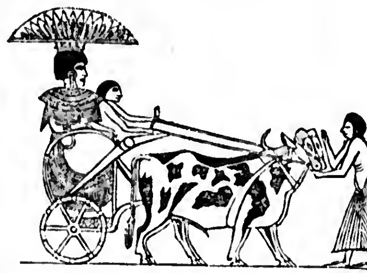
The first and most obvious improvement in modes of transport was the substitution of brute for human labour; and it is reasonable to conclude, that the value of this practice could not have been long in being pressed on the attention of mankind. We find the term "beasts of burden" used in the most ancient records, the animals meant being the ass, the horse, or the camel. No trace, however, exists of the progress from *burden* to *draught*, though it also must have been in very early times. The ass and horse are equally adapted for carrying or drawing, but the camel exerts its power only by carrying; draught is alone suitable for the reindeer and ox, the backs of these animals not being adapted by nature for bearing burdens.

The draught of the reindeer is employed in Lapland as the chief means of artificial locomotion, and is always exerted on a species of sledge, which, by its form, is suitable for gliding easily over the frozen ground or snow. The shape of the sledge somewhat resembles a small boat, with a sharp prow, and flat in the rear, against which the inmate of the vehicle rests. The traveller is swathed in his carriage like an infant in a cradle, with a stick in his hand to steer the vessel, and disengage it from pieces of rock or stumps of trees that it may chance to encounter in the route. He must also balance the sledge with his body, otherwise he will be in danger of being overturned. The traces, by which this carriage is fastened to the reindeer, are fixed to a collar about the animal's neck, and run down over the breast, between the fore and hind legs, to be connected with the prow of the sledge; the reins, managed by the traveller, are tied to the horns; and the trappings are usually furnished with little bells, the sound of which is agreeable to the animal. With this draught, the reindeer, if pressed, will travel from sixty to eighty miles in a day; but more frequently he does not travel more than forty or fifty, which is a good day's journey. Occasionally he halts to moisten his mouth with snow. Before he sets out, the Laplander whispers in his ear the way he has to go, and the place at which he has to halt, firmly persuaded that the beast understands his meaning. In the beginning of winter, the Laplanders mark the most frequented paths, by strewing them with fir boughs; which, being frequently covered with new snow, alternately pressed by the sleighs, hardens them into a kind of causeway, which is the more smooth, if the surface has felt a partial thaw, and been crusted by a subsequent frost. It requires great caution to follow these tracks; for, if the carriage deviates to the right or left, the traveller is plunged into an abyss of snow. In less frequented parts, where there is no such beaten road, the Laplander directs his course by certain marks made on the trees.

In Russia, and also in Canada, sleighs are used in winter for conveyance from place to place, the beast of draught being the horse. As the roads in many parts of Canada are very unsuitable for any species of travelling, it happens that sleighing over the hardened surface of the snow in winter, is by far the best mode of communication in that country. It is almost unnecessary to add, that the sledge or sleigh, which is the rudest kind of carriage for draught, has disappeared in all countries which have advanced considerably in improvement.

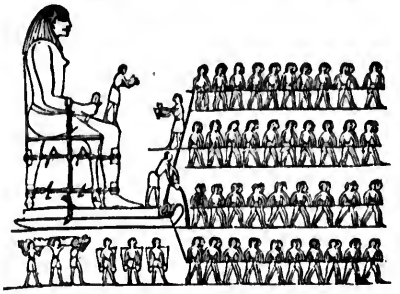
From the rude sledge, drawn with an incalculable degree of labour over the rough ground, the next important step in mechanical construction is to apply wheels, for the purpose of lessening the friction of the moving body. The first application of wheels to carriages is beyond the reach of record. Wagons are spoken of in the book of Genesis, from which it may be inferred that a knowledge of wheels was common in a very early age. It is further known, that the making of wheels formed a distinct trade among the citizens of Thebes in ancient Egypt, three or four thousand years ago.

Ancient Egyptian Carriages.—The most elegant of the Egyptian carriages was a kind of gig, or light open chariot, on two wheels, called the *plaustrum*, which is thus described by Mr. Wilkinson, in his work on the



Manners and Customs of the Ancient Egyptians:—"The plaustrum was very similar to the war-chariot and the curricle, but the sides appear to have been closed, and it was drawn by a pair of oxen instead of horses. The harness was much the same, and the wheels had six spokes. In a journey, it was occasionally furnished with a sort of umbrella, fixed upon a rod rising from the centre or back of the car; the reins were the same as those used for horses, and apparently furnished with a bit; and besides the driver, a groom sometimes attended on foot, at the head of the animals, perhaps feeding them as they went. The annexed wood engraving represents an Ethiopian princess, who is on her journey through Upper Egypt to Thebes, where the court then resided. The plaustra are called in Genesis *wagons*; they were commonly used in Egypt for travelling. Besides the plaustrum, they had a sort of palanquin, and a canopy or framework answering the purpose of a sedan chair, in which they sometimes sat or stood, in their open pleasure-boats, or in situations where they wished to avoid the sun."

From the researches of Mr. Wilkinson, we are enabled to form some estimate of the enormous trouble incurred by the ancient Egyptians in the transport of the heavy stones which they employed in building their temples. Some of these stones weighed 5000 tons, and were usually conveyed from the quarries from which they were cut, in flat-bottomed boats, on canals made for the purpose. Occasionally, however, when this mode of transport was unsuitable, the stone was drawn on sledges, perhaps some hundreds of miles, by oxen or by human labour. The following woodcut represents in an abridged form, the mode of conveying colossal figures in stone from the quarries to the temples in which they were to be set up. "One hundred and seventy-two men, in four rows of forty-three each [we



represent only as far as twenty each row], pull the ropes attached to the front of the sledge; and a liquid, probably grease, is poured from a vase by a person standing on the pedestal of the statue, in order to facilitate its progress as it slides over the ground, which was probably covered with a bed of planks, though they are not indicated in the painting. Some of the persons employed in this laborious duty appear to be Egyptians, the others are foreign slaves, who are clad in the costume of their country. Below are persons carrying vases of the liquid, or perhaps water, for the use of the workmen, and some implements connected with the transport of the statue, followed by taskmasters with their wands of office [but which we have not had space to include]. On the knee of the figure stands a man who claps his hands to the measured cadence of a song, to mark the time, and insure their simultaneous draught. The height of the statue appears to have been about twenty-four feet, including the pedestal. It was bound to the sledge by ropes, which were tightened by means of pegs, inserted between them, and twisted round until completely braced; and to prevent injury from the friction of the ropes upon the stone, a compress of leather or other substance was introduced at the part where they touched the statue." It may be added, that the representation is constructed without any reference to perspective, which was not understood by the ancient Egyptian delineators. Besides the great number of persons employed in drawing these huge blocks, it was customary for a band of some hundreds of soldiers to attend, perhaps for the purpose of overawing the slaves, and compelling obedience in their odious task. A more degrading means of mechanical conveyance it would be impossible to represent.

Conveyance by Camels.—From the earliest times, the camel, in its two varieties of camel and dromedary,* has been employed in the sandy regions of Asia, as a beast of burden; and without its invaluable services in this respect, these countries could scarcely have been habitable. In the sacred writings, we find frequent notices of the camel in connection with commercial transport. The brethren of Joseph having cast him into a pit, "they sat down to eat bread; and they lifted up their eyes and looked, and behold a company of Ishmaelites came from Gilead, with their camels bearing spicery, and balm, and myrrh, going to carry it down into Egypt." Thus the camel formed the engine of carriage among the merchants of Arabia, and conveyed the products of India across the deserts to the populous and wealthy land of Egypt.

The camel is expressly suited by nature for inhabiting and traversing sandy and parched deserts, in which there are places of rest and refreshment only at remote distances. "It is the most temperate of all animals, and can continue to travel several days without drinking. In those vast deserts, where the earth is everywhere dry and sandy—where there are neither birds nor beasts, neither insects nor vegetables—where nothing is to be seen but hills of sand and he[aps] of bones, there the camel travels, posting forward, wi[thout] requiring either drink or pasture, and is often found six or seven days without any sustenance whatsoever. Its feet are formed for travelling upon sand, and utterly unfit for moist or marshy places; the inhabitants, therefore, find a most useful assistant in this animal, where no other could subsist, and by its means, cross those deserts with safety, which would be impassable by any other method of conveyance.

"An animal thus formed for a sandy and desert region, cannot be propagated in one of a different nature. Many vain efforts have been tried to propagate the camel in Spain and America, but they have multiplied in neither of these countries. It is true, indeed, that they may be brought into both countries, and may perhaps be found to produce there; but the care of keeping them is so great, and the accidents to which they are exposed from the changeableness of the climate, are so many, that they do not reward the care of keeping. In a few years, also, they are seen to degenerate; their strength and patience forsake them, and, instead of making the riches, they become the burden of their keepers.

"The camel is easily instructed in the methods of taking up and supporting his burden; their legs, a few days after they are produced, are bent under their belly; they are in this manner loaded, and taught to rise; their burden is every day thus increased, by insensible degrees, till the animal is capable of supporting a weight adequate to its force. The same care is taken in making them patient of hunger and thirst: while other animals receive their food at stated times, the camel is restrained for days together, and these intervals of famine are increased in proportion as the animal seems capable of sustaining them. By this method of education, they live five or six days without food or water; and their stomach is formed most admirably by nature to fit them for long abstinence. Besides the four stomachs which all animals have that chew the cud (and the camel is of the number), it has a fifth stomach, which serves as a reservoir to hold a greater quantity of water than the animal has an immediate occasion for. It is of a sufficient capacity to contain a large quantity of water, where the fluid remains without corrupting, or without being adulterated by the other aliments: when the camel finds itself pressed with thirst, it has here an easy resource for quenching it; it throws up a quantity of this water, by a simple contraction of the muscles, into the other stomachs, and this serves to macerate its dry and simple food. In this manner, as it drinks but seldom, it takes in a large quantity at a time; and travellers, when straitened for water, have been often known to kill their camels for that which they expected to find within them.

"In Turkey, Persia, Arabia, Barbary, and Egypt, the whole commerce is carried on by means of camels; and no carriage is more speedy or less expensive in these countries. Merchants and travellers unite themselves into a body, furnished with camels, to secure themselves from the insults of the robbers that infest the countries in which they live. This assemblage is called a *caravan*, in which the numbers are sometimes known to amount to above ten thousand, and the number of camels is often greater than that of the men. Each of these animals is loaded according to his strength,

* The only essential difference between the two varieties, is hat the camel has two hunches and the dromedary one; but there are mixed breeds between them

and he is so sensible of it himself, that when his burden is too great, he remains still upon his belly, the posture in which he is loaded, refusing to rise till his burden be lessened or taken away. In general, the large camels are capable of carrying a thousand pounds' weight, and sometimes twelve hundred; the dromedary from six to seven. In these trading journeys, they travel but slowly; their stages are generally regulated, and they seldom go above thirty, or at most about thirty-five miles a day. Every evening, when they arrive at a stage, which is usually some spot of verdure where water and shrubs are in plenty, they are permitted to feed at liberty; they are then seen to eat as much in an hour as will supply them for twenty-four; they seem to prefer the coarsest weeds to the softest pasture—the thistle, the nettle, the cassia, and other prickly vegetables, are their favourite food; but their drivers take care to supply them with a kind of paste composition, which serves as a more permanent nourishment. As these animals have often gone the same track, they are said to know their way precisely, and to pursue their passage when their guides are utterly astray. When they come within a few miles of their baiting place in the evening, they sagaciously scent it at a distance, and, increasing their speed, are often seen to trot with vivacity to their stage.

The patience of this animal is most extraordinary; and it is probable that its sufferings are great, for when it is loaded, it sends forth most lamentable cries, but never offers to resist the tyrant that oppresses it. At the slightest sign, it bends its knees and lies upon its belly, suffering itself to be loaded in this position; by this practice the burden is more easily laid upon it than if lifted up while standing. At another sign it rises with its load, and the driver getting upon its back, between the two panniers, which, like hampers, are placed upon each side, he encourages the camel to proceed, with his voice and with a song. In this manner, the creature proceeds contentedly forward, with a slow uneasy walk of about four miles an hour, and when it comes to its stage, lies down to be unloaded, as before."*

From Major Skinner's account of his "Journey to India," in the course of which he travelled twenty days with a numerous caravan from Damascus to Bagdad, we have the following lively picture of the mode of conveyance by camels:—

"I must give a description of our equipage, now that we are fairly launched on the great waste. I ride a white camel, with my saddle-bags under me, and a pair of water-skins, quite full, beneath them: over the saddle is my bed. A thick cherry-stick, with a cross at the end of it, serves to guide the animal; a gentle tap on the side of his neck sends him to the left, and one on the opposite makes him turn back again to the right; a knock on the back of his head stops him, and a few blows between the ears bring him to his knees, if accompanied by a guttural sound, resembling, as the Arabs say, the pronunciation of their letter *sche*. To make him move quickly, it is necessary to prick him, with the point of the stick, on the shoulders.

"To the north there is a range of bare hills, and at their bases are patches of green; the rude tents of a tribe of Bedouins are pitched, and their cattle enliven the scene. We passed over a perfect level this morning, strewed with flowers, and thick with pasture for the camels, where we are now resting. It is not usual here, as in many parts of the east, for the camels to wind in long strings, one after the other. Our numbers, amounting to fifteen hundred, are scattered over the surface in all directions, as far as the eye can trace.

"In travelling, the sheiks or chiefs of the caravan, attended by the military part of their equipage, mounted on dromedaries, move in advance, while the loaded camels follow at some distance, in parallel masses, opening out, or changing the form, as the grass renders it necessary. They fall so naturally into military figures, that it is difficult to conceive their doing it without direction.

"We have several tents in the caravan. They are pitched so as to permit the camels belonging to each to lie in the intervals, where they are placed in *squads* for the night. They are by no means agreeable neighbours; for, although they are not able to move from their place, they make a most unpleasant gurgling noise, the bales of the merchants always form the windward defence, for the tents have no sides to them, and but flutter over the goods to keep the sun from their owners.

At the usual hours of prayer, a loud call is heard throughout the camp, and parties flock to where the muezzin takes his stand. At sunset, as the camels draw in from the pasture, all the Arabs are on their knees, in a line of two or three hundred, in two ranks. The priest, like a fugleman, in front, gives the time for bowing their heads, and performing the rest of the enjoined ceremonies. As they rise on the signal, they sink again to their knees, and press their foreheads to the earth with the utmost devotion: the scene is singularly impressive.

"The rate at which a loaded camel travels is estimated at two miles and a half an hour by almost every traveller. Our caravan has not, I think, exceeded this; but the variety of its movements has been very tiresome. The Arab drivers, who walk in front of the animals, never miss an opportunity of a piece of pasture; but, however distant it may be from the proper course, lead them towards it, and, with the short sticks they carry, beat them into the thickest part of it. The camels are anxious enough for the matter themselves, and huddle so together that their riders' legs are in tolerable danger of being crushed in the contact.

"There is so strong a resemblance to a voyage at sea in a passage across the desert, that I cannot divest myself of the belief that the moving mass is but a collection of small vessels, carried into a heap by the tide. Every man is ready with his stick to fend off the animal that approaches him; one push separates the camels as it would separate a couple of boats; and the camels move away, quite unconscious of the circumstance, till another movement swings them together again."

TRAVELLING IN PAST TIMES IN BRITAIN.

The modes of travelling, and conveyance generally, were of a comparatively rude and primitive kind in Britain till the latter part of the seventeenth century; and any thing like comfortable and quick travelling cannot be said to have been known till a century later, when mail-coaching was introduced. In old times, people of an humble rank travelled only on foot, and those of a higher station on horseback. Noblemen and gentlemen, as much for ostentation as use, kept running footmen—a class of servants active in limb, who ran before them on a journey, or went upon errands of special import. The pedestrian powers of these footmen were often surprising. For instance, in the Duke of Lauderdale's house at Thirlstane, near Lauder, on the table-cloth being one morning laid for a large dinner-party, it was discovered that there was a deficiency of silver spoons. Instantly the footman was sent off to the duke's other seat of Lethington, near Haddington, fully seventeen miles off, and across hills and moors, for a supply of the necessary article; he returned with a bundle of spoons, in time for dinner. Again, at Hume Castle, in Berwickshire, the Earl of Home had one night given his footman a commission to proceed to Edinburgh (thirty-five miles off), in order to deliver a message of high political consequence. Next morning

* Goldsmith's Animated Nature, vol. iv

early, when his lordship entered the hall, he saw the man sleeping on a bench, and conceiving that he had neglected his duty, was about to commit some rash act, when the poor fellow awoke, and informed Lord Home that his commission had been executed, and that, having returned before his lordship was stirring, he had only taken leave to rest himself a little. The earl, equally astonished and gratified by the activity of his faithful vassal, rewarded him with a little piece of ground, which to this day bears the name of the *Post Rig*—a term equivalent to the postman's field, and an unquestionable proof, as all the villagers at Hume devoutly believe, of the truth of the anecdote. The custom of keeping a running footman did not cease amongst noble families in Scotland till the middle of the last century. The Earl of March, father to the late Duke of Queensberry, and who lived at Neidpath Castle, near Peebles, had one named John Mann, who used to run in front of the carriage, with a long staff. In the head of the staff there was a recess for a hard-boiled egg, such being the only food taken by Mann during a long journey.

When the matter of communication was of particular importance, or required to be despatched to a considerable distance, horsemen were employed; and these, by means of relays of fresh animals and great toil of body, would proceed journeys of some hundreds of miles to accomplish what would now be much better done by a post-letter. Some journeys performed on horseback in former days would be considered wonderful even in modern times with good roads. Queen Elizabeth died at one o'clock of the morning of Thursday, the 24th of March, 1603. Between nine and ten, Sir Robert Carey left London (after having been up all night), for the purpose of conveying the intelligence to her successor James, at Edinburgh. That night he rode to Doncaster, a hundred and fifty-five miles. Next night he reached Witherington, near Morpeth. Early on Saturday morning he proceeded by Norham across the Border; and that evening, at no late hour, kneeled beside the king's bed at Holyrood, and saluted him as King of England, France, and Ireland. He had thus travelled four hundred miles in three days, resting during the two intermediate nights. But it must not be supposed that speed like this was attained on all occasions. At the commencement of the religious troubles in the reign of Charles I., when matters of the utmost importance were debated between the king and his northern subjects, it uniformly appears that a communication from Edinburgh to London, however pressing might be the occasion, was not answered in less than a fortnight. The crowds of nobles, clergymen, gentlemen, and burghers, who at that time assembled in Edinburgh to concert measures for opposing the designs of the court, always dispersed back to their homes after despatching a message to King Charles, and assembled again a fortnight thereafter, in order to receive the reply, and take such measures as it might call for. And even till the last century was pretty far advanced, the ordinary riding post between London and Edinburgh regularly took a week to the journey.

In consequence of the inattention of our ancestors to roads, and the wretched state in which these were usually kept, it was long before coaching of any kind came much into fashion. Though wheeled vehicles of various kinds were in use among the ancients, the close carriage or coach is of modern invention. The word *coach* is Hungarian, and the vehicle itself is supposed to have originated in Hungary. Germany certainly appears to have taken the precedence of the nations of Western Europe in using coaches. They were introduced thence into England some time in the sixteenth century, but were, after all, so little in vogue throughout the whole reign of Elizabeth, that there is no trace of her having ever used one. Lord Grey de Wilton, who died in 1593, introduced a coach into Ireland, the first ever used in that country. One was introduced into Scotland—we rather think from France—about the year 1571. It belonged to the famous Secretary Maitland of Lethington, who, during the horrid civil war between the adherents of Mary and those of her son James, made a journey in that vehicle from Edinburgh Castle, which he was holding out for the queen, to Niddry in West Lothian, for the purpose of holding a consultation with some others of her friends—the first time, it is believed, that a close carriage was ever used in Scotland. Fynes Morison, who wrote in the year 1617, speaks of coaches as recently introduced, and still rare in Scotland. For a long time, these conveniences were only used by old people, who could not well bear riding. The young and active despised them, as tending to effeminacy, and as not being so quick of movement as the horse. The Duke of Buckingham, in 1619, first used a coach with six horses—a piece of pomp which the Duke of Northumberland thought proper to ridicule by setting up one with eight. Charles I. was the first British sovereign who had a state carriage. Although Henry IV. was killed in a coach—the only one, by the way, he possessed—his ordinary way of appearing in the streets of Paris was on horseback, with a large cloak strapped on behind, to be used in case of rain. In Scotland, previous to the time of the civil war, coaches were only used by persons high in the state. It is very curious to find that the same sort of complaints now made by persons interested in coaching respecting the introduction of steam locomotives, were made when coaches were introduced. Taylor, the water-poet, complains, in the reign of Charles I., that large retinues of men were now given up by the great, since they had begun to use coaches. Ten, twenty, thirty, fifty, yea, a hundred proper serving men, were transformed, he says, into two or three animals. The old-wifical thinkers of that day were as much concerned about the fate of the discharged men-servants, as the twaddlers of the present are distressed about the needless horses. It is further very amusing to find Taylor, in his antipathy to coaches, complaining that their drivers were all of them hard drinkers.

In a pamphlet called the "Grand Concern of England Explained," published in 1673, the writer very gravely attempts to make out that the introduction of coaches was ruining the trade of England. The following is an example of his mode of reasoning:—"Before the coaches were set up, travellers rode on horseback, and men had boots, spurs, saddles, bridles, saddle-cloths, and good riding-suits, coats and cloaks, stockings and hats, whereby the wool and leather of the kingdom were consumed. Besides, most gentlemen when they travelled on horseback used to ride with swords, belts, pistols, holsters, portmanteaus, and hat-cases, which in these coaches they have little or no occasion for. For when they rode on horseback they rode in one suit, and carried another to wear when they came to their journey's end, or lay by the way; but in coaches they ride in a silk suit, with an Indian gown, with a sash, silk stockings, and the beaver hats men ride in, and carry no other with them. This is because they escape the wet and dirt which on horseback they cannot avoid; whereas in two or three journeys on horseback, these clothes and hats were wont to be spoiled; which done, they were forced to have new very often, and that increased the consumption of manufacture. If they were women that travelled, they used to have safeguards and hoods, side-saddles and pillions, with strappings, saddle or pillion cloths, which, for the most part, were laced and embroidered; to the making of which there went many several trades, now ruined." But the writer has other reasons to urge against coach travelling. "Those who travel in this manner," he observes, "become weary and listless when they ride a few miles, unwilling to get on horseback, and unable to endure frost, snow, or rain, or to lodge in the fields." Besides, he asks "what advantage it can be to a man's health to be called out of bed into these coaches an hour or two before day in the morning--to be hurried in them from place to place till one, two, or three hours within night; insomuch that, after sitting all day, in the summer time, stifled with heat and choked with dust—or in the winter-time, starving or freezing with cold, or choked with filthy fogs, they are often brought into their inns by torchlight, when it is too late to sit up to get supper, and next morning they are forced into the coach so early that they can get no breakfast? What addition is it to men's health or business to ride all day with strangers, oftentimes sick, ancient, diseased persons, or young children crying; all whose humours he is obliged to put up with, and is often poisoned with their nasty scents, and crippled with boxes and bundles? Is it for a man's health *to be laid fast in the foul ways, and forced to wade up to the knees in mire; afterwards* sit in the cold till teams of horses can be sent to pull the coach out? Is it for their health to travel in rotten coaches, and to have their tackle, or perch, or axle-tree broken; and then to wait three or four hours (sometimes half the day), and afterwards to travel all night to make good their stage?"

These, however, do not exhaust the patriotic clamours of the writer against the odious innovation of stage-coaching. He says that the practice "discourages the breed of horses," an argument which, it is amusing to observe, has also been used in opposition to the introduction of railways in recent times. In certain very peculiar circumstances, he allows, stage-coaching might be tolerated, but in no other. "If some few stage-coaches were continued, to wit, one to every shire-town in England, to go once a week backward and forward, and to go through with the same horses they set forth with, and not travel above thirty miles a day in the summer, and twenty-five in the winter, and to shift inns every journey, that so trade might be diffused—these would be sufficient to carry the sick and the lame, that they pretend cannot travel on horseback; and, being thus regulated, they would do little or no harm; especially if all be suppressed within fifty miles of London, where they are no way necessary, and yet so highly destructive."

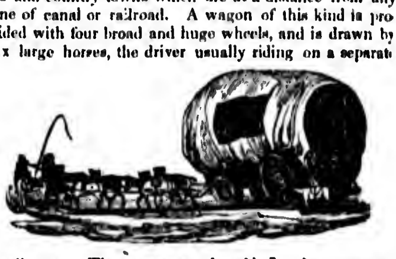
We have thought fit to introduce these extracts here, not so much for the purpose of amusing our readers with their absurdity, as to afford a caution to the general opponents of improvement. Arguments of a similar illogical nature are now used in reference to almost every proposed melioration in our social condition, and will doubtless, in a century hence, be quoted for their short-sighted folly, though at present meeting with countenance from a large class in the community.

Notwithstanding the introduction of stage-coaches in the seventeenth century, they were placed only on the principal roads, and used almost exclusively by persons of refined taste and wealth. The popular mode of conveyance continued for at least a century afterwards to be by stage-wagons; these were very large and cumbersome machines, drawn by six or eight horses, and devoted chiefly to the carriage of goods to and from the metropolis. The only part of the vehicle which afforded accommodation to passengers, was the tail of the wagon, as it was called, a reserved space with a hooped-up cover at the hinder part of the machine; and here, sitting upon straw as they best could, some half dozen passengers were slowly conveyed on their journey. The chance attacks of highwaymen, and other incidents which occurred to the occupants of the wagon, also their adventures at the inns where they slept for the night, are graphically described by Smollett in his story of Roderick Random, and will be in the recollection of most of our readers.

The wagons thus employed in the double office of carrying both goods and passengers, were, as we have said, confined chiefly to the great lines of road in England. On all the less important routes, and particularly in Scotland, the only means of conveyance for goods was by pack horses. These animals were loaded with sacks thrown

across the back; and, if not too heavy, piled to a considerable height. A number together were generally conducted in a line along the narrow and badly constructed paths, that which went before carrying a bell, by the tinkling sound of which the cavalcade was kept from straggling after nightfall. This exceedingly rude mode of conveyance continued in operation in some parts of the country till the year 1780, or thereabouts, when one-horse carts came into use.

The old-fashioned wagons still remain in use in England, notwithstanding the numerous improvements in modes of conveyance and locomotion. They are chiefly employed for the carriage of goods between the metropolis and country towns which are at a distance from any line of canal or railroad. A wagon of this kind is provided with four broad and huge wheels, and is drawn by six large horses, the driver usually riding on a separate



small pony. The wagons employed in London to convey coal from the wharfs to the houses of consumers, or beer from brewers, are of the same unwieldly form, and are drawn with a needless expenditure of power.

The length of time consumed in journeys by even the best kind of carriages of past times, is now matter for surprise. The stage-coach which went between London and Oxford in the reign of Charles II. required two days, though the space is only fifty-eight miles. That to Exeter (168½ miles) required four days. In 1703, when Prince George of Denmark went from Windsor to Petworth to meet Charles III. of Spain, the distance being about forty miles, he required fourteen hours for the journey, the last nine miles taking six. The person who records this fact, says, that the long time was the more surprising, as, *except when overturned*, or when stuck fast in the mire, his royal highness made no stop during the journey.

In 1742, stage-coaches must have been more numerous in England than in Charles II.'s time; but it does not appear that they moved any faster. The journey from London to Birmingham (116 miles) then occupied nearly three days, as appears from the following advertisement:—"The Litchfield and Birmingham stage-coach set out this morning (Monday, April 12, 1742), from the Rose Inn, Holborn Bridge, London, and will be at the Angel, and the Hen and Chickens, in the High Town, Birmingham, on Wednesday next, to dinner; and goes the same afternoon to Litchfield. It returns to Birmingham on Thursday morning to breakfast, and gets to London on Saturday night; and so will continue every week regularly, with a good coach and able horses." Thus the whole week was occupied in a journey to and from Litchfield by Birmingham, an entire space of probably not more than two hundred and forty miles—that is, at an average of forty miles a day.

Of the stage-coach journey to Bath, about 1748, we learn some particulars from Smollett's celebrated novel. Mr. Random enters the coach before daylight. It proceeds. A highwayman attacks it before breakfast, and is repulsed by the gallantry of the hero. Strap meanwhile accompanies the coach on horseback. A night is spent on the road, and the journey is finished next day, apparently towards evening—108 miles! At that time there was no regular stage-coach from London to Edinburgh; and the newspapers of the latter city occasionally present advertisements, stating that an individual about to proceed to the metropolis by a post-chaise, would be glad to hear of a fellow adventurer, or more, to lessen the expenses for mutual convenience. However, before 1754 there was a stage-coach between the two British capitals. In the Edinburgh Courant for that year, it is advertised that—"The Edinburgh stage-coach, for the better accommodation of passengers, will be altered to a new genteel two-end glass coach machine, hung on steel-springs, exceeding light and easy, to go in ten days in summer, and twelve in winter; to set out the first Tuesday in March, and continue it, from Hosea Eastgate's, the Coach and Horses in Dean Street, Soho, London, and from John Somerville's in the Canongate, Edinburgh, every other Tuesday, and meet at Burrowbridge on Saturday night, and set out from thence on Monday morning, and get to London and Edinburgh on Friday. In winter, to set out from London and Edinburgh every other [alternate] Monday morning, and to go to Burrowbridge on Saturday night; and to set out from thence on Monday morning, and get to London and Edinburgh on Saturday night. Passengers to pay as usual. Performed, if God permits, by your dutiful servant, Hosea Eastgate." Here the distance of two hundred miles requires six days in winter, being at the rate of little more than thirty-three miles a day. So lately as the end of the last century, the journey by the stage between Edinburgh and Glasgow (forty-two miles) occupied a whole day, the passengers stopping to dine on the road. It was considered a great improvement when, in 1799, a coach was started with four horses, which performed the journey in six hours. The usual time now taken is four and a half hours. It is not unworthy of being noticed, that, when the mail-coaches were started by Mr. Parker, in 1788, six and a half miles an hour was the utmost speed attained.

The length of time spent by carriers on the roads, whether with pack-horses or carts, was of course proportionally greater. An aged gentleman writing his recollections of past times (1770 to 1780) in Scotland, drolly observes, "that the common carrier from Selkirk to Edinburgh, thirty-eight miles distant, required two weeks to make out his journey between the two towns, going and returning, with a suitable resting-time at each to his poor fatigued horse, which had perhaps not less than five or six hundredweight of goods to drag along. The road originally was among the most perilous in the whole country; a considerable extent of it lay in the bottom of that district called Gala Water, from the name of the principal stream. The channel of the water itself, when not flooded, was the track chosen, as being the most level, and easiest to be travelled on. The rest of the way, very much up-and-down-hill, was far worse. The townsmen of this adventurous individual, on the morning of his way-going, turned out to take leave of him, and to wish him a safe return from his perilous undertaking."*

* Robertson's Rural Recollections

ROADS.

It will appear from the preceding notices respecting travelling and modes of carriage for goods, that little or no improvement could be expected in either case, till a great change for the better was made on the state of the roads. In no branch of art do our ancestors seem to have been more deficient or heedless than in that of making roads and keeping them in constant repair. In this respect, indeed, they were in a condition of greater ignorance than the ancient Romans, whose roads were on the most extensive and efficient scale, suitable to the necessities of the period, and may here be shortly described.

ANCIENT ROMAN ROADS.

It is, we believe, generally allowed that the Romans gained a certain degree of knowledge on the subject of road-making from Greece and Carthage, and also perhaps from Egypt; but whatever they learned they greatly improved upon, and therefore they are entitled to be called the first and best roadmakers of whom history has preserved any account. One great leading principle actuated the Roman authorities in establishing roads: it was that of maintaining their military conquests. On vanquishing a barbarous country, their first efforts consisted in penetrating it with good roads, which were maintained with jealous care, and were connected as far as possible in unbroken lines with the seat of government at Rome. this, indeed, formed one of their grandest engines of subjugation, and affords us a striking proof of their sagacious and active character.

Speaking of the subordinate Roman capitals in Asia Minor, Syria, and Egypt, Gibbon describes as follows the manner in which they were connected by roads:—"All these cities were connected with each other and with the capital by the public highways, which, issuing from the Forum at Rome, traversed Italy, pervaded the provinces, and were terminated only by the frontiers of the empire. If we carefully trace the distance from the wall of Antoninus [in Scotland] to Rome, and from thence to Jerusalem, it will be found that the great chain of communication, from the north-west to the south-east point of the empire, was drawn out to the length of 4080 Roman [or 3740 English] miles. The public roads were accurately divided by mile-stones, and ran in a direct line from one city to another, with very little respect for the obstacles either of nature or private property. Mountains were perforated, and bold arches thrown over the broadest and most rapid streams. The middle part of the road was raised into a terrace which commanded the adjacent country, consisting of several strata of sand, gravel, and cement, and was paved with large stones, or in some places near the capital, with granite. Such was the solid construction of the Roman highways, whose firmness has not entirely yielded to the effect of fifteen centuries. They united the subjects of the most distant provinces by an easy and familiar intercourse; but their primary object had been to facilitate the marches of the legions; nor was any country considered as completely subdued, till it had been rendered in all its parts pervious to the arms and authority of the conqueror. The advantage of receiving the earliest intelligence, and of conveying their orders with celerity, induced the emperors to establish, throughout their extensive dominions, the regular institutions of posts. Houses were everywhere erected, at the distance of only five or six miles; each of them was constantly provided with forty horses; and, by the help of these relays, it was easy to travel a hundred miles in a day along the Roman roads. The use of the posts was allowed to those who claimed it by an imperial mandate; but though originally intended for the public service, it was sometimes indulged to the business or conveniency of private citizens."

From other accounts, we learn that the Roman roads varied in importance and uses. The great lines were called *prætoriæ viæ*, as being under the direction of the prætors; and these formed the roads for military intercourse. Other lines were exclusively adapted for commerce, or civil intercourse, and were under the direction of consuls. Both kinds were formed in a similar manner. The plan on which they were made was more calculated for durability than ease to the traveller; and for our modern wheel carriages they would be found particularly objectionable. Whatever was their entire breadth, the centre constituted the beaten track, and was made of large ill-dressed stones, laid side by side to form a compact mass, of from twelve to twenty feet broad; and, therefore, in their external aspect, they resembled the coarse stone causeways which are still in use in towns and in the highways of France. Some of the roads had double lines of this solid pavement, of this nature, with a smooth brick path for foot passengers; and at intervals along the sides, there were elevated stones on which travellers could rest, or from which cavalry could easily mount their horses. One important feature in the construction of all the Roman roads, was the bottoming of them with solid materials. Their first operation seems to have been the removal of all loose earth or soft matter which might work upwards to the surface, and then they laid courses of small stones, or broken tiles and earthenware, with a course of cement above, and upon that were placed the heavy stones for the causeway. Thus, a most substantial and durable pavement was formed, the expense being defrayed from the public treasury. Various remains of Roman roads of this kind still exist in France, and also in different parts of Britain. One of the chief Roman thoroughfares, in an oblique direction across the country from London to the western part of Scotland, was long known by the name of Watling Street, which has been perpetuated in the appellation of one of the streets in the metropolis.

MODERN MACADAMIZED ROADS.

We now proceed to offer some account of the introduction of a proper kind of roads in modern times. Attempts to improve the roads forming the leading thoroughfares in England, were made at the beginning of the eighteenth century; and for that purpose turnpike acts for various districts were passed by parliament. It is a very remarkable fact, that some of the counties in the neighbourhood of London petitioned Parliament against the extension of turnpike roads into the remoter parts of the country. Those remoter counties, it was pretended, from the cheapness of labour, would be able to sell their corn at a lower rate in the London market than themselves, and would thereby reduce their rents and ruin their cultivation. In spite of these remonstrances, turnpike roads were extended into the remoter counties, and, as ought to have been expected, so far from injuring the neighbourhood of the metropolis, they greatly increased its value—for a free and easy interchange of commodities is always universally beneficial.

It is of little moment to ascertain the exact period when these improvements were effected on the roads of England; for, upon the whole, they were only partial, and as yet the proper mode of road-making was not understood. The plan consisted in making the paths somewhat more level than formerly, and of filling up the ruts and holes with stones gathered from the adjacent fields. By this means the holes, ruts, and sloughs were considerably limited in both breadth and depth; but as perfect levelness was not attained, carriages were dreadfully jolted over the rougher parts, and the wheels sunk jarringly into the softer ground beyond. As also no pains were taken to lay down stones of equal bulk, but small and large mixed, it happened that the larger ones in time wrought to the surface, and so created additional jolting to vehicles and damage to the roads. The defects in this species of improved roads were so conspicuous, that various engineers of eminence, and other individuals, turned their attention to the subject; and among these is to be numbered Mr. M'Adam, whose plans surpassed all others, and, as is well known, are now generally adopted. The name of this gentleman has become so completely associated with the idea of good roads, that a slight sketch of his history may here be acceptable.

John Loudoun M'Adam was the representative of an old and respectable landed family—the M'Adams of Waterhead, in the Stewartry of Kirkcudbright, and was born, September 21, 1756, in the town of Ayr. By the death of his elder brother, he became, in infancy, the only son of his father, and entitled to inherit the distinction—considered in Scotland, in such cases, a matter of some consequence—of being the representative of the family, and chief man of his name. In consequence of the destruction, by fire, of a house which he had built for his residence at Lagwyne, in the moorland parish of Carsphairn, his father removed, about this time, to Blairquhan, in Ayrshire, which he rented from Sir John Whitefoord. The family estate was now sold to the Earl of Stair, from whom it was afterwards purchased by a junior branch of the M'Adam family, who still possesses it. Mr. M'Adam received his education at the school of Maybole, under a teacher named Doick, who possessed considerable local reputation. On the death of his father in 1770, when he was only fourteen years of age, he was sent to New York, where his uncle William, a younger brother of his father, had been settled for some years as a merchant. Here he remained fourteen years, during which the war of Independence took place. Under the protection of the British forces, who possessed the city, he realized a considerable fortune, as an agent for the sale of prizes. At the conclusion of the war, he returned, with the loss of nearly the whole of his property, to his native country, and resided for some time at Dumcrieff, a beautiful place in the neighbourhood of Moffat, subsequently the seat of Dr. Currie, the biographer of Burns. He afterwards lived for thirteen years at Sauchrie in Ayrshire, where he was in the commission of the peace and a deputy lieutenant. During this period, he enjoyed the society of his first wife—a lady named Nichol, whom he had married at New York, and who brought him three sons and three daughters, most of whom survive him. He married, secondly, in 1827, Miss de Lancey, who survives him, but has no family.

In the year 1798, Mr. M'Adam received the government appointment of agent for victualling the navy in the western parts of Great Britain, and accordingly removed to Falmouth. He subsequently resided for many years at Bristol, and latterly at Hoddesdon in Hertfordshire. It was while acting as one of the trustees upon certain roads in Ayrshire, that he first turned his attention seriously to the mechanical principles involved in that branch of national economy. While engaged in England in duties of an entirely different kind, he continued silently to study the process of road-making in all its details, keeping particularly in view the great desiderata of a compact and durable substance and a smooth surface. By the exertions of various able engineers, who had turned their attention to road-making, the highways of Great Britain were already in the course of a rapid improvement; but Mr. M'Adam was the first to point out and prove, in practical operation, that a bed, of a few inches in depth, formed of fragments of primitive rock—granite, greenstone, or basalt—small enough to pass through a ring not larger than two inches and a half in diameter, was the best material for ordinary roads. His system, in its leading features, is so conspicuously displayed in the public eye, that any minute account of it would be superfluous. It was not till 1815, when on the borders of sixty, that he began to devote his whole mind to the business of road-making. Being then appointed surveyor-general of the Bristol roads, he had at length full opportunities of exemplifying his system, which he forthwith proceeded to do in a manner that attracted general attention, and caused it to be quickly followed throughout the whole kingdom. In 1823, Mr. M'Adam was examined before a committee of the House of Commons respecting the propriety of converting the ruble granite causeway of the principal thoroughfares into a smooth pavement, resembling those which he had already formed on the principal roads. He expressed himself as decidedly of opinion that such a change should be made: "I consider," said he, "that the expenses would be materially reduced; the convenience of passing over the surface would be generally facilitated, particularly in the leading streets; and the same weight of stone, now put upon those streets as pavement, would be obtained at infinitely less expense, in a different form, for the purpose of road-making." The consequence was, that, in London, Edinburgh, and Dublin, some of the principal lines of street, which had previously been remarkable for solidity of pavement, as well as the large sums that pavement had cost, were—to use a phrase already familiar to every ear—*Macadamized*.

In introducing this improvement into British roads, Mr. M'Adam had spent several thousand pounds from his own resources. In 1825, he proved this expenditure before a committee of the House of Commons, when an equivalent sum was voted to him, besides an honorary tribute of two thousand pounds, in consideration of the public benefits resulting from his labours. The inadequacy of this remuneration is very striking; and it is impossible to avoid contrasting it, in some bitterness of spirit, with the ratio in which services of other and less beneficial kinds are usually acknowledged. Many a lieutenant, in being promoted to a captaincy for some little display of personal bravery, has reaped nearly as valuable a reward as that bestowed upon Mr. M'Adam for bringing into operation a mechanical improvement, the consequences of which, in saving animal labour, facilitating commercial intercourse, and rendering travelling easy, quiet, and pleasant, are beyond all calculation. Though the remuneration was thus small, and never, as we have been informed, fully paid, Mr. M'Adam would have been the last to complain of it. He never made money an object, but, on the contrary, rejected on principle many opportunities of gathering wealth, which his office as a superintendent opened up to him, and which many men of by no means blunt feelings as to professional propriety would have taken advantage of. He therefore died a poor, but, as he frequently expressed himself, "at least an honest man." Mr. M'Adam's decease took place, November 26, 1836, at Moffat. He was in the 81st year of his age.

According to the principles of road-making, as laid down and consistently acted upon by Mr. M'Adam, a road ought to be an artificial and hard flooring, placed on a level and dry surface. To make a good road, therefore, we must in the first place level and prepare the ground. If the ground be soft, as, for instance, have a covering of turf and earthy matter beneath, the top must be pared off, and as much earth removed as will produce a hardish base. In some instances, it may be necessary to excavate, and fill up the gap with compact and substantial materials; but should this be the case, the materials used must on no account include any large stones, or be otherwise unequal in their nature: The principles on which the road should be made are thus alluded to by Mr. M'Adam:—"Roads can never be rendered perfectly secure, until the following principles be fully understood, admitted, and acted upon: namely, that it is the natural soil which really supports the weight of travel; that while it is preserved in a dry state, it will carry any weight without sinking, and it does, in fact, carry the road and carriages also; that this native soil must previously be made quite dry, and a covering, as much impenetrable to rain as possible, must then be placed over it, to preserve it in that dry state; that the thickness of a road should only be regulated by the quantity of material necessary to form such impervious covering, and never by any reference to its own power of carrying weight."

To put these principles in practice—after the base of the road has been prepared, it should be laid with a layer of small stones, made by breaking larger stones into pieces weighing about three ounces. No round pebbles or channel stones must be employed; all must be angular or irregularly shaped pieces. The covering of this kind of material, technically called *road metal*, should be spread to a depth of from six to ten inches, as may be found necessary, and raked level on the surface. The sides of the road must possess wet ditches or gutters, into which all water may be readily conveyed and run off. For this purpose, culverts, drains, and gratings may be necessary.

In certain cases it may be expedient to carry a line of road across a bog or peat morass; and this may be done with perfect security by laying a bottom of shrubs, furze, or small branches of trees, on the soft understratum, and covering it over with gravel, and the ordinary stone material above. The road so formed may perhaps yield or bend a little when travelled by a heavily loaded vehicle, but will sustain as much tear and wear as any other portion of the highway.

The width of the road is a matter of taste and convenience, but it should not be less than thirty-three feet, to allow a free passage of vehicles in different directions. On all the good roads in Britain, near towns, a side footpath, protected by a curb-stone, is added to the ordinary breadth. "With respect to the shape of the surface of the road, when completed, there is also some difference of opinion; but all agree that it should be convex, the only difference being in the quantity. The degree of convexity should be governed in a great degree by the locality. A road formed of soft materials should have a greater convexity than one formed of hard materials; for the obvious reason that water will injure a soft road quicker than a hard one. A road upon uneven ground should have a greater convexity than one upon level ground, to prevent the descent of rain-water along the face of the road, which is there caught by the slightest impressions of wheels; and thus wear channels, as may too often be seen, from the top to the bottom of the hill A wide road also requires to be more crowning than a narrower one; which more readily frees itself from rain-water, inasmuch as the distance the water has to run is less. But it must be borne in mind, that the freeing of a road from rain-water is not the only object to be kept in view in making a road crowning. The ease and safety of carriages, and particularly those with heavy burdens or with high loads, must be consulted. A carriage moves most freely, or with the least resistance, when the load lies evenly upon the wheels. Just in proportion as the weight or load is thrown on one side or the other, the resistance is increased. Hence the inconveniency of a very crowning road on a steep; and hence the utility of bars or breaks in long ascents. It is plain that a road should be equally and duly convex in every part of it; otherwise it becomes more partially worn; the more level parts being most used.

When a road is carried round a hill instead of going directly over it, or when a road is made on a side-hill, it should not be made convex from the middle, but it should be formed like half of a common road, with the highest part on the upper side, thus giving the water a tendency to run off on the lower side. Mr. Walker recommends the least possible convexity consistent with a proper drainage of the road. In most localities this will rarely exceed four inches; that is, the middle should be four inches higher than the sides. An idea of a perfect road may be formed from a frozen canal, where flatness, smoothness, and hardness are combined; in imitation of such a surface, railways were invented, and fully illustrate the principles assumed. Roads cannot be made with all of these perfections, but they should always be kept in view; for the nearer we approach to this standard, the greater will be the draught. M'Adam says, roads should be made as flat as possible. 'Where a road is made flat,' he says, 'people will not follow the middle of it, as they do when it is made quite convex, which is the only place where carriages can run upright, by which means three furrows are made by the horses and the wheels, and the water continually stands there; and I think that more water actually stands upon a very convex road, than on one which is reasonably flat.'

"In laying out a new road, it is of some importance that the rises and falls be not too great. The most approved angles of ascents and descents in England are about one inch in a foot—from this to one inch in a yard. In order to obtain ascents not exceeding these, it is necessary in our uneven country to wind up a hill instead of going directly over it. In such cases the road is to be built upon the side of a hill, and this is considered the most advantageous ground upon which a road can be built, provided the hill has not too great an ascent; because what is taken from the upper side serves to form the embankment on the lower side. While we are speaking of embankments, we may mention the English method of forming them, which is so manifestly superior to our own, that it deserves to be imitated. 'The natural sod, which would be covered by the base of the embankment, having been cut off and set aside, the earth is then wheeled or carted on to form the two outsides, which are raised to the required height, leaving the middle open. The sods are then placed on one another, the grassy surface at right angles to the face of the outer slopes, forming as it were a battering wall of sods against the embankment.' This method is found effectual in preventing the banks from washing away and gullying. While the outsides are forming, the lumps of earth, stone, &c., run downward to the middle; and in this way the whole is finished. When the work settles, it is found to tend towards the centre, thus preventing the outside slopes from giving way."*

The following judicious observations are made by the same authority on the subject of fences, and junctions of different roads:—"Fences are necessary along the sides of a road in all enclosed countries; but they should never be allowed to rise higher than four feet on common roads. It is absolutely necessary that the air and sun have free admission to a road; besides, where the fences are high, it gives a sweeping power to the wind, which is not beneficial. Mr. Telford thinks that fences should never be more than four feet high, and that all trees within twenty feet of the sides of the road should be removed. He also thinks that twenty per cent. of the expense of repairing or improving roads is incurred by the improper state of the fences and trees along the sides, particularly on the sunny side; this will be manifest to any person who will take the trouble to examine the condition of that part of a road which is much shaded, compared to the other parts which are exposed to the sun and air.

*"The junction of one road with another requires a little attention: it should always be made at right angles, and on the same level, if possible. All engineers agree that plantations of trees should not be made close to roads; but what the distance should be depends on the elevation of the country, the soil, the breadth of the road, as well as its direction, &c., &c. An elevated situation is always more exposed to winds than a level or hollow. A broad winding road has chances of the direct influence of the sun and wind, according to the obliquity of its angles; a road running north and south, though planted closely on both sides, will enjoy the sun during a part of every day in the year; one running east and west, planted on the south side with trees forty feet high, or more, will enjoy no sun during the winter months. The least injurious trees are single rows trained to high stems, properly pruned."

For some time after a road has been laid with fresh materials, it presents a rough surface, unpleasant to the feelings of those who are conveyed over it: but this roughness is gradually abated, the small stones are crushed into a compact mass, and finally, the road is smooth, hard, and level. The length of time that may elapse before any new repair is required, depends on the amount and kind of traffic, as well as the weather. Rain is a great enemy to macadamized roads, and particularly so when accompanied with much traffic. The water lies on the surface, and softening the material, the action of the horses' feet and of the wheels causes a certain depth of thin liquid mud. This mud should, by all means, be scraped off to a side, for the longer it lies, the stratum beneath is the more liable to be cut up and damaged. The scraping of the roads, therefore, becomes an essential duty of all who are interested in preserving the highways economically in repair. When the mud which is scraped aside thickens by exposure, it should be carted off, and may be employed on many soils as a useful manure. Besides containing a proportion of refuse from horses, it is loaded with particles of iron from wheels and horse shoes; and being substantially silica or ground stone, it may be administered with special advantage to heavy clay grounds.

Roads exposed to much traffic require to be renewed in surface at least once a year. The first indications of decay are observable in the form of slight hollows, and ruts next make their appearance. In some cases, where the decay is only partial, a small quantity of metal may be scattered in the hollows, bringing them up to a level with all around. However, this is not usually done on well-kept roads near large towns. There the road undergoes a thorough repair once a year, which is preferable to partial mendings. The best time for repairing roads is about November, or before the winter frost and snow set in. In commencing the repair the road should be picked across, at intervals of twelve or fifteen inches. This is done by men, each having a pick by which he indents the hard bottom, or forms scores an inch deep in the road. The use of such a preliminary process, is to cause a ready union between the new and old materials. If the fresh metal were scattered over the old road, without any preparation, it would with difficulty unite to the substratum, and at best form an upper crust, which would be too easily damaged.

With respect to the keeping of roads in efficient repair, the most advantageous plan consists in assigning the entire duty to a contractor. This person, by undertaking to keep all the roads in a county or district in constant or uniform repair, is able to execute his functions much more economically than the private gentlemen who act as trustees of the highways and turnpikes. The trustees appointed by local acts of parliament to superintend highways, now generally employ contractors to keep the roads in repair at a specified price per mile, the payment being made from funds collected from the lessees of the toll-bars.

The aggregate length of the turnpike roads of Great Britain is now calculated to be 25,000 miles, at a general breadth of from fifty to sixty feet.* The cost of

* Scientific Tracts. Boston: 1833.

* Turnpikes were so called from poles or bars, swung on a pivot, having been placed on them, and turned either way when dues were paid. Gates are now substituted for these poles in Great Britain. In Germany, the pole is still used, one end being depressed to raise the other and so permit a free passage.

keeping these roads in repair differs considerably in different counties. In the neighbourhood of London, the annual cost is about £550 per mile, in Yorkshire it is £60, and in Wales £20. The average is about £50. Nearly all the road trusts are in debt for borrowed money. It is supposed that the debt is on an average of £320 per mile, or probably £6,000,000 for the whole.

Law of the Road.—For general convenience and safety, drivers of vehicles and riders, in travelling along a road, are expected to take a particular side; and this practice is now so well understood, and is in itself so proper, as to have become a part of the common law. The law of the road is, that when drivers meet from different directions, each shall keep his left hand to the wall or footpath. Secondly, when one driver overtakes another, and wishes to pass him, he must keep his left hand to the vehicle which he passes. In the case of either meeting or passing, each party is entitled to the half of the road. The same rules apply to riders. If these regulations be neglected, and an accident occur, the law is always in favour of the party who kept his own proper side, and no excuse can shelter the aggressor. The trustees of the road are liable in an action of damages for any injury that may be sustained through the carelessness of themselves or servants, in leaving the road grossly out of repair.

According to a well-known rule, foot-passengers on pavements or side-paths are expected to walk with their right hand to the wall—that is, they keep their left hand to those whom they are meeting and passing. This custom prevents confusion in the streets of large towns, but is not a matter of law.

CANALS.

A canal is an artificial channel of water, and is usually constructed for inland navigation. Where natural rivers can be resorted to for purposes of this kind, they are preferable to canals, because little expense may be required to suit them for navigation, and they may be easily kept in repair. But few rivers, generally speaking, are sufficiently level, straight, or deep, to admit of being profitably navigated by barges, and therefore artificial channels require to be cut. Canals are extremely suitable in level countries, possessing rivers or brooks which can afford a due supply of water. In China, from a very early age, certain large rivers have formed natural canals longitudinally through the country from west to east, while artificial canals have been made to proceed in a cross direction from north to south, thus effecting a universal water communication throughout the empire. Canals existed in ancient Egypt in connection with the Nile, on a similar plan to what now prevails in China. Notwithstanding that canals were known to have existed from a remote antiquity in the east, it was long before they were introduced into western Europe. In modern times, they were first used by the inhabitants of the Netherlands, in consequence of the extreme flatness of their country, and the numerous channels of water which intersect it in all directions, in connection with the lower branches of the Rhine, and other rivers. In Holland and Belgium, therefore, canals in a great measure exist as an essential requisite in the general arrangements of the country, and are, in point of fact, so many wet ditches or drains to receive the superfluous waters.

In countries differently constituted, canals are constructed only with reference to the profit, in the form of commercial speculation. The great question, accordingly, in forming the project of a canal, is, whether the anticipated amount of traffic will raise tolls sufficient to compensate the outlay of the undertaking and subsequent charges for repair and superintendence. It simplifies such an inquiry to know the following truths in reference to cost of conveyance. The cheapest mode of conveyance is by sloops, smacks, brigs, packets, steamboats, &c., and these will at all times be employed for heavy and bulky goods, such as coal, barrels of liquids, iron, and other cumbrous materials proceeding coastwise. The next cheapest mode of conveyance is by barges on rivers; and the next is by means of canals. After this are ranked, in point of economy, conveyance by land, on railways and roads, the last being the dearest, though often the only means of transport which can be obtained. According to this view, canals can never answer as profitable speculations, when they have to compete with coasting vessels of any description, or with any species of conveyance by rivers. They cannot even in certain circumstances compete successfully with railways, on account of the slowness of speed at which barges or boats are drawn along them; and as speed is becoming daily a matter of greater moment in traffic, canals are gradually losing the conveyance of every kind of goods for which quickness of transit is desirable. For the sake of economy in national resources, it is very desirable that these truths in statistics should be generally understood and remembered.

When the undertaking appears warrantable, from a careful consideration of circumstances, the next thing to be taken into account is the obtaining of an adequate supply of water, and the fixing on the best—that is, the most level and unexpensive—line of route. In some parts of England, where an enormous traffic could be reckoned upon, canals have been projected and executed on a stupendous scale; mountains have been perforated to admit channels of water through them, valleys raised by embankments, and bridges built in the form of aqueducts across rivers; in short, no expense has been spared to render the inland navigation complete.

The supply of water necessary for a canal which is level throughout its course, is small in comparison with that of one pursuing an uneven line. When there is a common level of surface, the only expenditure of water is by evaporation; but when the level is various, a large loss is incurred at the locks in raising or lowering vessels. A lock is a portion of the canal enclosed by folding doors, and must at least measure the length of a vessel. If a vessel is to be raised from one level to another, it is drawn up to the doors of the lock, and these are opened to admit it. Having sailed into the lock, the doors are closed behind it, and it is now in a kind of prison from which there is no apparent escape. While in this situation, the doors at the opposite end of the lock, which retain the water at a higher level, are slowly opened, and admit a rush of the liquid mass, which speedily buoys up the vessel, and allows it to sail off along the higher level. The lock is not immediately emptied, but remains full of water, and is therefore ready to be employed in letting a vessel down. When the vessel approaches, and is fairly within the lock, the upper doors are shut, and then the lower doors are opened; by this means the vessel is carried into the lower level along with the rush of liquid, and is drawn on its course. A lockful of water has now evidently been shot from a higher to a lower level on the canal, and is lost, unless required for lower locks. To prevent inundation of the banks from the issuing of water from the locks, waste outlets require to be provided at certain distances, particularly at the lower termination of the line of canal. The provision of water to supply the locks is ordinarily from an artificial lake, which is established near the highest ground in the line.

The breadth of most canals varies from twenty to thirty feet, and the depth from four to six feet. If the depth of water be sufficient to keep the vessels from touching the bottom, no greater volume is necessary, for less power is required to pull a boat upon a shallow than a deep water, there being less liquid agitated or displaced. At one side of the canal a narrow road, called the towing-path, is constructed, and upon this the horses, which drag the vessel, proceed. There is a difference in the manner in which the dragging rope is attached to the vessel. In Holland it is the practice to attach the rope to near the bow of the boat, and to cause it to proceed over the outer extremity of a pole or species of mast, so as to keep it considerably above the water, and prevent its friction on the banks. This is not attended to in England, where the rope proceeds direct from the bow to the horse, and, except when in a state of great tension, it trails along the bank and surface of the water. In either case, the draught of the horse is exerted with a loss of power, for instead of being a fair draught behind, it is oblique, or in the direction of the rope slanting to the vessel. The tendency of the draught is to bring the boat to the shore, which is counteracted by the helm, and this again assists in diminishing the general amount of available power.

Throughout the canals of England and Scotland, only one horse is employed to drag a boat, loaded to the extent of from fifty to seventy tons; and with this weight dragging after it in a manner most disadvantageous, it will travel at the rate of two miles and a half or three miles an hour. That one horse should be capable of drawing fifty tons of goods in this unexpensive manner gives an apparently favourable view of canal conveyance; but laying all charges out of the question, the slowness of the motion, and consequently the detention of goods by the way, is a drawback of the most serious nature, and in reality renders canals almost useless for the transport of any but heavy and raw materials. Latterly, on a few canals, attempts have been successfully made to run "swift boats" for passengers, drawn by two horses, at a rate of seven or eight miles per hour; but as these vessels are run at a great expense for horse power, and at the utmost speed are not quicker in their transit than stage-coaches, it may be expected that they will utterly fail in competing with railways.

It may not be generally known that the principal obstacle to the use of steam-engines on board canal-boats, is the injury done to the banks by the action of the water from the paddles. How far this obstacle might be overcome by the use of the Archimedian screw propeller, it would be premature to say. Meanwhile, an attempt has lately been made in Scotland to introduce the use of steam-power for inland navigation, by means of a railway and locomotive tug, along the line of the Forth and Clyde Canal. The following account of an experiment is from the Edinburgh newspapers of November, 1839:—

"The experiment, which was of a novel nature, was conducted by Mr. John Macneil, civil engineer, and consulting engineer to the Canal Company. It is well known that the haulage of boats on this canal has hitherto been performed by horses; the rates of speed being, for the heavy sloops, brigs, &c., in the London, Dundee, and other trades, about 1½ to 2 miles per hour, when drawn by two or five horses, according to the state of the weather; and for the swift or passenger boats between 8 and 9 miles per hour, on an average, when drawn by two horses. The object of the experiment was to ascertain the possibility of using locomotive steam power to draw the boats, instead of horses. Accordingly, a single line of rails, upon blocks, like an ordinary railway, was laid down for a considerable space along the canal banks, near Lock 16; and a locomotive engine and tender, built by Mr. William Dodds, having been brought down the canal and set on the rails on the morning of the 21st, Mr. Macneil, Mr. Johnston, the canal director, and several engineers and gentlemen, being present, the experiment commenced by attaching to the engine the towing-line of the first passenger-boat that made its appearance, and which contained upwards of ninety passengers, with their luggage. There was a trifling delay in disengaging the horses and tying the line to the engine; but this was amply compensated when the 'Victoria' briskly set off, and almost immediately gained a speed of 17½ miles per hour, which she kept up round two curves, and until the termination of the rails made it necessary to stop, amid the cheers of the delighted passengers. This experiment was repeated, during the course of the day, with each passenger-boat as it came on the railed space, and with equal success each time. On one occasion a towing-rope, which was much decayed, got foul of a curb-stone and broke, but without causing the slightest inconvenience, except about one minute's delay. The engine employed being intended only for a slow trade, was not calculated to go at greater speed than 18 miles per hour; but it was the opinion of all present, that, with proper passenger locomotives, a speed might be obtained equal to that upon the best railways, few of the latter possessing the advantage secured by the canal bank of a perfect level throughout. The nature of the motion was highly gratifying to all the passengers, being more uniform, steady, and smooth, than when the boats were drawn by horses. Several of the heavy (masted) vessels were also taken in tow during the two days of trial, at the rates of 3, 3½, 4, and 5 miles per hour; and on one occasion, two loaded sloops, and a large wagon-boat, were together attached to the engine, and hauled with ease at the rate of 2¾ miles per hour, whilst only one-fourth of the steam was allowed to pass the throttle valve. The foregoing statements render palpably apparent the immense advantages which might be gained by this new adaptation of steam power—a great economy of haulage expenses, as one engine might draw at least six sloops, which now would require from eighteen to twenty-four horses, and, if necessary, at double the present speed; and a proportional increase of the present traffic on the canal, which might be reasonably expected. Passengers would increase in a great proportion, when attracted by economy and speed of transport. The Union Canal from Edinburgh to Falkirk might be traversed in 2 hours, and the Forth and Clyde Canal from Falkirk to Glasgow in 1½ instead of 4 hours and 3½, as at present, and this by only assuming 16 miles per hour, though more might easily be performed, as the experiments have shown."

Fully more satisfactory results ensued from subsequent experiments, but as the mode of draught has not come practically in operation, it is unnecessary to narrate them here.

One of the largest canals in Europe is that which extends from the German Ocean to the river Ai, at Amsterdam, by which vessels are enabled to reach that city by a direct channel, instead of sailing round by the Zuyder Zee. This ship canal was begun in 1819, and finished in 1825, at an expense of £850,000. Its length is nearly 52 English miles; its breadth 125 feet at the surface, and 38 feet at the bottom; and its depth 20 feet 9 inches. Traversing a perfectly flat country, it has no locks except at its extremities, and is of such magnitude, that two frigates or the largest merchant vessels can pass each other. There is a towing-path for horses on each side and about eighteen hours are required to perform the voyage from Amsterdam to the ocean. As a commercial speculation the canal yields no profit, but its service to the shipping of Amsterdam is incalculable, and without it the town must have sunk into comparative insignificance.

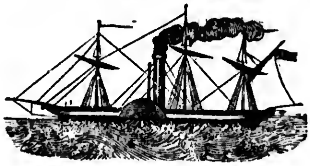
France possesses about fifty different canals, some of which are of great importance for general traffic. The chief canal is allowed to be that of Briare, called also that of the Loire and Seine. It was completed in 1642 measures 34½ miles in length and has 40 or 42 locks. The width is 25 feet at bottom. By this canal Paris receives large supplies of inland produce. The Canal du Midi, or Languedoc Canal, makes a communication between the Mediterranean at the city of Cette and the Atlantic Ocean at the mouth of the Garonne, passing through the province of Languedoc. Altogether, there are 900 miles of canals in France.

The United States of North America possess upwards of 2500 miles of canals, the whole of which have been constructed within the last thirty years. The principal undertaking of this kind is the Erie Canal, which unites the river Hudson at Albany with Lake Erie at Buffalo, a distance of 363 miles. The Miami Canal, from Cincinnati to Lake Erie, which extends 265 miles, is another great undertaking; and there are a number of other canals scarcely less important for the general traffic of the country. The Rideau Canal in Canada, extending a distance of 160 miles, from the Ottawa (a tributary of the St. Lawrence) to Lake Superior, is a stupendous undertaking, and will ultimately be of great service to the trade of British America.

The canals of Great Britain are believed to extend to an aggregate length of 2400 miles. The greater part are in the midland districts of England, including Lancashire, and have for their object the connection of the large seats of manufacture with the sea on both sides of the island and with the Thames at London. The Grand Trunk Canal, connecting the Mersey with the Trent and Humber, extends 93½ miles. The Birmingham and Worcester connects the Grand Trunk Canal with the Severn. The Grand Junction connects the Grand Trunk with the Thames. Thus, the four great ports of the kingdom, London, Bristol, Liverpool, and Hull, are connected by canals. So generally are these and other canals spread over England, that it is supposed there is not a place south of Durham more than fifteen miles from water communication. The trade on some of the lines of canal, since the introduction of railways, has sunk in an extraordinary degree, greatly to the loss of the proprietors. Ireland has about 300 miles of canals, mostly government undertakings, and in general they possess little trade.

Scotland has a number of canals, but they are chiefly confined to the western and middle district of the country. That which possesses the largest traffic is the Forth and Clyde Canal, reaching from the Clyde, a short way above Dumbarton, to the Forth, at Grangemouth. This canal, which was opened in 1790, and affords a ready communication for small vessels between the east and west coast, extends 39 miles in length; its highest level is 160 feet, with 20 locks on the eastern acclivity and 19 on the western. The canal is connected with Glasgow by a side cut; and it is now joined by the Union Canal, which extends from near its eastern extremity to Edinburgh. This latter canal has proved a poor commercial speculation, but has been of great service to Edinburgh, by introducing coal at a cheap rate to the city, and affording an exceedingly convenient means of conveyance for goods to and from Glasgow. The Caledonian Canal is formed in a great measure by a chain of lakes, stretching across the country from Inverness on the east to Loch Eil on the west coast, a distance of 59½ miles. The canal part is 20 feet deep, 50 feet wide at bottom, and 110 feet at top, which affords a passage to frigates of 32 guns, or merchant vessels of a similar size. This great canal was undertaken as a public work by government; and after a labour of eighteen years was opened in 1822, having then cost £800,000. It possesses 13 locks on the east and 12 locks on the west coast, the highest level being 94 feet. By this canal the dangers of rounding the northern extremity of the island, by the Pentland Firth, may be avoided; but from the prejudices of seamen it has never been much used, and is now abandoned by government to a private company. As a means of allowing steam-boats to run between the Clyde and Inverness, the canal has been of great public service.

CONVEYANCE BY STEAM POWER.



STEAM-BOATS.

Until the year 1807, the only means of communication by sea was by sailing vessels affected by the winds, and on the land by the power of draught in animals, both of which were exceedingly defective. In 1807, Fulton introduced the use of steam-propelled vessels on the Hudson, between New York and Albany. In 1812, Bell introduced a similar mode of steam navigation on the Clyde at Glasgow; and in two or three years afterwards, steam-boats were common on British rivers and on the sea around the coasts. We do not consider it of the least moment to mention how or by whom steam propulsion was first discovered; the merit of this and every other great invention is alone due to the person who brought it into practical use, and in the present instance it is clear that that person was Fulton.

Leaving all account of the *mechanique* of steam power, as applicable to propulsion, to be given in our article on the Steam-Engine, we need here only allude to the extraordinary changes which have been effected upon conveyance by sea and land by this newly applied motive force.

Steam navigation has hitherto been chiefly applied to coasting and voyaging on rivers and estuaries, and in these respects it has greatly altered the system of transit. In 1840 there were in the United Kingdom and colonies 630 steam-vessels, possessing an aggregate burden of 71,000 tons. The rivers on which they principally plied were the Thames, the Mersey, the Clyde, the Forth, the Tyne, and the Severn. The Clyde alone owned 76 steamers, having nearly 8000 tons. Besides those which were devoted to making trips up and down these rivers, a large proportion plied regularly between different coasts in Britain and Ireland, and between different ports and the Thames. From the Thames, also, steamers proceeded to many different ports on the continent. In short, steamers are now found traversing the whole line of coast, steering up and down rivers, and holding communication with ports in distant parts of the globe.

One of the finest lines of large steamers now in operation in Britain is that between Edinburgh and London. it has for several years consisted of from six to eight vessels of about 800 tons each, and these sail regularly twice a week. Formerly, the passage by sailing smacks occupied, on an average, six or seven days, but sometimes it was three weeks; now the voyage by steam is performed with remarkable precision in from 48 to 54 hours, the distance being 400 miles. The lines of steam-packets between Glasgow and Liverpool, Glasgow and Belfast, Liverpool and Dublin, Bristol and Cork, Aberdeen and London, Dundee and London, London and Rotterdam, London and Hull, London and Newcastle, Southampton and Havre, Dover and Calais, are all upon a great scale, and effect an amount of communication for passengers and transit for goods, of which no description of ours could convey any just idea.

The above may, however, be considered only to include those vessels which proceed on voyages of not more than two days' duration. Latterly there have been added steamers which proceed between England and Lisbon, and thence to Madeira; also steamers to India by the Cape of Good Hope; and more lately still, steamers which make the voyage across the Atlantic, and form a means of regular communication between Britain and North America. The Great Western, a steamer of 1340 tons burden, was the first large vessel which plied regularly on this station. This vessel departed from Bristol on the 7th of April, 1838, and reached New York on the 23d of the same month; but the clear days occupied on the passage were only 14. This voyage established the practicability of steam-vessels crossing the Atlantic, and now there are several which sail at regular intervals. Besides crossing from London, Bristol, and Liverpool, to New York, and returning, there is also a line of large steamers which sail between Liverpool and Halifax in Nova Scotia. The largest of the Atlantic steamboats is the British Queen, which measures in entire length 275 feet. Her two engines are of 250 horse power each, and she is calculated to carry 1862 tons. The outward voyage of 18 days of this magnificent steam-vessel requires a consumption of 540 tons of coal, and her homeward voyage of 12 days 360 tons. Larger and more powerful vessels are now in preparation.

On the coasts and rivers of North America, steam navigation has been carried on to a much greater extent than in Great Britain or any other country. In 1834, there were 234 steam-vessels on the Ohio, Mississippi, and other western waters; but now the number is above 500. Some of the American steam-vessels are larger than any in Britain, and also more splendid in decoration; but they are much more liable to accidents, from the employment of steam at a very high pressure, and a general carelessness in the mode of management.

The Rhine, the Seine, the Danube, and other large rivers on the continent of Europe, are now navigated by steam-vessels, chiefly for conveying passengers. The engines used are mostly made in England.

RAILWAYS.

Before the practice of steam navigation had attained that degree of improvement which it now possesses, a not less wonderful mode of travelling by steam power on land had come into use; wherefore, during the first thirty years of the nineteenth century, infinitely greater improvements in the means of locomotion have been discovered and brought into practical operation for the benefit of mankind, than had ever previously been known. To understand and value the application of steam-power to land-travelling, we must advert to the subject of draught on common roads.

There exist three obstacles to the rapid motion of carriages—terrestrial attraction, the atmosphere, and friction. By no human power can the two former be removed: but the latter can be so far modified as to form little or no opposition. On all common roads, no matter how well they may be constructed, there is a certain degree of roughness which it is impossible to remove, and this causes so great a friction, that to overcome it much of the drawing power is consumed without advancing the carriage. On some roads, the plan of laying down continuous lines or *tramways* of smooth pavement for the wheels to roll over, has been resorted to, but has never been found generally answerable, not only in consequence of the great expense of construction, but because drivers will not take the trouble to keep their vehicles upon it.

The draught of a horse upon a macadamized road may be estimated at fifteen hundredweight, walking at an ordinary pace and for several hours continuously. Particularly strong horses may habitually draw twenty or twenty-two hundredweight, but to cause them to pull to that amount is not economical. Allowing, however, that all horses can draw a ton weight, that is a small amount of draught in relation to great purposes of commerce; and the speed at which the fleetest horse can travel, when drawing a weight after it, though perhaps ten miles an hour, is unsuitable for the rapid transit of passengers on long journeys. To drag a mail-coach from London to Edinburgh, a distance of about 400 miles, in 43 hours, which was reckoned a good speed, it was necessary to employ four horses, and to change these every eight miles on an average; thus 200 horses were required for the performance of the whole journey. Having attained this rate of locomotion by improvements on roads, carriages, and in the breed of horses, nothing more could be done. Something new required to be devised.

The idea of employing steam-power to drag carriages over common roads, and thus save a large outlay for horses, besides accomplishing a greater speed, was suggested by various enterprising minds, but to its practical application there were and are many serious objections. Independently of the ordinary and unavoidable roughness of common roads, all highways are less or more uneven, because to construct them upon a perfect level throughout would be attended with an expense which the tolls from no traffic could sustain. The general unevenness of roads, therefore, causes a great loss of drawing power. In these circumstances, it is evident that, for the avoidance of friction and economizing of forces, an entirely new species of road required to be contrived. This important desideratum is found in the invention of *railways*. The design of a railway is to furnish a hard, smooth, and unchanging surface for wheels to roll upon. No provision, as respects smoothness, is required for any part of the path, except the narrow lines which are immediately to come under the rim of the wheels. Accordingly, it is sufficient to provide two rows or lines of strong and straight iron rails, that is, long slips of iron about an inch in thickness, and four or six inches deep. These rails, laid in two parallel lines, to suit the width of a carriage, are raised a little above the general level of the ground, being placed neatly end to end, and secured by fastenings to blocks of wood or stone at short intervals. Such is the very simple contrivance of a railway, or *chemin de fer* (road of iron), as it is called by our French neighbours. By the establishment of railways, a way was opened for the adaptation of steam power to locomotion, and now, as is well known, this has come generally into use.

The earliest railway of which there is any account was one constructed near Newcastle-upon-Tyne. In Roger North's Life of Lord Keeper North, he says that at this place, in 1676, the coals were conveyed from the mines to the banks of the river, "by laying rails of timber exactly straight and parallel; and bulky carts were made with four rollers fitting those rails, whereby the carriage was made so easy, that one horse could draw four or five chaldrons of coal." One hundred years afterwards, about 1776, Mr. Curr constructed an iron railroad at the Sheffield colliery. The rails were supported by wooden sleepers, to which they were nailed. In 1797, Mr. Barnes adopted stone supports in a railroad leading from the Lawson main colliery to the Tyne, near Newcastle; and in 1800, Mr. Outram made use of them in a railroad at Little Eaton in Derbyshire. Twenty-five years afterwards, this species of road was successfully adopted on a public thoroughfare for the transportation of merchandise and passengers, namely, the Stockton and Darlington railway, which was completed in 1825, and was the first on which this experiment was made with success. From that time, accordingly, a new era commenced in the history of inland conveyance.

It is a remarkable circumstance, that the early practisers of railway conveyance could not imagine that a carriage, moved by steam-power, could proceed along rails without the aid of toothed wheels and a rack; and to overcome this imaginary difficulty, no small degree of expense and labour was fruitlessly incurred. About the year 1815, Mr. Blackett, of Wylam, near Newcastle, effectually proved, by repeated experiments, that the adhesive power of the wheels on the rails was at all times sufficient to cause a progressive motion in an engine, with a train of loaded carriages, upon a railway either level or with a small acclivity. Important as was this discovery, fifteen years elapsed before steam locomotives were established. This great triumph of art occurred in connection with the opening of the Liverpool and Manchester railway, on the 15th of September, 1830, since which period railways have spread to all populous parts of the country.

Simple as is the idea of a railway, a prodigious expense is necessarily incurred in bringing it into practical operation. All inequalities of surface in the ground must be removed, low parts must be filled up by embankments, high parts must be reduced, eminences, which it would be impolitic to level, must be perforated by tunnels—the whole route being brought as nearly as possible to a level. Besides, the land over which it is to proceed must be purchased, frequently at an exorbitant cost; and the preliminary expense of overcoming petty opposition and securing an act of parliament to establish the line, sometimes amounts to as much as £2000 per mile. An entire charge of £30,000 per mile is considered a moderate outlay in the construction of railways in Britain.

No long line of railway that has yet been formed is perfectly level throughout, but the acclivity is seldom more than one foot per mile, and this does not produce any retardation, which it would be absolutely necessary to obviate by an excess of expenditure. Every line, also, is curved, or bent from a truly straight direction, at various places in its course; and this is another evil which it is necessary to tolerate to a certain extent, rather than avoid by uneconomical outlay. For the reasons now stated, nearly all railways are neither perfectly straight nor perfectly level; and so far as such is the case, there is loss of power in drawing vehicles along them. Yet, in the most disadvantageous known circumstances, the railways are so comparatively smooth and suitable for transit, that they allow the nearest approach to a total absence of friction. It is deserving of notice, that the absence of friction in railroads is advantageous not only in the saving of power, but the saving of painful sensations to the traveller. The suffering usually endured in ordinary modes of land-conveyance is that which chiefly arises from *friction*. Friction is the grand evil to be overcome. Were friction altogether removed, we should feel no sensation in moving; as, for example, we experience no sensation of motion in being carried along with the earth in its ceaseless rotations, although proceeding at an inconceivable velocity. It may be argued from these premises, that no one need fear to be carried at any rate of speed—even a hundred miles an hour—provided the motion be perfectly smooth or free from friction, and that there is a protection from the atmosphere. Practically, in locomotion upon railways, a degree of friction is required between the wheels and the rails, to cause adhesion, and this is accomplished by the ordinary roughness of the iron.

Rails.—The experience of ten years has introduced a few improvements in the construction and management of railroad. At first, malleable iron rails were considered to be preferable to those of cast-metal; but now it is understood that cast rails, if properly made, will endure all the tear and wear to which they can be fairly subjected. To be of the strongest and best form, each individual rail should be at least twelve feet in length, four inches in depth at the two ends, and thence gradually swelling beneath in the fish-belly form to the centre. The thickness should be fully one inch, and the upper surface, on which the wheel is to run, should be an inch and three-quarters or two inches, so as to project laterally like the cross top of the letter T. The rails are to be supported at their joint extremities, where they are pinned together, and also at intervals of every three feet. The supporters should consist of transverse bars of wood, sunk in the ground; by being thus crossing from the one track to the other, both lines of rail are kept from separating or shifting, and if there is any tendency to subside, both are equally lowered. On many lines of railroad stone sleepers are preferred to wood, but, as it seems with no adequate advantage. Stone sleepers present too unyielding a base to the rolling of the wheels, and cause a jolting most injurious to the mechanism of the carriages. In several instances, lines with stone sleepers have been taken up, and wood substituted. The railways in Belgium are laid on wood. To attain the highest perfection in the mode of laying rails, a plan has been followed on the Newcastle and Shields line, and also on that of the Great Western between London and Bristol, of placing rails having an even under side upon longitudinal beams of timber, which are united at certain intervals by transverse bars: thus the whole substructure is a handsome framework laid on the ground, and presents the best species of support. In general, this will be found too expensive a kind of railway; and it may be anticipated that the method of fixing rails upon cross-bars of wood, at intervals of three feet, will ultimately come into universal use.

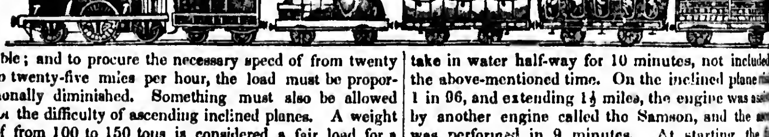
Turn-outs.—If all the wagons upon a railroad, whether for the transportation of passengers or merchandise, were to travel at the same time, and at the same speed, two sets of tracks would be sufficient to accommodate the whole, as there would be no necessity of their turning out to pass each other. But in the transportation of passengers, greater speed is desirable than in the transportation of merchandise; for the transportation of merchandise, whether by horse-power or steam-power, can be done more economically, and with less injury to the road, at a low than a very high rate of speed. It is, therefore, a very considerable object, in railroads upon lines of public travel, to allow wagons to pass others travelling in the same direction. Provision must be made, accordingly, for turning out. This provision is particularly necessary in case of a road with a single set of tracks, on which the carriages must meet. These turn-outs are made by means of a movable or switch-rail at the angle where the turn-out track branches from the main one. This rail is two or three feet, more or less, in length, and one end may be moved over that angle, and laid so as to form a part of the main track, or the turn-out track. The switch-rail is usually moved by the hand, so as to form a part of that track on which the wagon is to move.

Carriages—Wheels.—The principal consideration, in regard to the construction of carriages, relates to their bearings on the axle and the rim of the wheel. The rule given by Mr. Wood, as to the bearing on the axle, is, that in order to produce the least friction, the breadth of the bearing should be equal to the diameter of the axle at the place of bearing. This diameter must be determined by the weight to be carried; and the breadth of the bearing will accordingly vary with it. In order to keep the wheels fairly on the rails, they are furnished with thin edges which dip on the outside; these *flanges* are about an inch and a half in depth. The mid-wheels of locomotives are now made without flanges, but the fore and hind pair require flanges of rather more than usual depth. Wheels of large diameter move with greater ease over the rails than those which are small, because the large ones, in this as in all similar cases, have more power in overcoming obstacles. Yet there is a proper medium in the dimensions of wheels. Large wheels are inconvenient in point of height, and are apt to produce a rocking motion. It would appear that the most suitable diameter for the wagon or carriage wheels is from two and a half to three feet, which is the usual size. The wheels of the locomotive have a diameter of about four feet; to make them broader is considered injudicious.

Curvatures in the Road.—The curvatures of the railroad present some obstructions, since the axles of the car and wagons being usually fixed firmly to the frames, every bend of the tracks must evidently cause some lateral rubbing, or pressure of the wheels upon the rails, which will occasion an increased friction. If the wheels are fixed to the axles, so that both must revolve together, according to the mode of construction hitherto most usually adopted in passing a curve, the wheel that moves on the outside or longest rail must be slided over whatever distance it exceeds the length of the other rail, in case both wheels roll on rims of the same diameter. This is an obstruction presented by almost every railroad, since it is rarely practicable to make such a road straight. The smallest curvature that is allowable should not be less than a radius of 300 feet. In going round a height, the radius should on no account be so small as this, in order that the engine drivers may have a clear look-out ahead, and so prevent collisions and overtakings on the road.

Inclined Planes.—Where the inclination of the road is greater than that for which the ordinary power is calculated, the ascent must be effected by means of an additional power, the amount of which can be readily computed, since in those parts no additional friction of the cars or wheels is to be provided for, and only the additional resistance arising from gravity is to be overcome. If, for instance, the additional inclination is one in ninety-six, or fifty-five feet in a mile, the additional power must be to the weight as one to ninety-six, or as fifty-five to the number of feet in a mile, namely, 5280. In descending planes, so much inclined that the gravity would move the carriages too rapidly for safety, the velocity is checked by means of a break, which consists of a piece of wood of the same curvature as the rim of a set of the wheels, upon which the break is pressed by means of a lever, so adjusted as to be within reach of the conductor, in his position on the carriage.

Locomotive Engines.—Within the last few years, very considerable improvements have been made in the construction of the locomotives by which the draught of the trains of carriages is effected. Originally the locomotive was placed upon four wheels, the two front ones being smaller than those behind. Now, six wheels are employed, the front and hind pair being smaller than those in the middle, these middle ones being the wheels upon which, by the action of cranks from the engine, the whole mass is propelled. As may be seen by the small annexed engraving, which represents a railway train, the locomotive consists of a long iron barrel or cylinder supported by six wheels, with a chimney rising in front, and affording standing space behind for the engineer who conducts and regulates the machine. It is unnecessary to confuse the mind of the unscientific reader with a minute account of this wonderful apparatus; it will suffice to say, that the end of the barrel-like object next the engineer, consists of a furnace or fire-box, and the heat generated in it by the consumption of coke, is conducted thence through a great number of tubes in the cylinder, and finally escapes at the chimney. The cylinder in which the water is boiled and steam generated, is sheltered from the external air by a case; and by receiving the action of heat from so many tubes passing through it, the steam is rapidly generated for the use of the engine. The engine lies horizontally beneath the chimney, and in such a position as to permit the working of the piston upon the crank of the axle of the middle set of wheels. By means of lever handles affecting the mechanism, the engineer can at pleasure produce or stop the motion, as effectually and much more readily than a coach-driver could set off or arrest the progress of his horses. Immediately behind the locomotive is a carriage called the tender, which is loaded with a supply of fuel and a tank round its sides containing water. The weight of a locomotive, supplied with its proper quantity of water and fuel, is about twelve tons. The tender, when filled with water and fuel, weighs seven tons: it can carry 700 gallons of water, and eight hundredweight of coke forms a sufficient supply for a trip of from thirty to forty miles with an ordinary load. The cost of a locomotive is about £1700, and it seldom wears longer than two years without undergoing a very extensive repair. On the Great Western Railway, which is of unusual breadth of track, the locomotives are much larger and more powerful. Ordinary locomotives evaporate seventy-seven cubic feet of water per hour, but those on the Great Western evaporate about 200 cubic feet. It is calculated that the evaporation of one cubic foot per hour, produces a great mechanical force of nearly two horse power; consequently, to ascertain the power of a locomotive, we must multiply by two the number of cubic feet which it evaporates per hour. In common circumstances, an ordinary sized locomotive exerts a power of 150 horses, and larger one exerts a power of 400 horses. To estimate this degree of force, it is necessary to recollect that a horse upon a common road cannot draw for any length of time more than fifteen hundredweight, while on a railway it will pull with equal ease ten tons, being thirteen times the amount. We may now, therefore, compute that the power of a locomotive, such as is usually employed, is equal to a draught of 1500 tons. With the weight to drag, however, only a slow motion is obtainable; and to procure the necessary speed of from twenty to twenty-five miles per hour, the load must be proportionally diminished. Something must also be allowed for the difficulty of ascending inclined planes. A weight of from 100 to 150 tons is considered a fair load for a locomotive to draw; but it is seldom more than sixty to seventy tons. The following experiments on the power of draught were made by Dr. Lardner on the Liverpool and Manchester Railway in 1832:—



"On Saturday, the 5th of May, the engine called the Victory took 20 wagons of merchandise, weighing gross 92 tons, 19 cwt., 1 qr., together with the tender containing fuel and water, of the weight of which I have no account, from Liverpool to Manchester (30 miles), in 1 hour, 34 minutes, 45 seconds. The train stopped to take in water half-way for 10 minutes, not included in the above-mentioned time. On the inclined plane rising 1 in 96, and extending 1½ miles, the engine was assisted by another engine called the Samson, and the ascent was performed in 9 minutes. At starting, the fire-place was welled with coke, and the coke supplied to the tender accurately weighed. On arriving at Manchester, the fire-place was again filled, and the coke remaining in the tender weighed. The consumption was found to amount to 929 pounds net weight, being at the rate of one-third of a pound per ton per mile. Speed on the level was eighteen miles an hour; on a fall of 4 feet in a mile, 21½ miles an hour; fall of 6 feet in a mile, 25½ miles an hour; on the rise over Chat Moss, 8 feet in a mile, 17⅞ miles an hour; on ground sheltered from the wind, 20 miles an hour. The wind was moderate; but direct ahead. The working wheels slipped three times on Chatmoss, and the train was retarded from two to three minutes. The engine, on this occasion, was not examined before or after the journey, but was presumed to be in good working order.

"On the 29th of May, the engine called the Samson (weighing 10 tons 2 cwt., with 14 inch cylinders, and 16 inch stroke; wheels 4 feet 6 inches diameter, both pairs being worked by the engine; steam 50 lbs. pressure, 130 tubes) was attached to 50 wagons laden with merchandise; net weight about 150 tons; gross weight, including wagons, 223 tons 6 cwt. The tender weighed 7 tons, making a gross load (including the engine) of 240 tons 3 cwt. The engine with this load travelled from Liverpool to Manchester (30 miles) in 2 hours and 40 minutes, exclusive of delays upon the road for watering, &c.: being at the rate of nearly 12 miles an hour. The speed varied according to the inclinations of the road. Upon a level, it was 12 miles an hour; upon a descent of 6 feet in a mile, it was 16 miles an hour; upon a rise of 8 feet in a mile, it was about 9 miles an hour. The weather was calm, the rails very wet; but the wheels did not slip, even in the slowest speed, except at starting, the rails being at that place soiled and greasy with the slime and dirt to which they are always exposed at the stations. The coke consumed in this journey, exclusive of what was raised in getting up the steam, was 1762 lbs., being at the rate of a quarter of a pound per ton per mile."

General Appearance and Management.—In America and Belgium, most lines consist of but one track; in Great Britain all possess two tracks, suitable for trains going in opposite directions, besides which there are turn-offs at which quick-going trains may pass those of slower motion. At certain convenient points along the line there are station-houses, at which the trains stop to take up and set down passengers, and there is no stoppage at any other place. On most of the lines there are slow trains, taking goods and second-class, or an inferior kind of carriages, and fast trains, taking only first and second-class carriages; some lines also have mail trains, which proceed at more than usual speed, and taking only first-class carriages, stop at fewer places by the way. The first-class carriages are covered, and resemble three coach bodies united, but of more commodious dimensions; second-class carriages are open at the sides, and not lined with any stuffing; third-class carriages are entirely open; goods carriages are open trucks, on which the articles are piled and fastened; trucks for cattle are open with a railing round the sides. All the carriages in a train are linked one to the other by strong iron hooks; and to prevent them from shocks against each other, the various carriages are provided with projecting rods on springs, cushioned at the outer extremities. Generally, the fares charged for transmission are higher than they need be; a common charge is at the rate of 3d. per mile for each passenger in a first-class carriage; and it is understood that lower rates would create more than a compensatory amount of traffic.

There are certain excellences in the arrangements of the railways which deserve to be mentioned. Each line, being the property of a private association, is secluded from one end to the other from the intrusion of the public; and therefore no jostling or confusion takes place, either upon entering or leaving the carriages. The rails of one line, likewise, join those of another, by which means carriages generally proceed onwards without changing passengers or luggage. A carriage in which passengers take their seats at London goes straight to Preston—that is, along the lines of three companies. The extraordinary magnitude of the railway undertakings has enabled the directors to organize rules which could never be enforced in the irregular scramb of stage-coaching. It is customary to dress the subordinate functionaries on all the lines in a uniform resembling that of the London police—each man having his number inscribed in figures on some part of his dress; so that, if any one be guilty of incivility or inattention, he can be easily reported to his superior. There is one pleasing peculiarity in the arrangements, which is entitled to the highest commendation: it is the rule that no officer shall on any account take a fee from passengers, on pain of instant dismissal. Those who imagine that fees to guards, coachmen, or waiters, are requisite to ensure civility, will be surprised to find that railway attendants are infinitely more polite and attentive than their brethren of the coach conveyances. This, in itself, gives travelling by railway a great superiority over all other modes of public conveyance.

The London and Birmingham line, which was the first completed after that of Manchester and Liverpool, has always appeared to us to be among the best managed of the various railways, as well as the most complete in all its arrangements. There are accommodations on this line which are to be seen on no other. On all the lines there are waiting-rooms both for ladies and gentlemen at the different stations; but exclusively of those on this line, there is a large and commodious house of entertainment at the Birmingham terminus, where meals stand ready prepared for the passengers. At Wolverton, a place half way from the metropolis, and where the train stops ten minutes, there is likewise a large establishment in the form of an open booth or shop where tea, coffee, or viands of a more substantial kind, with different liquors, are sold on the instant to those who require refreshment.

Passengers who make the journey for the first time by the mail-train, will be amused by observing a travelling post-office in the string of carriages. This "Grand Northern Railway Post-Office," as the inscription on its side denotes, is a carriage consisting of two small apartments, one of which is appropriated to the guard, whose duty is to exchange the bags, and the other is fitted up with a table for sorting letters, and holes round the walls for their reception. The manner in which the duties of the clerk and guard are performed in this flying-office, is strikingly significant of the new order of things introduced by the railway system. Outside the vehicle a species of net is extended by a hoop, and into this the letter-bags are dropped as the train sweeps onward in its course, the bags which are to be left being at the same time tossed from the window by the guard. The fresh bag of letters being received, it is speedily opened, its contents re-arranged, and a new bag for next town being made up, it is projected as before at the place of its destination. By this means a letter may be written, sent through the post-office, and delivered at the distance of twenty miles, in the space of a single hour.

The number of railway companies incorporated by act of parliament up till January 1839, in Great Britain and Ireland, was 107, and the capital which they were allowed to raise by shares was £41,610,814; they were besides allowed to raise by loan £16,177,630. A considerable number of these railways being jobbing, or at least crude speculations, have never commenced, and the number of railways actually begun to be prepared or finished at the beginning of 1840, in the united kingdom, was only about fifty. The principal lines are—the Liverpool and Manchester Railway, about thirty two miles long, and uniting these populous towns; the London and Birmingham Railway, about one hundred and twelve miles long, connecting the metropolis with the centre of England; the Grand Junction Railway, continuing the London and Birmingham line to that of Liverpool and Manchester, and also to a

Entrance to the Railway Tunnel, Liverpool.

railway proceeding northward to Lancaster, and thus forming a most important thoroughfare obliquely across the country; the Midland Counties, North Midland, and Great North of England railways, connecting the great seats of trade in Northumberland, Durham, Yorkshire, and Derbyshire, with the London and Birmingham line; the New Castle and Carlisle Railway, connecting these towns; the Great Western Railway, about one hundred and seventeen miles long, connecting London with Bristol, and with smaller tributary lines opening up the west of England; the South-Western Railway, about seventy-seven miles long, connecting London with Southampton; the Manchester and Leeds Railway, connecting these populous towns. In Scotland, the Edinburgh and Glasgow Railway, and the Glasgow and Ayr Railway, are the principal lines. The greatest of the whole of these undertakings is the Grand Western. This line has two tracks, each of seven feet wide, while on all other railways in this country the width is between four and five feet; the carriages, therefore, which run on the Grand Western, must be necessarily confined to itself. The most prosperous of all the lines is that of the London and Birmingham, the weekly revenue of which is upwards of £16,000: the weekly revenue of the Grand Junction, which joins it, is £9000.

The speed at which railway trains usually proceed is from twenty to twenty-five miles per hour, though sometimes it is much more. At the ordinary rate of speed, a journey from London to Liverpool by the mail train is performed in about nine hours; and when railways are extended north to Edinburgh, the journey from London to that city will be performed in eighteen hours, or perhaps less. Travelling by railway at any of the common rates of speed is attended with less personal danger than stage-coaching, because the locomotives are perfectly under control. Any deaths or personal injuries which have occurred on railways, are, with scarcely an exception, attributable to the carelessness of the engine-drivers, and by the employment of a superior class of men to direct the motions of the trains this fruitful cause of mischief is in the course of being obviated. With this improvement, conveyance by railways will be ranked among the most useful and stupendous inventions of art.

[RECENT OPERATIONS IN RAILWAYS.

Since the first publication of the preceding article, the subject of transportation and travelling by railways has received increased attention in Great Britain and on the continent of Europe, especially in France. Like all other subjects which are discussed in countries possessing an active and widely diffused system of newspapers, it attracted the universal attention of the trading and business community; and speedily led to an extensive system of speculations. An immense number of companies were formed and routes were surveyed and laid out for railways in every part of the United Kingdom. Parliament was beset with innumerable applications for charters; and the whole trading community became infected with the rage for speculation in railway shares. The same scene was exhibited in France and Belgium on a smaller scale. At length certain statistical calculations were made and published, by which it became apparent that more capital would be required to complete all these railways within the time proposed than could possibly be raised for the purpose; and that the amount of travelling required to enable the companies to pay their current expenses and the interest on the capital invested, was much greater than could ever become necessary;—in short, that the greater number of the projected railways would ultimately turn out a dead loss. The consequence was, as usual in such cases, a general explosion of these schemes, and the ruin of the large holders of stock. Nevertheless, a considerable number of railways, which had been judiciously planned and were sustained by heavy capitalists, are either completed or in a course of completion.

In the United States, many extended and useful railways have been completed within a few years. The most important and profitable of these is the Great Western Railroad from Boston to Albany, which by opening a direct communication between New England and the Western States, has wonderfully benefited the manufactures and trade of New England, and especially of its capital, Boston. A similar undertaking with reference to Philadelphia is now proposed, the Central Railroad from Philadelphia to Pittsburg; and its completion is expected to prove of immense importance to the industry and trade of Philadelphia.

In every part of the United States the railway system is making steady and rapid progress, thereby increasing the facilities for internal commerce and national defence.—*Am. Ed.*]

NATURAL PHILOSOPHY.

Natural Philosophy is a term of wide import, and has a reference to all those branches of physical science which treat of existing substances, their motions, their mutual connection, and their influence on each other. In this enlarged sense it may be considered as embracing astronomy, mathematics, dynamics, hydrostatics, geology, chemistry, optics, botany, in short, a vast range of human knowledge, which for the sake of convenience is usually divided into distinct branches of science. In its more limited and ordinary meaning, the term applies only to inorganic substances, and the laws which regulate their connection with each other, but without alteration of character; and it is this most important branch of knowledge, which in reality is the basis of all others, of which we now propose treating. We shall commence with an explicit definition of the meaning of the term *substances* or *matter*, it being necessary that this be clearly understood.

MATTER AND ITS PROPERTIES.

Matter—or that of which all bodies are composed whose existence is made known to us by means of the senses or by the test of philosophic experiment—is possessed of various properties, some of which are essential to its existence, while others are only accidental or contingent. The essential properties of matter are Impenetrability, Extension, Figure, Divisibility, Inertia, and Attraction.

Impenetrability is that quality of bodies, in virtue of which each occupies a certain portion of space, and excludes other bodies from existing in the same place at the same instant. In the usual sense, we call any hard body, such as a stone, impenetrable, because it firmly resists our efforts to pierce it. But as it is understood philosophically (although we can condense, pierce, and remove the greater number of them), all bodies are alike impenetrable, because they equally possess the property of excluding other substances from the spaces which they occupy. This, in fact, is saying no more than that two things cannot be in the same place at once, which is a self-evident truth, whether we apply it to a single particle of matter or a large mass.

Every body, or portion or particle of matter, possesses a certain extension or magnitude. It is impossible to form a conception of matter, however minute may be the article, without connecting with it the idea of its having certain bulk, and filling a certain extent of space. In common phraseology, we express this property of bodies by the word *size* or *volume*.

The next property demanding our attention is the *figure* of bodies. Figure or form is the result of extension, for we cannot have the idea of a body possessing length and breadth, without its having some kind of figure, however irregular. The volume of a body has no relation to its figure. Bodies which have the same figure may possess very different volumes; and bodies may have the same volume, but possess very different figures. Thus, two masses of matter may have the same volume, although the one be round and the other be square.

Matter is divisible into parts, and these parts may again be subdivided into other parts. By this is meant *divisibility* or separability. To the practical subdivision of matter there seems to be no assignable limit; and many of the instances of it which may be found in philosophical investigations almost exceed credibility. The thinnest part of a soap-bubble, which is a thin shell of water and the matter of soap, does not exceed in thickness the 2,500,000 part of an inch. The useful arts, also, furnish many striking examples; but it is in the organized world that the most astonishing proofs of the extreme divisibility of globules, or particles of matter, are to be found.

Animalcules—that is, animals which are so small as to be invisible to the naked eye, and which, by means of microscopes, are seen floating in water—are in some cases so minute, that it would require a million of them to form the bulk of a grain of sand. As these animalcules possess, in every case, a perfect organization to enable them to perform all the functions of life, the smallness of their different parts, and the extreme minuteness of the particles of matter which compose them, are too exquisite to be made the subject of calculation: the imagination is lost in the contemplation of their wonderful economy. The effluvium or odour which excites the sensation of *smell*, consists of an incalculable number of particles of matter floating in the atmosphere, and so minute as to be altogether invisible to the eye. These particles are not more remarkable for their inconceivably small size than for the length of time which they will remain in suspension in the atmosphere, or in connection with some particular place. The effluvium given forth by a single grain of musk has been known to perfume a large apartment for twenty years, and yet at the expiry of that period there was no sensible diminution of the little mass of matter from which the smell had proceeded.

The diffusion of particles of matter invisible to the naked eye, is also obvious in the case of the melting of a piece of sugar in our tea; the solid mass of the sugar disappears, and the particles of which it was composed are diffused in the liquid. There is a similar diffusion of particles of salt in the ocean. When we look through a glass full of sea water, we perceive that it is pure and limpid; but if we pour the water into a vessel on the fire, and boil it, we shall at length discover that, while the liquid has escaped in the form of vapour, the particles of salt it held in solution remain incrusted on the vessel.

Particles of matter are never destroyed or lost, although they may disappear from our immediate observation Under certain circumstances, the particles may again be collected into a body without change of form. Mercury, water, and many other substances, may be converted into vapour, or distilled in close vessels, without any of their particles being lost. In such cases, there is no decomposition of the substances, but only a change of form by the heat; and hence the mercury and water assume their original state again on cooling. When bodies suffer decomposition or decay, their elementary particles, in like manner, are neither destroyed nor lost, but only enter into new arrangements or combinations with other bodies. When a piece of wood is heated in a close vessel, such as a retort, we obtain water, an acid, several kinds of gas, and there remains a black, porous substance, called charcoal. The wood is thus decomposed, or destroyed, and its particles take a new arrangement, and assume new forms; but that nothing is lost is proved by the fact, that if the water, acid, gases, and charcoal, be collected and weighed, they will be found exactly as heavy as the wood was, before distillation. In the same manner, the substance of the coal burnt in our fires is not annihilated; it is only dispersed in the form of smoke, or particles of culm, gas, and ashes or dust. Bones, flesh, or any animal substance, may in the same manner be made to assume new forms, without losing a particle of the matter which they originally contained. The decay of animal or vegetable bodies in the open air, or in the ground, is only a process by which the particles of which they were composed change their places and assume new forms.

The decay and decomposition of animals and vegetables beneath the surface of the earth, fertilize the soil, which nourishes the growth of plants and other vegetables; and these, in their turn, form the nutriment of animals. Thus is there a perpetual change from death to life, and from life to death, and as constant a succession in the forms and places which the particles of matter assume. Nothing is lost, and not a particle of matter is struck out of existence. The same matter of which every living animal and every vegetable was formed in the earliest ages, is still in existence. As nothing is lost or annihilated, so it is probable that nothing has been added, and that we ourselves are composed of particles of matter as old as the creation. In time, we must in our turn suffer decomposition, as all forms have done before us, and thus resign the matter of which we are composed, to form new existences.

Inertia means passiveness or inactivity. Thus, matter is perfectly passive in submitting to any condition in which it is placed, whether of rest or motion. When at rest, it shows an inability or reluctancy to move; and when in motion, it shows an equal inability or reluctancy to come to a state of rest. It is obvious that a rock on the surface of the earth never changes its position in respect to other things on the earth. It has of itself no power to move, and would therefore for ever lie still, unless moved by some external force. Now, it is just as true that inert matter has no power to bring itself to rest when once put in motion, as that it cannot put itself in motion when at rest; for having no life, it is perfectly passive both to motion and rest, and therefore either state depends entirely upon external circumstances.

Many instances might be given of the tendency which matter has to remain in the condition in which it happens to have been already placed. The following are among the most instructive:—When the sails of a ship are loosened to the breeze, slowly and heavily at first the vessel gets into motion, but gradually its speed increases, as the force by which it is impelled overcomes the inertia of its mass. A great force is necessary at first to set a vehicle in motion; but when once this is effected, it goes onward with comparative ease, so that, in fact, a strong effort is necessary before it can be stopped. If a person be standing in it when it is suddenly set a going, his feet are pulled forward, whilst his body, obeying the law of inertia, remains where it was, and he accordingly falls backwards. On the other hand, if the vehicle be suddenly stopped, and the individual be standing in the same position as formerly, the tendency which his body has to move forward—for it acquired the same motion as the carriage by which it was borne along—will cause him to fall in the opposite direction.

The following is a familiar example of the inertia of matter:—Upon the tip of the finger let a card be balanced, and a piece of money—say a shilling—laid upon it. Let the card then be smartly struck, and it will fly from beneath the coin, leaving it supported upon the finger. This arises from the inertia of the metal being greater than the friction of the card which passes from beneath it.

Coursing, or hare-hunting, affords a striking illustration of inertia. In that field sport, the hare seems to possess an instinctive consciousness of the existence of this law of matter. When pursued by the greyhound, it does not run in a straight line to the cover, but in a zigzag one. It *doubles*, that is, suddenly changes the direction of its course, and turns back at an acute angle with the direction in which it had been running. The greyhound, being unprepared to make the turn, and therefore unable to resist the tendency to persevere in the rapid motion which it has acquired, is impelled a considerable distance forward before it can check its speed and return to the pursuit. But, in the mean time, the hare has been enabled to shoot far ahead in the other direction; and although a hare is much less fleet than a greyhound, by this scientific manœuvring it often escapes its pursuer. Those who have witnessed horse-racing, may have observed that the horses shoot far past the winning-post before their speed can be arrested. This is also owing to the inertia of their bodies.

We have now arrived at a most important property, *attraction*, which it is desirable should be carefully studied. It is a fundamental law of nature, ascertained by Sir Isaac Newton, that every atom or particle of matter has a tendency to approach or to be attracted towards another atom or particle. This forms one of the leading principles in modern natural philosophy. Experience and observation demonstrate that this power of mutual attraction pervades all material things, and, though unseen except in its results, is ever present with us—is the cause of particles of matter adhering to each other, and forming solid masses—of these masses assuming in many instances a round or globular form—of the falling of bodies to, and their stability on, the earth—and is one of the causes of the whole of the planetary bodies moving in their paths in the heavens.

Attraction is of different kinds, although some of these may be merely modifications of others, and has received different names according to the circumstances under which it acts. The force which keeps the particles of matter together, to form bodies, or masses, is called *attraction of cohesion*. That which inclines different masses towards each other, is called *gravitation*, or *attraction of gravitation*. That which causes liquids to rise in tubes, or in very confined situations, is called *capillary attraction*. That which forces the particles of different kinds of matter to unite, is called *chemical attraction*. That which causes the magnetic needle to point constantly towards the poles of the earth, is *magnetic attraction*. And that which is excited by friction in certain substances, is known by the name of *electrical attraction*.

Attraction of cohesion acts only at insensible distances, as when the particles of bodies apparently touch each other. This kind of attraction may be described as the quality in nature which causes matter to cohere or stick together. It is much stronger in some bodies than in others. It is stronger in the metals than in most other substances, and in some of the metals it is stronger than in others. In general, it is most powerful among the particles of solid bodies, weaker among those of fluids, and least of all, or almost entirely wanting, among elastic fluids, such as air and the gases. Thus, a small iron wire will hold a suspended weight of many pounds, without having its particles separated; the particles of water are divided by a very small force, while those of air are still more easily moved among each other. These different properties depend on the force of cohesion with which the several particles of these bodies are united.

When the particles of a body can be suspended in the air in a fluid state, they will, if not under the attractive influence of some other body, arrange themselves, by virtue of the same law, around a centre, and take a spherical or round form. Thus, a small quantity of dew suspended on the point of a thorn or leaf, becomes a globule, because in that case the attraction of the particles towards their own centre is greater than the attraction of any neighbouring body. Tears running down the cheeks, drops of rain, and hail are all examples of this tendency in insulated fluid bodies to assume the globular form. When two perfect globules of mercury are brought into contact, they instantly unite together, and form one spherical drop. The manufacture of shot is also a striking illustration. The lead is melted and poured into a sieve, at the height of about two hundred feet from the ground. Each stream of lead, immediately after leaving the sieve, separates into little globules, which, before they reach the ground, are cooled and become solid: thus is formed the shot used by sportsmen. To account for the globular form in all these cases, we have only to consider that the particles of matter are mutually attracted towards a common centre, and in liquids, being free to move, they arrange themselves accordingly. In consequence of this law of nature, it is considered probable that the planetary bodies, including our earth, were originally in a fluid state—that, in that state, they unavoidably assume a spherical form, and were then hardened into their present consistency.

The force by which small tubes, or porous substances, raise liquids above their levels, is called capillary attraction, from *capilla*, the Latin word for a hair. In a wet tea-cup, or other vessel containing liquid, you may perceive the liquid at the sides rising above the level of that of the other parts of the surface; this is caused by attraction. If two glass plates be brought very near each other, so as to stand parallel with their flat sides in almost mutual contact, and then their lower end be dipped into a vessel of water, the fluid will rise up between the plates, and the height to which it rises will be greater the nearer the plates are to each other. The water rises very little on the outsides of the plates, for this attraction is insensible at even moderately small distances. If a glass tube, with an exceedingly small or capillary bore, be dipped in water, the fluid will rise in the interior of the tube; and the smaller the bore, the higher does the water ascend.

A great variety of porous substances are capable of this kind of attraction. If a piece of sponge or a lump of sugar be placed, so that its lowest corner touches the water, the fluid will rise up and wet the whole mass. In the same manner, the wick of a lamp will carry up the oil to supply the flame, though the flame is several inches above the level of the oil. If the end of a towel happens to be left in a basin of water, it will empty the basin of its contents; and, on the same principle, when a dry wedge of wood is driven into the crevice of a rock, and afterwards moistened with water, as when the rain falls upon it, it will absorb the water, swell, and sometimes split the rock.

It is this kind of attraction which is supposed to be one of the causes of springs of water in the earth. The water creeps up by capillary attraction through porous beds of sand, small stones, and crevices of rocks, and in this manner reaches the surface even at great heights. The lower parts of the walls, and also the earthen floors of cottages, are in the same manner apt to become damp, by the attraction of the moisture upwards from the ground. Hence the necessity for clearing away all wet earthy matter from the foundations of houses.

Besides these varieties of attraction, there are, as already said, chemical, magnetic, and electric attraction, but as these are respectively alluded to under the heads Chemistry and Electricity in the present series of treatises, they do not require particular notice here, and we proceed to consider the kind of attraction which seems to unite all ordinary masses and particles of matter. Reference is here made to the *attraction of gravitation*.

As the attraction of cohesion unites the particles of matter into masses or bodies, so the attraction of gravitation tends to force those masses towards each other to form others of still greater dimensions. The force of attraction increases in proportion as bodies approach each other, and by the same law it must diminish in proportion as they recede from each other. Attraction, in technical language, is inversely as the squares of the distances between the two bodies; that is, in proportion as the square of the distance increases, in the same proportion attraction decreases, and so the contrary. Thus, if, at the distance of 2 feet, the attraction be equal to 4 pounds, at the distance of 4 feet it will be only 1 pound; for the square of 2 is 4, and the square of 4 is 16, which is 4 times the square of 2. On the contrary, if the attraction at the distance of 6 feet be 3 pounds, at the distance of 2 feet it will be 9 times as much, or 27 pounds, because 36, the square of 6, is equal to 9 times 4, the square of 2. The intensity of light is found to increase and diminish in the same proportion. Thus, if a board a foot square be placed at the distance of one foot from a candle, it will be found to hide the light from another board of two feet square, at the distance of two feet from the candle. Now, a board of two feet square is just four times as large as one of one foot square, and therefore the light at double the distance being spread over four times the surface, has only one fourth the intensity.

The gradual diminution of attraction as the distance increases, is exemplified in the following table. In the upper line, the distance is expressed by progressive numbers; in the lower corresponding squares the diminution of attraction is indicated by the common arithmetical fractions.

Distance	1	2	3	4	5	6	7	8	and so on
Attraction	1	$\frac{1}{4}$	$\frac{1}{9}$	$\frac{1}{16}$	$\frac{1}{25}$	$\frac{1}{36}$	$\frac{1}{49}$	$\frac{1}{64}$	and so on

It is here seen, that at the distance of 8, the attractive force is diminished to a 64th part of what it was at 1.

The attractive force of matter is also in proportion to the numbers of the atoms of matter which a body contains: the attraction, therefore, does not proceed from the mere surface of a body, but from all the particles which individually compose it. Some bodies of the same bulk contain a much greater quantity of matter than others: thus, a piece of lead contains about twelve times as much matter as a piece of cork of the same dimensions; and therefore a piece of lead of any given size, and a piece of cork twelve times as large, will attract each other equally. The attractive power of any mass acts from the centre. At all equal distances from the centre, the attractive power is equal; for instance, in a body perfectly spherical, the attraction to the centre would be the same at all parts of the surface. The distance of the centre of a sphere from its surface is called the *semi-diameter* of that sphere—that is, the half of its thickness. At a point as far from the surface of a sphere as its semi-diameter, its attractive power is diminished to a fourth. At three distances, the attraction is a ninth; at four distances, a sixteenth; and so on. When we wish, therefore, to ascertain the relative amount of the attraction which any mass of matter exercises over another, the rule is, to inquire how many semi-diameters of the one the other is distant from it, and then to multiply that number by itself. The result shows how many times the attraction at this distance is less than at the surface of the former. The moon, for instance, is distant 240,000 miles from the earth, or as much as sixty semi-diameters of the earth; 60 multiplied by 60 gives 3600; consequently, the attraction exercised by the earth upon the moon is a 3600th part of what it would exercise upon the same mass at its own surface. If the earth were a perfectly spherical body, its attraction would be equal everywhere at the level of the sea. As the surface at the pole is thirteen miles nearer the centre than the surface at the equator, the attraction is stronger at the former than at the latter place: it gets proportionally weaker as we advance towards the equator, on account of the increase of distance from the centre. Hence, a mass of iron which is considered a pound weight in Britain, would be less than a pound on the coast of Guinea, and more than a pound in Greenland, for weight is only a result of attraction. If we ascend a mountain, the effect is the same as if we proceed towards the equator: we are always getting farther from the centre of attraction, and consequently weights become lighter. On the top of a hill four miles high, a ball of four thousand pounds' weight would be found to be two pounds lighter.

Pressure downwards, or weight, is in philosophical language termed GRAVITY, and under that head it is hereafter treated, in connection with the phenomena of falling bodies.

The attraction of bodies is mutual, and in proportion to the quantity of matter they contain. Therefore, any body, however small, exerts some degree of attraction upon the mass of the earth. Any body which comes immediately under our observation, is so small in comparison to the earth, that its attractive force is altogether unappreciable; but if the body were of great density, and of dimensions approaching to those of the earth, then we should see the earth rise to meet the body, or fall towards the body. The heavenly bodies, when they approach each other, are drawn out of the line of their paths or orbits, by mutual attraction. It is found by experiment, that a plumb-line suspended in the neighbourhood of a mountain, is sensibly attracted towards the mountain from the true vertical line. The mutual attraction of matter is exemplified by the diminution of the weight of bodies as we penetrate into the earth. At the depth of a mile, a body weighing a pound would be found to be lighter than at the surface. This is in consequence of the attraction of the matter of the shell of the earth, which is exterior to the point, being nothing, in consequence of the attractions of its particles on this point counteracting each other; and hence the only efficient attraction on it arises merely from the smaller sphere below the point; and, therefore, the nearer the point is to the centre, the less is this internal sphere, and the less therefore is its attraction on the point. Were we to proceed to the centre of the earth, we should there find that weight altogether ceased, because the attractive power would be equal on all sides. Were there a cavity at the earth's centre, the body would hang suspended in space.

The attraction of the earth's mass performs an important function, in binding the atmosphere, which is an elastic fluid, around the surface of our planet, and in causing the air to perforate every open crevice and pore in the superficial substances of the globe. The attractive force, in this respect, produces what is called *atmospheric pressure*, the air being pulled or pressed down by a force equivalent to about 15 lbs. on the square inch, at the level of the sea, and diminishes in proportion to the distance above that common level.

THE REPULSIVE QUALITY IN MATTER—HEAT.

While attraction tends to unite and compress the particles of matter, there is another and equally universal principle known in familiar language by the appellation of *heat*, the tendency of which is to keep the particles of matter at a certain degree of expansion. Heat is often, in scientific works, named *caloric*, from the Latin word for heat. Heat pervades all things, but some in greater degrees than others. Even ice has been found to contain a certain portion of heat. In fact, there is no such thing in nature as positive cold. The things which seem cold to us, are only under a low degree of heat.

The absolute nature of this universal principle is unknown. We only know it by its effects, and the sensations it produces. Some have conjectured that it is a fluid; others think it is a quality or affection of matter, resulting from electrical action. From its producing no sensible difference in the weight of any substance, it has been called an *imponderable body*. When the heat of any particular substance, as ice, stone, or wood, is not sensible to us, it is called latent (that is concealed) heat. We may very readily detect its presence in a piece of wood or metal by rubbing or friction. If a button, for instance, be rubbed on a table, it will soon become too hot to be held by the fingers. In like manner, the axle of any carriage-wheel soon becomes hot, unless the friction is prevented by grease.

Heat, in its extreme form, becomes fire. Thus, if an ungreased wheel be rapidly turned for a long time on its axle, so much heat will be excited that both wheel and axle will burst into a flame. The effects of powerful friction are known to savage nations, among whom it is common to produce fire by rubbing two sticks together. Two pieces of flint struck together, or a flint struck hard upon a piece of iron, evolve sparks of fire. By such means, many important purposes are served; for instance the discharge of fire-arms. Fire can also be evolved from the common atmosphere, by compressing a quantity of it suddenly in a tube, at the bottom of which a piece of tinder has been placed. The evolution of heat by these means, and other circumstances, lead to the conclusion that heat is an element mixed up with the atoms of matter, which it serves to keep at a lesser or greater distance from each other. Thus, as we squeeze the pores of a sponge together, and disengage the liquid which they held in cohesion, so, when squeezing or rubbing a portion of matter, do we disengage the heat which it retained amongst its component atoms. In all cases of the development of heat by pressure, hammering, and friction, the cause is the squeezing together of atoms which had been kept asunder by the latent fluid, and which fluid must, as a matter of necessity, come forth and make itself sensibly felt or seen.

Heat, then, is a principle of *repulsion* in nature, and in this capacity its uses are as obvious as those of terrestrial gravitation, to which it apparently acts as a counterpoise. The force of attraction is so powerful, that, unless for a counteracting principle of repulsion, all bodies would hasten into close contact; there would be no air, no water, no vegetable or animal life; all would be a uniform dead solid mass, and the earth itself might perhaps be reduced to a small portion of its present bulk.

Heat, by pervading all things, modifies attraction, and, according to circumstances, regulates the density or solidity of bodies. Hence we possess in nature a beautiful variety of substances, some solid and hard, like stone and marble; others soft, or of the jelly form; a third class liquid, like water; and a fourth kind aëriform, or gaseous. Heat expands most bodies in proportion as it is increased in quantity, and they become solid in proportion as it is withdrawn. Water may thus be either expanded into the form of vapour or steam, or hardened into ice. When withdrawn, the process of *cooling* is said to take place; *cold* being simply a state of abstraction or comparative absence of heat.

Heat is diffused or communicated by *conduction* and *radiation*. When it passes slowly from one portion of matter to another in contact with it, it is said to be conducted; and the process, in scientific language, is termed the *conduction of caloric*. Metals are the best conductors, then liquids, and lastly, gases. Gold, silver, and copper, are the best conductors among solids; glass, bricks, and many stony substances, are very bad conductors; and porous spongy substances, as charcoal, hair, and fur, are the worst. Clothing is generally made of bad conductors, that the heat of the body may not be conducted quickly to the surrounding air. Furnaces, where great heat is required, are built with porous bricks, which are very effectual in preventing the escape of heat, and do not readily communicate the fire to adjacent bodies.

Heat is said to radiate when it is emitted from a fire or from the rays of the sun, and affects the atmosphere or substances at a distance from its source. Radiant heat is absorbed when it falls upon bodies having painted or rough surfaces, such as are presented by bricks and other porous solids, by many kinds of stony matter, and numerous animal and vegetable substances, and makes them warmer as it is taken up. But brilliant and polished metallic surfaces absorb little heat; they reflect or turn it back again. Heat, as already mentioned, can be brought into action in most substances, by percussion and rubbing. It is also produced by the burning of certain inflammable substances, as coal and wood; and in this manner its chief purposes in domestic economy are effected. But the most remarkable source of heat is the sun; though whether this luminary is a burning mass, throwing off warmth like a common fire or red-hot ball, or produces the effect by some peculiar and unknown operation, is as yet uncertain. Heat, besides being produced by the sun's rays, and by the friction and combustion of inanimate substances, is evolved by chemical action, a familiar example of which is observable in fermentation. It is by means of a natural chemical action in connection with the circulation of the blood, that heat is resident and sustained in most living animals. A stoppage of the circulation of the blood, as every one knows, leads to an absence of animal heat, or a very considerable degree of coldness. On the contrary, quick circulation of the blood, and active muscular motion, as well as rubbing, produce heat. In these cases of motion and rubbing, the heat seems to be in a great measure evolved by the momentary compression of the parts.

Heat is unequally distributed over the globe. At and near the equator, where the rays of the sun are sent in the greatest degree of directness, the greatest heat prevails. In the parts of the earth adjacent to the north and south poles, he transmits his rays so slantingly as to have little power; and there, accordingly, the air is seldom of a genial mildness. The higher we ascend in the air, the colder it becomes; the summits of very high mountains are always covered with snow. In penetrating into the body of the earth, after gaining a certain depth, the heat becomes greater in proportion as we descend. The interior of the globe is by many believed to be at a very elevated degree of heat, if not in a state of ignition. On the surface, great expanses of sea tend to equalize and temper the degrees of heat and cold in their neighbourhood, and great continents have the contrary effect.

The degrees of heat and cold in the atmosphere are called its temperature; and for ascertaining this correctly, with reference to a standard, a very ingenious instrument has been invented. This is called the *thermometer* (a word signifying heat-measurer). It is a glass tube with a bulb at the bottom, into which mercury or quicksilver is put, with a scale of figures along the tube to mark the rising of the quicksilver. This instrument differs from the barometer, in as much as the quicksilver is sealed up close from the air. The atmospheric heat, however, affects the metallic fluid in the bulb, and, according to its warmth, causes it to expand and rise in the tube. The degree of temperature is indicated by the figures to which it ascends.

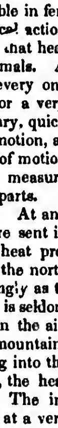


Fig. 1.

Our common thermometer has a graduation from No. 1, near the bulb, to 212, the degree of heat of boiling water. In the scale of figures, 32 is marked as the freezing-point—that is to say, when the mercury is at the height of 32, water freezes; and the more it is below that point, the more intense is the frost: 55 is reckoned moderate heat, and 76 summer heat, in Great Britain: 98 is the heat of the blood in the average of living men.

The rising of mercury in the table of the thermometer offers a familiar example of the repulsive power of heat in expanding or dilating bodies. Common experience affords many such examples. A bar of iron is longer and thicker when hot than when it is cold. The iron rim of a wheel slips easily into its place when hot, and grips or binds fast when it becomes cool. When heated from 32 to 212, air expands 3-8ths of its volume, alcohol 1-9th, water 1-22d, and hammered iron 1-273d. In these, and all similar instances, the expansion arises from the fluid of heat lodged among the atoms of matter pressing outwards on all sides, according as it is excited.

When the temperature of the atmosphere falls below the freezing-point (32), which it does principally from the weakness of the sun's rays in winter, the phenomenon of frost, or freezing, ensues. Freezing is a process of congelation, or properly crystallization, produced by the withdrawal of heat, and by which water assumes the form of ice. When the temperature of the atmosphere rises above the freezing-point, the ice melts, and is resolved into its original elements. When the temperature of the atmosphere is below the freezing-point, the particles of water which are upheld in the clouds are frozen in their descent, and reach the earth in the form of flakes of snow. If this freezing take place after the particles have become united into rain-drops, we have hail instead of snow. When the descending flakes of snow come into a temperature above the freezing-point as they approach the earth, they are apt to melt, and in such a case fall in the shape of sleet, which is half-melted snow or hail.

Heat has a constant tendency to preserve an equilibrium in all situations; and hence its diffusion through nature, and many of the ordinary phenomena in relation to temperature. When we touch a cold substance with our hand, a portion of the heat of the hand rushes into the substance, and leaves the hand so much deficient of its former heat. On the same principle, when we touch a substance which is warmer than the hand, some of the heat rushes into the hand, and renders it hot. When we pour a quantity of hot water into that which is cold, an equalization of the two temperatures immediately ensues. When the air at any particular place becomes heated or rarefied, it ascends by virtue of its greater lightness, leaving a vacancy which the neighbouring air rushes in to supply. This is one of the chief causes of winds. The same principle is observable in the case of heated apartments. If the door of a heated room be thrown open, a current of cold air immediately rushes in to supply the deficiency in the rarefied atmosphere.

Evaporation is always accompanied by the withdrawal of heat, or production of cold, when no heat is directly applied; the heat necessary for the production of the vapour is then derived or radiated from surrounding objects, as is mentioned above in the case of dew forming on plants.

In the great operations of nature, the withdrawal of heat to produce intense cold, and the application of heat to produce great warmth, ordinarily take place gradually. Thus, although water freezes at a temperature of 32, it is some time before frost is completely effectual in changing the aspect and condition of liquid bodies; and when the temperature rises a few degrees above 32, after a frost, the ice and snow which have been formed do not vanish immediately; indeed, ice will remain unthawed for several days after the temperature has risen some degrees above the freezing-point. By this slow process, either in the absorption or evolution of heat, the animal and vegetable worlds are not liable to the injury which would ensue from instantaneous changes in the condition of their elementary fluids.

Water is increased in volume by freezing, which circumstance explains the ordinary phenomena of the bursting of water-pipes, and other similar occurrences, during frost. When a vessel of moderate strength is filled with water, its expansion, when it is converted into ice, by exposure to a freezing temperature, causes the vessel to burst. If the vessel is not brittle, but possessed of considerable tenacity, as a leaden water-pipe, the rupture will seldom be observed during the continuance of the frost while the water remains in a solid state, but it readily appears when thaw takes place, as the water is then forced out with a velocity corresponding to the vertical height of the column of water in the pipe. The fissures of rocks, too, are widened by the freezing of the water which may happen to lodge in them before frost; and this process, therefore, is a powerful agent in the disintegration of rocks. Portions of steep banks, also, from a similar cause, tumble down after thaw; for the moisture in them expands when frozen, and thus rends them to pieces, which, however, during the frost, are bound together as by cement, and fall down whenever thaw dissolves the moisture.

Heat has a powerful effect in causing certain bodies to shrink and diminish in volume. This happens with those substances which do not liquefy, such as wood and clay. The contraction arises from the heat carrying off the watery particles from the bodies, and thus allowing the constituent atoms to come more closely together. As wood becomes drier, its fibres are sometimes split asunder, so as to emit loud cracking noises, which, in the case of household furniture, are ascribed by the ignorant to supernatural causes.

Heat is further treated of under the articles Chemistry, Pneumatics, and Meteorology.

ACCIDENTAL PROPERTIES OF MATTER.

Having shown how the beautiful and extensive variety of form in bodies—solid, liquid, gaseous, and the different modifications of them—are to be traced to the operation of chiefly two great leading principles in nature, attraction and repulsion, we have now to mention the peculiar forms or characters which bodies assume from the influence of these and other causes, and which are usually classed under the term *accidental properties of matter*. The following are these properties:—Density, Porosity or Rarity, Compressibility, Elasticity, Dilatation, Hardness, Brittleness, Malleability, Ductility, and Tenacity.

Density signifies closeness of texture, or compactness. Bodies are most dense when in the solid state, less dense when in the condition of liquids, and least dense of all when gaseous or aëriform. In this manner the degree of density is in agreement with the closeness of the atoms to each other. The density of bodies may generally be altered by artificial means, as is afterwards mentioned. The metals, in particular, may have the quality of density increased by hammering, by which their pores are made smaller, and their constituent particles are brought nearer to each other.

The more dense in substance that a body is, it is the more heavy or weighty. In speaking of the density of different solid and liquid bodies, the term *specific gravity* is used to denote the comparison which is made. Thus, the specific gravity of a lump of lead is greater than an equal bulk of cork; or the specific gravity of water is greater than that of an equal quantity of spirituous fluid. For the sake of convenience, pure distilled water, at a temperature of 62°, has been established as a standard by which to compare the specific gravity or relative weights of bodies. Water, as the standard, is thus said to be 1. When, therefore, any body, bulk for bulk, is double the specific gravity of water, it is called 2, and so on to 3 and 4 times, up to 22 times, which is the specific gravity of platinum, the heaviest known substance. In almost every case of comparison there are fractional parts, and these are usually written in figures, according to the following arrangement: Fractional parts are divided into tens, hundreds, thousands, and so on. If, in addition to the figure expressing the main part of the specific gravity, there be one other figure, with a dot or point between them—thus 2·5—the additional figure signifies tenths, and the body is two times and five-tenth parts of a time more dense or heavy than water. If two figures occur—thus, 10·40—hundredths are signified, and the body is ten times and forty-hundredth parts of a time heavier than water. If there be three figures, thousandths of parts of a time are meant; if four figures, ten thousandth parts; and so on. Common air is sometimes taken as a standard with which to compare gases, being a more simple mode of comparing the relative weights of aërial substances. But all the solids and liquids are estimated with reference to water as the standard.

Any body of greater specific gravity than water, will sink on being thrown into water; but it will float on the surface, if its specific gravity be less than that of water. A body, such as a piece of wood, after floating a certain length of time on water, will imbibe such a quantity of liquid that its specific gravity will be gradually increased, and in the course of time it may sink to the bottom.

Porosity is the quality opposite to density, and means that the substance to which it is applied is porous; that is, full of small pores or empty spaces between the particles, and that the body is comparatively light. The instances of porosity are numerous in every department of the material world, but those which are connected with animal and vegetable bodies are the most remarkable. Bone is a tissue of pores or cells, and, when seen through a microscope, may be said to resemble a honeycomb. Wood is also a tissue of cells or tubes. If the end of a cylinder of straight wood be immersed in water, whilst the other is forcibly blown into, the air will be found to pass through the pores of the wood, and rise in bubbles through the water. When a gas is comparatively light, it is said to be *rare*, or to possess *rarity*.

By *compressibility* is meant that quality in virtue of which a body allows its volume to be diminished, without the quantity or mass of matter being diminished. It arises, of course, from the constituent particles being brought nearer to each other, and is effected in various ways. All bodies are less or more capable of being diminished in bulk, which is a conclusive proof of their porosity. Liquids are less easily compressed than solid bodies; nevertheless they, to a small extent, yield, and go into smaller bulk by great pressure. The water at the bottom of the sea, by being pressed down by the superincumbent water, is more dense or compact than it would be at the surface. Atmospheric air and gases are much more easily compressed than liquids, or even than many solids. Air may be compressed into a hundredth part of its ordinary volume. When at this state of compression, it has a great tendency to expand and burst the vessel in which it is confined.

Some bodies have the power of resuming their former volume or shape when the force which diminished it is withdrawn. This quality is termed *elasticity*. Steel is one of the most elastic of metallic bodies, but its elasticity is not nearly so great as that of India-rubber, which, though twisted, drawn out, or compressed in different ways, always resumes its original form. The aëriform fluids, such as atmospheric air, and the gases, are all exceedingly elastic; and so are liquids, such as water, but to a smaller extent.

Dilatability is that quality of bodies by which they are enabled to be expanded or enlarged in their dimensions, without any addition being made to their substance. *Hardness* is the quality which is the opposite of softness, and does not depend so much on the density of the substance, as the force with which the particles of a body cohere, or keep their places. For instance, glass is less dense than most of the metals, but it is so hard that it is capable of scratching them. Some of the metals are capable of being made either hard or soft. Steel, when heated to a white heat, and then suddenly cooled, as by immersion in water, becomes harder than glass, and when cooled slowly, it becomes soft and flexible. *Brittleness* is that quality by which bodies are capable of being easily broken into irregular fragments, and it belongs chiefly to hard bodies. Iron, steel, brass, and copper when heated and suddenly cooled, become brittle. *Malleability* is the quality by which bodies are capable of being extended by hammering. Some of the malleable metals are gold, silver, copper, zinc at the temperature of boiling water, lead, iron, and some others. Some of the metals possess the opposite quality of brittleness. Gold is the most malleable of all metals, and it may be hammered so thin as to be translucent, or permeable to light. By *ductility* is understood that property by which metals may be drawn to wire. The most malleable metals are not the most ductile. Tin and lead may be rolled into thin leaves, but cannot be drawn into wire. The most ductile metal is platina, which can be drawn into wire as fine as the threads of a cobweb. *Tenacity* is the quality by which bodies are not easily torn asunder. Steel is the most tenacious of all substances; a wire of this metal, the hundredth of an inch in diameter, will support a weight of 134 lbs.; while one of the same size of platina will sustain only 16 lbs., and one of lead only 2 lbs.

MOTION AND FORCES—GENERAL EXPLANATIONS.

Motion is the changing of place, or the opposite of rest.

Matter, according to the definitions which have been given of its properties, is substance devoid of life and volition, and which is perfectly passive, or inert. It has been described as possessing the property of inertia, and in this respect it is said to possess an unwillingness or reluctance to move, but these phrases are only figurative, and are used for the purpose of conveying a forcible idea of the passiveness of its character. It is also, in consequence of this property of inertia, or passiveness to submit to any condition to which it is subjected, that a body, when once in motion, will continue to move continually with the same velocity and in the same direction, till it is disturbed by some external cause.

Any instance of [illegible] comes under our observation, is only rest in a *relative*, not an *absolute*, sense; that is, it is rest as relates to the earth, but not rest as relates to the universe; for though the stone which falls to the ground lies at rest on the earth, the earth is always in motion, and therefore the stone is no more at rest than the insect which sits upon a moving wheel is at rest. Hence, in speaking of bodies coming apparently to a state of rest, we must always recollect, that it is only relative, not positive or absolute rest. It is supposed that there is no such thing as absolute rest in creation. All the planets are in motion round the sun; and the sun itself has a motion on its own axis; it is also believed by many astronomers that the sun has an onward or progressive motion in space, besides its rotatory movement; and thus, perhaps, revolves round some distant centre, with all its planets in its train.

Common experience would lead to the conviction that rest is more natural for matter than motion; but this conviction is founded on a limited consideration of circumstances. The reason why we see ordinary moving bodies coming to a state of rest—such as a wheel stopping after having been whirled on its axle, a ball stopping after rolling on the ground, or an object falling to the earth after being thrown upwards—is, that they are sooner or later arrested in their progress by the earth's attraction or their own gravity, by the friction or rubbing against some other body, or by the opposition presented to them by the atmosphere. Except for these three prevailing causes of impediment and stoppage, all bodies set in motion would go on moving for ever. Taking this expanded view of things, and dismissing the erroneous impressions arising from what is obvious only to our limited experience, we find that there is nothing more remarkable in perpetual motion than in perpetual rest.

It is only, however, in the great works of creation, or the heavenly bodies, that perpetual motion is observable. The planetary bodies are under the ever-acting impulses of centrifugal and centripetal forces, and are not impeded by friction, or by the atmosphere, for they move in space, or in a comparative vacuum. Many ingenious attempts have been made to produce perpetual motion on mechanical principles in terrestrial objects, but they have all necessarily failed, as no human effort can destroy gravity in bodies, or altogether prevent friction in movement.

In regard to bodies on the earth, of which a state of rest is the ordinary condition, motion is produced by certain agencies, or impelling causes, either belonging to the phenomena of nature or to art. The property of capillary attraction causes a motion in liquids under certain circumstances; the winds blow, and cause motion; rivers, in flowing down their channels, and the action of the tides, likewise produce motion; thus, there exist many natural causes of motion, which are taken advantage of by man in the economy of arts and manufactures. Motion in the animal economy is produced by a principle of life; but of the nature of this kind of motion mankind are ignorant, and nothing here requires to be said regarding it. The causes of motion which have to engage our attention are those which consist of *forces*, whether natural or artificial, and which forces have the property of impelling inanimate objects from a state of rest to a state of motion, of stopping them when in motion, or of altering the character of their motion. These forces are also called powers.

Motion, according to the mode in which the force acts, is susceptible of innumerable variations. According as the moving body is affected, it may move rapidly or slowly; proceed in a straight line, turn in a circle, or curve; it may move with uniform or irregular speed, or be retarded or accelerated. The body may also move upon or in respect of another body which is also moving. Some of these peculiarities in motion will immediately engage our attention; meanwhile, it has to be explained, that, for the sake of convenience in language, and accuracy in the application of terms, certain words are used to define the nature of motion in bodies, and the forces affecting them.

Motion is said to be *common* to two or more bodies when they move in contact or together; or when, though not in contact, they are carried along in a similar manner, and with the same velocity; that is, when they have a motion in common, or participate in the same motion. Motion is said to be *absolute*, when a body actually moves from one point of space to another, or when it moves towards, or when it passes, another which is at rest. Therefore, setting aside the idea of the earth moving, we should say that a vessel moving on the sea has an absolute motion, while the land is fixed or stationary. Motion is said to be *relative*, when the motion of one moving body is considered in reference to that of another moving body. Thus, if two bodies move in the same direction, their relative motion is the difference of their motions; if they move in opposite directions, it is the sum of their separate motions.

When a force, applied to any material object, is resisted or counteracted, so that no motion ensues, it is called a *pressure*; and forces so counteracted are said to *balance* each other, or to be in *equilibrium*.

The degree of speed in the motion of bodies is called *velocity*. Velocity is measured by the space or distance passed over, with an invariable motion, and in a given time, as one second. Thus, if a body, in one second, with an invariable motion, pass over twenty feet, its velocity is said to be twenty feet per second.

When a motion is invariable, it is said to be *uniform*; if it be gradually increasing, it is said to be *accelerated*; and if it gradually decrease, it is said to be *retarded*.

A force is said to be an *accelerating* or *retarding* force, according as it produces an accelerated or retarded motion.

Forces are either *instantaneous* or *continued.* The former is an impulse, like a stroke; the latter acts without intermission. When a continued force remains always of the same intensity, it is called a *constant* force. Other continued forces are said to be *variable.*

A body, in moving, possesses a force which is called its *momentum,* or *motal force.* Momentum is very different from velocity. A light body and a heavy body may move at the same velocity, but the momentum of the light body will be small in comparison with that of the heavy one. The light one, on coming to a state of rest, will perhaps fall harmlessly on the ground, while the other, by its momentum, will strike *forcibly* on the earth, or destroy any object which opposes it. Momentum is proportionate to the mass and velocity of bodies, and, by multiplying the weight by the number of feet moved over per second, we find that the momentum is the product. Thus, if a body of twelve ounces move with a velocity of twenty feet per second, its momentum is (twelve times twenty) two hundred and forty. In ordinary language, the term *impetus* is used to signify the violent tendency of a moving body to any point.

Before entering upon a consideration of motion as produced by ordinary forces, it will be appropriate to describe the effects produced upon bodies when simply falling—that is, moving downwards towards the earth, when the supports which upheld them are withdrawn.

THE PHENOMENA OF FALLING BODIES—WEIGHT.

Attraction, as already explained, is a force inherent in nature, by which particles and masses of matter are drawn towards each other. This force, it has also been stated, increases in proportion to the quantity of matter which the attracting body contains, and it also increases as the bodies approach each other. Further, it has been mentioned that this powerful and subtile quality in matter is the cause of the falling or drawing of bodies downwards towards the earth, and thus produces what is termed *weight* or *gravity.* Gravity, then, is simply the tendency which any substance has to press downwards in obedience to the law of attraction, as exemplified in the phenomena of bodies falling from heights to the ground, when the supports which upheld them are removed.

All falling bodies tend directly towards the centre of the earth, in a straight line from the point where they are let fall. If, then, a body be let fall in any part of the world, the line of its direction will be perpendicular to the earth's centre. Consequently, two bodies falling on opposite sides of the earth, fall towards each other. Suppose any body to be disengaged from a height opposite to us, on the other side of the earth, its motion in respect to us would be upward, while the downward motion from where we stand, would be upward in respect to those who stand opposite to us, on the other side of the earth. In like manner, if the falling body be a quarter, instead of half the distance round the earth from us, its line of direction would be directly across or sidewise, that is, at right angles with the lines already supposed.

It will be obvious, therefore, that what we call *up* and *down* are merely relative terms, and that what is down in respect to us, is up in respect to those who live on the opposite side of the globe. Consequently, *down* everywhere means towards the centre of the earth, and *up* signifies from the centre of the earth. The velocity or rapidity of every falling body is uniformly accelerated, or increased, in its approach towards the earth, from whatever height it falls, if the resistance of the atmosphere be not reckoned. If a rock be rolled from the summit of a steep mountain, its motion is at first slow and gentle, but as it proceeds downwards, it moves with perpetually increased velocity, seeming to gather fresh speed every moment, until its force is such that every obstacle is overcome; trees and rocks are dashed from its path, and its motion does not cease until it has rolled to a great distance on the plain.

The same principle of increased velocity in bodies as they descend from a height, is illustrated by pouring treacle, honey, or any thick syrup, from an elevated vessel. The bulky stream, which is perhaps two inches in diameter where it leaves the vessel, is reduced to the size of a straw or thread on reaching its destination; but what it wants in bulk is made up in velocity, for the small thread-like stream at the bottom will fill a vessel just as soon as the large and slow moving stream at the outlet; the velocity is indeed so great, that the stream has not time to sink at once into the mass below, but falls in overlaying folds.

From the same principle, a person may leap from a chair without danger; but if he jump from the housetop, his velocity becomes so much increased, before he reaches the ground, as to endanger his life by the fall.

It is found by experiment, that the motion of a falling body is increased, or accelerated, in regular arithmetical progression. In other words, in every second of time during its descent, it acquires an additional rate of speed, the rate regularly increasing by the accumulation of the preceding additions.

It is ascertained that a dense or compact body, when falling freely, passes through a space of 16 feet 1 inch during the first second of time. Leaving out the odd inch for the sake of even numbers, we find that the space fallen through in a given time is determined by the following arithmetical computation.

Ascertain the number of seconds which a body occupies when falling. Take the square of that number (that is, the number multiplied by itself), and multiply the square by 16, which is the number of feet fallen during the first second, and the result is the amount of feet which the body altogether falls. For example, if a ball occupy 3 seconds in falling, we take the square of 3, which is 9; then we multiply 9 by 16, which gives 144 as the result, and that is the number of feet fallen. Again, if we find that the ball occupies 4 seconds in falling, we take the square of 4, which is 16, and multiplying 16 by 16, the result is 256, which is the number of feet fallen. And so on, always following the same rule of computation.

It is not always easy, by the above mode of calculation, to arrive at a correct result as to the height fallen by bodies, and all that can be expected is an approximation to a true result. This arises from bodies being of different bulks, and receiving different degrees of opposition from the atmosphere in their descent. It is a common supposition that large and heavy bodies fall more quickly than small and light ones. This opinion, which was maintained even by philosophers, until Galileo rectified the mistake, perhaps originates in the error of confounding *momentum* with *velocity.* Be this as it may, it is now an ascertained truth in science, that all bodies, of whatever density, fall with the same velocity. Thus, a ball containing a pound of lead falls with the same velocity as a ball containing an ounce. This equality in the rate of falling is, however, disturbed by the quality of figure and bulk of bodies. A solid ball of gold will fall more quickly than the same quantity of gold beat out into a thin leaf, because in the case of the leaf the resistance from the atmosphere on a large surface impedes the descent. Thus the atmosphere prevents bulky and porous substances from falling with the same velocity as those which are compact.

If the atmosphere were removed, all bodies, whether light or heavy, large or small, would descend with the same velocity. This fact is ascertained by experiments performed with the air-pump.

When a piece of coin, for instance a guinea, and a feather, are let fall at the same instant of time, from a hook which has held them at the top of the exhausted receiver of an air-pump, they are observed to fall at an equal rate, and to strike the bottom at the same moment. Hence it is demonstrated, that were it not for the resistance of the atmosphere, a bag full of feathers, and one of coins, would fall from a given height with the same velocity, and in the same space of time.

It has been stated that the attraction of gravitation increases in proportion to the quantity of matter which the attracting body contains. Thus, the mass of our planet, the earth, exerts a force of attraction which produces the phenomena of weight, and the falling of bodies with a certain velocity.

In consequence of the different size and density of the sun and planetary bodies, attraction is much stronger in some of them than others, and consequently the weight of bodies differs in each. On the surface of the sun, our pound weight would weigh upwards of 27 pounds, and a body would fall upon it 434 feet the first second. On the surface of Jupiter, our pound would weigh about 2 pounds 4 ounces. And on the surface of the moon, our pound would weigh only the fifth part of a pound.

As a body in descending to the earth receives increasing accessions to its velocity during every successive second, so when a body is projected upwards from the surface of the earth, its velocity decreases in the same proportion, till it comes to a state of momentary rest, when it instantly begins to descend with a gradually increasing velocity, which at any point in the descent is equal to its velocity at the same point when ascending. In this calculation, however, we omit the influence of the atmosphere, which would cause the final velocity in the descent to be less than the original velocity with which the body was projected upwards.

THE CENTRE OF GRAVITY.

Terrestrial gravitation, as already explained, does not act on the mere surface of bodies, or according to their bulk, but is exerted in reference to all the particles or atoms individually which compose the mass of a body. As the earth is nearly of a spherical form, its attraction is the same nearly as if it proceeded entirely from the centre. On account of the great size of the earth, compared with that of any ordinary body at its surface, its attractive force acts in straight lines, sensibly parallel, proceeding from the earth's centre. In the case of liquids, in which the atoms slightly cohere, the atoms have liberty to spread themselves over the earth, and to seek the lowest situation for repose. In the case of solids, a different operation is observable. In them, the particles of matter stick so closely together, that they are not at liberty to obey the law of gravitation individually, but rally, as it were, round a common centre, upon which the force of attraction may be considered to act for the general behoof. This centre is called the *centre of gravity*, the *centre of inertia*, or the *centre of parallel forces*.

Every solid body or dense mass possesses a centre of gravity, which is the point upon or about which the body balances itself, and remains in a state of rest, or equilibrium, in any position. The centre of gravity may be described as a point in solids which always seeks its lowest level, in the same manner that the lowest level is sought for by water; for it is only by propping up the body, that the centre of gravity is prevented from displaying the same mode of action. The centre of gravity in round, square, or other regular shaped bodies, of uniform density in all their parts, is the centre of these bodies. When a body is shaped irregularly, or when there are two or more bodies connected, the centre of gravity is the point about which they will balance each other.

Any square or angular body which we may place on the ground, will remain stationary, or safely at rest, provided an ideal line, drawn from its centre of gravity, and passing to the ground in a direction perpendicular to the earth's surface, fall within its base, as in fig. 2. A point below A is the centre of gravity; and from that point the line of direction goes downward to B, which is within the edges of the base. An object of this form, and so placed, will stand.

Fig. 2.

If the line of direction from the centre of gravity falls without the outer edge of the base, as in fig. 3, from A to B, then the object will not remain balanced on its base; it will fall over, and attain some position in which the line of direction falls within the boundary of the base on which it stands. By keeping this simple principle in view, stability and safety will generally be secured in the erection of objects of art, such as houses, monumental edifices, spires, and obelisks, as well as in the lading of coaches, carts, and other vehicles, and the piling of timber or any kind of goods in heaps. In every instance, the base ought to be sufficiently broad to admit of the line of direction from the centre of gravity falling within it.

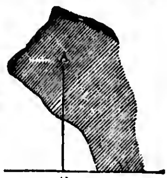


Fig. 3.

A small degree of experience seems to point out the propriety of erecting all kinds of structures with a base wide enough to secure stability; nevertheless, in opposition both to experience and the simple principles of science, we often find that stage-coaches are laden in such a manner that their centre of gravity is liable to too great a change of position, and that they are overturned, to the personal injury, and even loss of life, of the passengers. The error in these instances consists in raising the centre of gravity too high. At first, perhaps, the centre of gravity is so comparatively low, that, in the case of swaying to a side, the line of direction would fall within the edge of the wheel, and no danger would ensue; but it is common to go on piling masses of goods or luggage, or placing a number of passengers on the roof of the vehicle, so that the centre of gravity becomes considerably elevated; so high, indeed, that when the carriage is swayed, or jolts to one side, the line of direction is thrown beyond the wheel, and the vehicle will consequently fall over. In the annexed cut, fig. 4, a loaded vehicle is represented crossing an inclined plane, or we may suppose that its wheel on one side has come in contact with a stone S, which has raised it above the level of the other wheel, so as to incline the body of the vehicle very considerably from the horizontal. The centre of gravity is represented in two different positions, a lower with the line of direction L C, and a higher with the line of direction U C. Had the vehicle not been high laden, the line of direction would have remained as L C, and as it falls within the wheel or base, the vehicle would have maintained its balance; but being now laden to a considerable height, the line has risen to about the

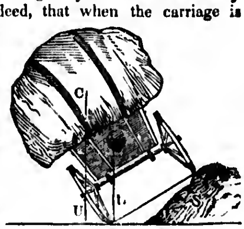


Fig. 4.

place where it is marked descending from C to U, beyond the base; consequently the vehicle must overturn.

There are instances in which bodies will not be overturned, although the line of direction falls considerably beyond the base. These exceptions to a common rule are observable in the case of rapidly and smoothly moving bodies, in which centrifugal force acts as a counterpoise to the weight of the body. A familiar example of this kind occurs in the case of skaters, in making their circular turns on the ice, in which they bend or lean greatly beyond the perpendicular position without falling. A notice of this peculiarity in moving bodies will engage our attention, under the head Centrifugal Force.

The tendency which leaning bodies have to fall, may also be counteracted in some measure by the cohesion of parts. Thus, there are many instances of walls, steeples, and towers, inclining sensibly from the vertical line, and yet, by the strength of the cement which binds them, they have stood for ages.

Whatever raises the centre of gravity, or narrows the base, allows the line of direction to pass more easily without it, and diminishes the stability. Hence the imprudence of rising up in carriages or boats, when in danger of being upset; and hence, as we have just mentioned, the danger of high-loading of vehicles. Lately an improvement has been effected in stage-coach building, by which a chief part of the load is placed as low as the axle of the wheels; and by this means the danger of overturning is almost entirely averted.

The centre of gravity of a body is not always in the substance of the body. Thus, the centre of gravity of a circular ring is in the centre of the circle; of an elliptic or oval ring, in the centre of the ellipse; and of a hollow cylindric tube, it is in the imaginary axis of the tube. In a drum, for instance, the centre of gravity is a point in the centre of the drum, where there is nothing but air.

When a circular object is placed on level ground, or a horizontal plane, it remains at rest on a point of its surface, because the line of direction from its centre, which is its centre of gravity, falls perpendicularly downwards to the point on which it is in contact with the earth and at rest; and because it could not possibly get its centre of gravity nearer the earth by changing its position. When a similar circular object is placed on an inclined plane, it will not remain at rest, but roll over, because the line of direction from its centre of gravity falls perpendicularly downwards in front of the point on its surface which touches the plane. On this account it rolls over, as if it were seeking a spot on which it might have the line of direction from its centre of gravity passing through its point of contact with the earth. Hence a circular body continues rolling down an inclined plane till it find a level spot on which the line of direction passes through its point of rest.

In a bar of iron, six feet long and of equal breadth and thickness, the centre of gravity is just three feet from each end, or exactly in the middle. If the bar be supported at this point, it will balance itself, because there are equal weighs on both ends. This point, therefore, is the centre of gravity. If a bar of iron be loaded at one end with a ball of a certain weight, then the centre of gravity will not be at the middle, but situated near the heavy end of the bar. But if we attach a ball of the same weight to both ends, the centre of gravity is again in the middle of the bar.

A remarkable illustration of the principles now detailed, is exhibited in the case of the earth and moon. The earth revolves round the sun, in consequence of a cause already explained, namely, the sun's attraction; but instead of the centre of the earth describing the oval or elliptic orbit round the sun, it is the centre of gravity of the earth and moon that describes it. We shall briefly explain the reason for this. The earth, in its course, is encumbered with the moon a body of about the seventieth of its mass; in other words, the moon is like a small ball stuck at one end of a bar, having the earth or a larger ball at the other end—the bar between being the mutual attraction of the earth and moon. On this account, the centre of gravity of the earth and moon is at a point somewhere between the centres of the earth and moon. This point lies not far below the earth's surface. Therefore, if the earth were to fall towards the sun, it would be this point which would proceed most directly towards it.

In suspending an irregularly shaped body from different points successively, we may learn where the centre of gravity of the body is placed, by observing that the line of direction in each case passes through the same point, which point is the centre of gravity. For example, let a painter's palette, which is an irregularly shaped body, be suspended from the thumb-hole, as in the annexed cut, fig. 5, and the line of direction will necessarily be from A to B. Next suspend it from a point at D, and a new line of direction will be obtained, crossing the line A B. The place where the two lines intersect, is thus the centre of gravity. The point of suspension, on being removed to C, will give the same place of intersection in the original line of direction; and a similar result will follow any other change of the suspension point.

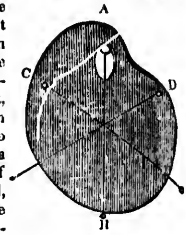


Fig. 5.

In the various natural structures displayed in the animal and vegetable kingdoms, the centre of gravity is always so situated, as to produce a just equilibrium and a harmony of parts. Every animal is properly balanced on its limbs, and every tree has a tendency to grow in a direction perpendicular to its base, whether it grow from a level or an inclined plane. Some animals are enabled to move in opposition to the law of gravity, as, for instance, flies creeping on the ceiling of an apartment; but in such cases, other powers in nature are exerted to preserve the secure footing of the animals.

THE PENDULUM.

Gravity, which causes bodies to fall, also causes them to swing backwards and forwards, when suspended freely by a string or rod from a point, and when once moved to a side, to give them an occasion of falling. A body suspended in this manner is called a Pendulum.

Pendulums usually consist of a rod or wire of metal, at the lower end of which a heavy piece or ball of brass or other metal is attached. When a pendulum swings, it is said to oscillate or vibrate; and the path which its ball pursues in swinging, from its resemblance in figure to an inverted arch or bow, is called its arc. In the accompanying cut, fig. 6, a pendulum of the most common construction is represented. A is the axis or point of suspension. B is the rod. C is the ball, or a round flattish piece of metal, which is fastened to the rod by a screw behind, and by which screw it can be raised or lowered on the rod. D D is the path or arc which the ball traverses in swinging. When the pendulum is at rest, it hangs perpendicularly, as here represented, and the place which the ball is seen to occupy is called the point of rest.

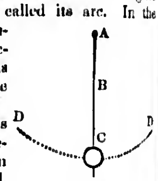


Fig. 6.

The pendulum remains at rest till its ball is drawn aside to allow it an opportunity of swinging on its axis. Being raised to any height on one side, and set at liberty, the ball, by the force of gravity, has a tendency to fall to the ground; but being confined by the suspending rod it is compelled to make a sweep to that point where it was formerly hanging at rest, immediately beneath the point of suspension. But it does not stop here; it has acquired a velocity sufficient to carry it onward in an ascending course to nearly as high a point on the opposite side as that from which it was let fall. Of its o ac-cord, it again falls downwards in the same arc, a rises to near the point where it set off; and thus, itself, continues to swing to and fro, or vibrate, for a certain length of time, till its force is expended, and it finally comes to a state of rest in its original dependent situation under the point of suspension.

At every sweep of the pendulum (when not meddled with, or assisted by any external force), the length of the path or arc traversed by the ball is in a small degree diminished. This arises from two causes—the obstruction offered by the atmosphere, and the friction on its axis or point of suspension. These causes, therefore, sooner or later, bring the pendulum to a state of rest, unless external force of some kind continues to be applied to urge it to sustain its action.

The ball of a pendulum in swinging, as has been mentioned, describes the figure of an arc. This arc is a certain portion of a circle. The extent of this portion depends on the force exerted in setting the pendulum in motion, or in drawing it aside to let it fall. A circle being divided by mathematicians into 360 degrees or parts, the ball may be made to swing over five, ten, twenty, or any other number of degrees under 180, which is half a circle. The extent of the arc traversed under ordinary circumstances, is from ten to twenty degrees.

A pendulum with a long rod vibrates slower than one with a short rod. The time does not become longer, however, in exact proportion as we extend the rod. The vibration, it must always be recollected, is analogous to the falling of bodies. The spaces fallen through by a body in 1, 2, 3, or 4 seconds, are not in proportion to 1, 2, 3, 4, and so on, but in the proportion of 1, 4, 9, 16, 25, and so on, or the squares of the time occupied in falling. In the case of pendulums, it is found that their lengths are as the squares of the times of vibration. Thus, if the times occupied by one vibration of two pendulums be 1 and 2 seconds respectively, the lengths of the pendulums will be as 1 and 4; so if the time of one vibration of several pendulums be as 1, 2, 3, 4, their lengths are as 1, 4, 9, and 16.

The vibrations of the pendulum being produced by terrestrial gravitation, it follows, as a natural result, that, if the force of gravitation be weakened, so will the tendency of the ball of the pendulum to fall or swing be weakened. This result is distinctly observable in different parts of the earth. At the equator, the earth, as already mentioned, bulges out to a thickness of 26 miles on the diameter, or 13 miles from the surface to the centre; and as the attraction of gravitation proceeds from the centre, the force of this attraction is consequently weaker at the surface at the equator than it is at the surface at the poles. At every part of the surface between the equator and s, there is a proportionate increase of gravity. Be the effect produced by the greater distance of the surface from the centre at the equator, centrifugal force, which is strongest at the equator, assists in weakening the attractive force at that place.

In consequence of these combined causes, a pendulum of a given length vibrates more slowly at the equator than at the poles. In proportion as we advance on the surface of the earth from the equator towards the poles, so does the pendulum swing or vibrate more quickly. In order, therefore, to preserve uniformity of speed in pendulums at different parts of the globe, that is, in order that they may all vibrate in one second, their length must be regulated according to the distance of the places from the equator. Thus each degree of latitude has its own length of pendulum.

From a knowledge of these laws we are enabled, by this instrument, not only to detect certain variations in that attraction in various parts of the earth, but also to discover the actual amount of the attraction at any given place.

To compare the force of gravity in different parts of the earth, it is only necessary to swing the same pendulum in the places under consideration, and to observe the rapidity of its vibrations. The proportion of the force of gravity in the several places, will be that of the squares of the velocity of the vibration. Observations to this effect have been made at several places, by Biot, Kater, Sabine, and others.

The uniform vibration of the pendulum has rendered it useful in regulating the motion of clocks for measuring time. In the common clock, a pendulum, connected with the wheel-work, and impelled by weights, or a spring, regulates the motions of the minute and hour hands on the dial-plate, by which the time of day is pointed out. If no pendulum were employed, the wheels would go very irregularly. The pendulum is regulated in length, so as to vibrate sixty times, each time being a second, in the space of a minute. At each vibration, it acts upon the tooth of a wheel, which turns the rest of the machinery. In order that the pendulum may vibrate neither quicker nor slower than sixty times in a minute, in the latitude of London it must measure 39 inches and about the 7th of an inch from the point of suspension to the centre of oscillation. A pendulum at Edinburgh would require to be a small degree longer. The greatest possible nicety is required in the adjustment of the length, for a difference in extent amounting to the 1000th part of an inch, would cause an error of about one second in a day. Therefore, to make a pendulum go slower by one second a day, it must be lengthened by the 1000th part of an inch; and to make it go quicker, it must be shortened in the same proportion.

It is possible to cause short pendulums to regulate the movement of clocks the same as long pendulums; and this is done in cases where long pendulums would be inconvenient, or inelegant in appearance. This is accomplished by shortening the pendulum to a fourth of its ordinary length, by which it beats or vibrates twice instead of once in a second. The wheel-work is constructed to suit this arrangement.

THE LAWS OF MOTION.

Motion, as al y mentioned, is the changing of place, or the opposite of rest. According to the general explanations which have been given, it appears that motion in bodies is as natural as rest, and that matter passively submits to remain in either of these states in which it may be placed, provided no external force or obstacle interfere to cause an alteration of condition. These and other fundamental laws of nature, in relation to rest and motion of matter, are laid down by Sir Isaac Newton in the following three propositions:—

1st. Every body must persevere in its state of rest, or of uniform motion in a straight line, unless it be compelled to change that state by forces impressed upon it.

2d. Every change of motion must be proportional to the impressed force, and must be in the direction of that straight line in which the force is impressed.

3d. Action must always be equal and contrary to reaction; or the actions of two bodies upon each other must be equal, and their directions must be opposite.

These propositions we shall treat separately. In the first of the series there are three points requiring consideration, namely, the permanency, the uniformity, and the straight line of direction of motion in bodies.

As was formerly observed, it is impossible to show either permanency or uniformity of motion in bodies upon or near the earth; for all moving bodies are sooner or later brought to a state of rest by the force of attraction, friction, and the opposition of the atmosphere. It is only, therefore, in the case of the great works of nature, or planetary bodies, that the laws of motion are most clearly and fully illustrated.

The tendency of a body to move in a straight line from the point whence it set out, is as much a property of matter as the uniformity of motion. If we conceive the idea of a body impelled into a state of motion by any given force, and at the same time conceive the idea that there is no obstacle to interrupt it, no attractive force to bend it aside, we shall then fully understand that a moving body must, as a matter of necessity, from its property of inertia, proceed in a straight line of direction—it must go on in an even path for ever.

CENTRIFUGAL FORCE AND CIRCULAR MOTION.

Bodies in flying round a centre have a tendency to proceed in a straight line, and this principle of motion, as already mentioned, is termed *centrifugal force*. Examples of this tendency are very familiar to our observation. When we whirl rapidly a sling with a stone in it, and suddenly allow the stone to fly off, it proceeds at first sensibly in a straight line, but is gradually pulled to the earth by attraction. In turning a circular grindstone rapidly with water in contact with it, we perceive a rim of water first rising on the stone and next flying off; and the more rapidly we turn the stone, so does the water fly off with the greater force. In grinding corn by two rapidly turning stones playing on each other, the grain poured in at an opening at the centre is quickly shuffled towards the edges of the stones, and expelled in the condition of meal or flower. If we put some water in a vessel, and rapidly turn it in one direction, we shall find that the water endeavours to escape, and rises up to the edges of the vessel, leaving a deep hollow in the middle. The tendency to fly off from a centre is made use of in the manufacture of pottery: Soft clay being placed on a revolving wheel, it quickly spreads towards the circumference of the machine, and is guided or moulded by the hand of the potter into the required form. In forming common crown or window-glass, advantage is also taken of the principle of centrifugal force. A thick round mass of glass, softened by heat and fixed at the middle on an iron rod, being made to turn rapidly round, first in one direction, and then in the opposite, and continuing this alternating rotary motion till the glass becomes cool, is found to spread out into a large, thin, circular plate. From this plate, square panes of glass are afterwards cut.

In the same manner as solid bodies laid on a whirling table are thrown off, so water in a vessel which is caused to spin round in any way, as on the centre of a horizontal wheel, instead of lying at the bottom, is raised all round against the sides of the vessel.

Equestrians, in performing their feats of horsemanship, always incline their bodies inwards when standing on a horse which is running round a circle. Centrifugal force having a tendency to impel them outwards, is thus counteracted by the inward leaning, and forms a species of support to their overhanging bodies. A horse running in a circle, or quickly turning a corner, naturally adopts the same counteracting posture, and leans inwards. A skater, in moving in a circular or curvilinear path on smooth ice, also leans inwards, so much so, that if he were to stand still in this posture, he would inevitably fall on his side; but centrifugal force, which has a tendency to impel his body outwards from the curve, or in a straight line of motion, sustains him, as it does the equestrian, and he therefore moves gracefully and safely in the circular path which his fancy directs. In this and other instances, we find the force of gravity overcome by centrifugal force. It is in obedience to this principle, that the earth bulges out to the thickness of 26 miles upon the circumference at the equator, where the whirling motion is most rapid

Thus, centrifugal force is the tendency to fly off in a straight line, or at a tangent, from motion round a centre; and the power which prevents bodies from flying off, and draws them towards the centre, is, as already mentioned, called *centripetal*, or *centre-seeking* force. All bodies moving in circles are constantly acted upon by these opposite forces, as may be exemplified by the annexed cut, Fig. 7. A is a point to which a string with a ball at the end of it, B, is attached. On forcing the ball B into motion, it will describe a circle round the point A, in which case the string is the centripetal force. The ball in whirling, however, having a continual tendency to fly off, if it be disengaged from the string at C, will go in a straight line, C D; if at E, it will go in the line E F; if at G, in the line G H; and so on, at every point in the circle.

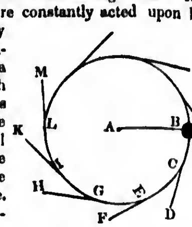


Fig. 7.

The mutual action of centrifugal and centripetal forces, in the case of circular motion, proceeds according to a certain ratio. If the mass of the revolving body be increased, its distance from the centre and velocity remaining the same, its centrifugal force will be increased in the same proportion. If the distance from the centre be increased, while the mass and the time of revolution remain the same, the centrifugal force will also be increased in the same proportion. If the number of revolutions performed in a given time be twice as many, the distance and mass being unchanged, the centrifugal force will be four times as great; if three times as many, the force will be nine times as great; if four times as many, it will be sixteen times as great; and so on in the same proportion. The masses of the planets, and their distances from the sun, being various, the forces which affect them are also similarly varied.

The line round which a body performs a motion of rotation, is called an *axis*. This axis may be only imaginary, like that of the earth; or real, as the axle of a wheel. The body may revolve about two projecting pins or pivots resting in sockets, in which case its axis is a straight line joining the pivots; or it may turn on a cylindrical rod of small diameter, passing through the body, like a wheel on its axle. It is evident that every point of the body, during its revolution, will describe a circle, the centre of which is a point in the axis of the body.

In the turning of a wheel on its axis, that part which is at the greatest distance from the centre, has the greatest velocity; and at this extremity of the circumference the centrifugal force is greatest. For example, in the representation of a wheel with arms radiating from a centre, Fig. 8, the velocity is greater at the extremity of the arm, at A, than it is at B, half the distance from the centre. But the point B goes round as often as the point A, having a smaller circle to traverse.

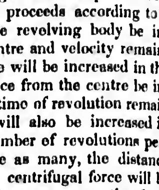


Fig. 8.

In this manner, the velocity of revolving bodies must always, as a matter of necessity, increase in proportion to the distance from the centre of motion. Hence a comparatively small centrifugal force near the centre is prodigiously increased towards the circumference. By increasing the force, and adding to the velocity of a revolving body, the centrifugal force becomes so great that it will in some cases overcome the cohesiveness in the material in the body, and causes it to break and fly off in pieces. When grinding-stones are thus whirled with great rapidity, they are apt to be destroyed, flying in pieces, to the extreme danger of those who are using them.

Bodies movable on an axis of rotation are submitted to different kinds of forces. They are generally distinguished by the duration of their action into instantaneous and continued forces. If the body which sustains an action of the former kind be quiescent and free, it will move in the direction in which the impulse is given with uniform motion. If, however, the force impressed upon it be incapable of setting it in motion, then it receives a shock, the effect of which is called *percussion*. A continued force produces a continued effect. If the body be free and previously quiescent, this effect is a continual increase of velocity. If the body be so restrained that the applied force cannot put it in motion, the effect is a continued pressure on the points or lines which sustain it.

A solid body which is movable upon a fixed axis, is susceptible of no motion, except one of rotation upon the axis. If it be submitted to the action of instantaneous forces, one or other of the following effects must ensue:—1. The axis may resist the forces, and prevent any motion. 2. The axis may modify the effect of the forces, sustaining a corresponding percussion, and the body receiving a motion of rotation. 3. The forces applied may be such as would cause the body to spin round the axis even were it not fixed, in which case the body will receive a motion of rotation, but the axis will suffer no percussion.

What has been just observed of the effect of instantaneous forces, is likewise applicable to continued ones. 1. The axis may entirely resist the effect of such forces, in which case it will suffer a pressure which may be estimated by the rules for the composition of force. 2. It may modify the effect of the applied forces, in which case it must also sustain a pressure, and the body must receive a motion of rotation which is subject to constant variation, owing to the incessant action of the forces. 3. The forces may be such as would communicate to the body the same rotatory motion if the axis were not fixed. In this case the forces will produce no pressure on the axis.

The power of centrifugal force in rapidly whirling bodies, may be rendered so great as to overcome the force of gravity. In whirling a sling with a stone in it, the stone does not fall out of its place in the sling. The following is a more striking example:—Place a jug of water on the inside of the rim of a wheel a few feet in diameter; then, beginning gradually, set the wheel in rapid motion, and it will be observed that the jug retains its place, whirling round in a perfectly stable manner, and that even the water in it is not spilled. Thus, gravity, or the tendency to fall downwards, is overcome by centrifugal force. If the jug were placed in a situation in the wheel, near the centre of motion, where the centrifugal force is weak, it would at once fall to the ground.

LAWS OF PROJECTILES.

Bodies, on being projected by any impulsive forces, are called *projectiles*, and are observed to pursue a curvilinear or bent line of direction in their motion. The bending from the straight line is produced by the force of gravity, and "the change is proportional to the impressed force." A ball projected from a cannon, a stone thrown by the hand, and water spouted from a confined vessel, furnish familiar examples of curvilinear motion.

It is a remarkable law of motion, that whether the force which projects a body be great or small, the body, if thrown horizontally, will reach the surface of the earth from the same height, in the same space of time, not calculating resistance of the air. For example, if two guns are fired from the same spot, at the same instant, and in a horizontal direction, one of the balls falling half a mile, and the other a mile distant, it will be found that the ball which proceeds the greatest distance takes precisely the same time to reach the ground which the other does. The time of flight, as it is called, of two balls will be the same in whatever directions and with whatever velocities they are fired, provided they reach the same height. The reason for the same length of time being occupied in falling by both balls, is, that they are both carried downward at the same rate by gravity. Hence, a ball dropped perpendicularly from the top of a high tower, does not reach the ground sooner than a ball shot from the same height to the distance of one or more miles in a horizontal direction.

In projecting bodies through the atmosphere, great advantage, in point of distance, is gained by impelling them from heights, because a ball thrown from a high situation to a lower, reckoning its whole course, is more aided than retarded by gravity. When the ball is projected from a lower situation to a higher, it is in the first place retarded by gravity in its ascent, and the acceleration afterwards by gravity being less than this previous retardation, it consequently does not go so far, or has not such a wide range, as if projected from a height. Skilful generals, in bombarding towns at a safe distance, take advantage of this law of projectiles.

We are now prepared for the consideration of one of the most important principles in dynamics, namely, the law of motion which governs a body after receiving a projectile impulse.

A projectile exhibits a composition of motion, namely, a horizontal motion forward, when thrown in that direction, produced by the impressed force; and a descending motion, produced by gravity, or the earth's attraction. These two motions are unequal; they are not at the same velocity. The horizontal motion is uniform, while the descending motion, according to the law of gravitation in relation to falling bodies, is accelerated. The consequence is, that the projectile, as already mentioned, pursues a curved line of direction, the convex side of the curve being uppermost.

The degree of curvature of the line of motion depends on the amount of the original projectile force. The law is, the greater the projectile force, or the greater the original velocity of the object, so is the sweep of the curve proportionally greater.

Let us suppose that the projectile force is sufficient to carry a cannon ball ten miles; this will give a very wide curve, allowing that the ball is shot from a lofty situation But let us add to the projectile force, and send the ball double the distance, and the curve is now exceedingly wide. If we in this manner go on adding to the projectile force, we at length give the ball such a motal force, that it will go quite round the world; instead of describing portions of curves, it will describe a whole circle.

This conducts us to a most extensive result. We have at once placed before us a reason why the planetary bodies should have assumed curvilinear paths in relation to the sun. The original projectile force which they received in connection with the force of gravitation, has obliged them to pursue curved lines in their motion; and once being disengaged, they have, by a balance of centrifugal and centripetal forces, continued to travel in circular, or, properly speaking, elliptical orbits—the ellipticity being caused by a want of exact uniformity between the forces which affect them.

ACTION AND REACTION.

We proceed to a consideration of the first clause in the third proposition of Newton—"Action must always be equal and contrary to reaction."

Action is the impression of force. A blow is action; pressure is action. Reaction is resistance; but the word resistance does not fully convey the meaning of reaction, which properly signifies the action of striking or pressing back, even although the body struck or pressed upon do not move. When a man strikes a hammer upon a fixed stone, the stone strikes the hammer at the moment of contact as much as the hammer strikes it. But if the stone be not fixed, and be liable to be easily upset, then its reaction is less, and it acquires a momentum. When a boy throws his ball against the wall of a house, the wall reacts on the ball, and causes it to rebound; but if the boy throw his ball at a pane of glass with the same force, the glass, having the power to resist only a portion of the force, gives way before it. In this case, if we suppose the ball to possess the action or force of 4, and the glass to possess the reaction of 2, the ball passing through the glass loses 2 in its force, and retains the remaining 2. If it then came against another pane possessing a reactive power of 2, it would not break the glass, and, its force being now spent, it would fall to the ground. Thus, "action and reaction are equal."

A story is told of a person who, from his knowledge of the law of action and reaction, betted that he would lie down on the ground and allow an anvil to be placed upon his breast, and that any one might strike the anvil with as much force as he was pleased to exert. In this case, the person who made the offer was quite safe, provided he could support the weight of the anvil; for if a blow were given with the utmost force by a comparatively light body, as a hammer, though it would communicate nearly double its momentum to the anvil, yet the anvil, being so heavy, would acquire so small a velocity that the shock given to the person would be insensible. Were a freestone of the same weight as the anvil used, it would give a still less shock, for the action and reaction of perfectly elastic bodies is twice as great as that of inelastic bodies. Iron has more elasticity than stone.

It is by reaction acting contrary or in opposition to action, that the movements of living objects are rendered effectual. When we walk on the ground, the ground resists the pressure, and we feel ourselves steadied. A bird in flying pushes itself onward by the flapping of its wings against the partially resisting medium of the atmosphere. The partially resisting force of water, in the same manner, allows a fish to propel itself by its tail and fins. A sailor in rowing a boat causes the oars to push against the water, and, the water partially resisting the force, motion is communicated to the boat. In pushing a boat from the shore, the firm ground has such a power of reaction, that we are able to give the boat much greater momentum than if we pushed only against water. If we go into the boat and try to move it, by merely pressing against some part of its fabric, no motion whatever is produced, for the action and reaction are equal. The whole force employed must be rendered greater than the reaction, otherwise no motion can be communicated to the body.

When two bodies come into collision with each other, as in the case of two bodies moving in a straight line, but opposite course, to each other, the law of action and reaction being equal, will not be clearly illustrated, unless the collision be in the direction of the centre of gravity or inertia of the two—in common language, unless the blow be *fair*. The centre of gravity in cases of this kind, is called the *centre of action*, or *percussion*. For example, when we strike a ball with a club, fairly against its side opposite to its centre of gravity, it is impelled to considerable distance; but if we strike it above this central point, a part of the force is expended in vain, or lost, and the ball moves but a comparatively short distance. Experience has demonstrated that the centre of action in hammers should be in the head or striking part; and, therefore, in striking with these instruments, the blow may be given with every advantage. But when an attempt is made to strike with an object in which the centre of action is at a place short of its extreme point, for instance, a common iron poker, a part of the action is expended towards the hand of the person who strikes, and he feels a disagreeable jarring sensation in his arm.

This definition of the centre of action applies only to the motion of bodies in a straight line. In the case of revolving bodies, the centre of action or percussion is a point in it, to which if an immovable obstacle be applied, the body will remain at rest without any tendency to move in any direction, and the axis will receive no shock. In straight rods, or bodies of any form, suspended as pendulums, the centre of oscillation is the same as the centre of action in revolving bodies.

MOTION IN ELASTIC BODIES.

In reference to the effects of collision, bodies are divided into three classes—hard, soft, and elastic. A hard body is one that suffers no change of form by the action of any force. A soft body is one that undergoes a change of form by this means. An elastic body suffers a momentary change of form by the action of any force impressed upon it, and immediately springs back, or recovers its original form. The first two classes are styled *inelastic* bodies.

If two equal inelastic bodies be moving with equal velocities in opposite directions, and come in collision, each will destroy the onward motion of the other, and, consequently, both will be reduced to a state of rest. If there be any elasticity in the bodies, they will, according to their degree of elasticity, rebound from each other, and a positive process of reaction will be exhibited. By this means there will be at once a counteraction and transmission of force. As above stated, when the bodies are perfectly elastic, the action and reaction are double that of inelastic bodies.

An example of the transmission of force or motion from one body to another, while the transmitting bodies remain at rest from their mutual counteraction of the force communicated, may be seen in the case of a row of billiard balls, which possess a certain elasticity. Place six billiard balls in a row on a smooth plane, and let them all be pretty close to each other, or even in contact. Then give a smart blow to the first ball, or, as we may call it, No. 1; it will instantly strike against No. 2, which will communicate the force to No. 3, and from 3 it will be given to 4, and from 4 to 5, and from 5 to 6. None of the balls, however, will sensibly move from the spot in which it rests, except the last of the row, which, having no ball to impinge upon, will roll away, and thus expend the force communicated by the blow upon No. 1. An experiment of this kind is generally performed upon a number of elastic balls of a small size, suspended in a row by threads, as in fig. 9, in which case there is no friction to interrupt the process of action and reaction.

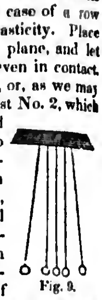


Fig. 9.

REFLECTED MOTION.

A body projected by a single force proceeds in a straight line till a new force act upon it, and send it on a new line of direction. When a moving body is thus impelled into a new line by striking against some body, its motion is said to be *reflected*.

Examples of reflected motion are very common—as, for instance, when a rolling ball encounters an opposing stone in its path, in which case it flies off obliquely in a new direction; when we throw a thin piece of slate along the surface of a river, and make it skip from point to point; or when an apple, in falling from a tree, touches a lower branch in its descent, and rebounds in a slanting direction to the ground.

It is found by experiments, that moving bodies observe certain laws in respect to the line of direction they pursue in rebounding or being reflected from any impediment with which they happen to come in contact. In the accompanying cut, fig 10, the line A B is a level marble slab. C is an ivory ball, which being thrown towards the slab in the direction of C E, is reflected in the direction E D. Thus the two angles F and G are exactly equal; and it is demonstrated, that a perfectly elastic ball striking a smooth wall or floor makes the same angle in leaving the point where it strikes that it does in approaching it.

Fig. 10

Whatever be the angle at which the ball strikes the smooth fixed surface, the same rule will be observed to be followed. This is exemplified in fig. 11. If the ball be dropped perpendicularly from L to K, it will rebound and return to L. If sent in the line H K, it will rebound or be reflected to I. The angle which a ball makes with the perpendicular line in going from H to K, is called the *angle of incidence;* and the angle which it makes in rebounding from the point at K to I, is called the *angle of reflection.* These angles are always equal.

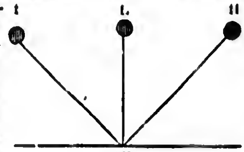


Fig. 11.

A calculation of the angles of reflected motion is necessary in the case of presenting a shield or other object to ward off a missile or blow from the person. If the angle be too acute, that is, if the blow be too point-blank, the shielding object may be damaged, or perhaps destroyed; while if the angle be obtuse, the object which gives the blow will slide off harmlessly.

If a billiard-player strike a ball perpendicularly against the cushion, it will return in the same direction. If, however, he strike the ball at an angle against the side of the table, it will rebound or fly off at an opposite angle. Suppose a ball to be placed half way up the side of an oblong table, and to receive sufficient force in such a direction as would make it strike the centre of the end of the table, the ball will fly off at an angle, and approach the side of the table opposite to that from which it was put in motion. By a knowledge of these laws, the billiard-player often makes a ball fly from one corner, strike the centre of the table, and reach the corner parallel to that from which it was struck. A similar kind of skill is required by those who handle the bat at the game of cricket.

COMPOSITION OF MOTION AND FORCES.

Hitherto we have spoken only of the motion of a body as produced by a single impulsive force, and turned aside or reflected by another force acting upon it; we have now to consider the subject of compound motion and force, or motion and force produced by two or more forces acting on a body in different directions at the same time.

If two or more forces act on a given point of a body, at certain angles, a single force may be found which would produce the same effect. This single force is technically called the *resultant* or *equivalent.* For instance, a wind blowing from the north-west, and a current setting from the north-east, both acting on a ship and tending to carry it with equal velocities in their own directions, the ship will be found to move in an intermediate direction, as if it were acted on by a single force, like a breeze, from due north.

It is usual, in treating of combinations of mechanical forces, to represent them by diagrams, the various lines of which are significant of the quantity or intensity of the forces, of the directions in which they act, and of the effects produced by them. This explains the reason for illustrating the action of forces by the following figures:—

In fig 12, we have an example of motion produced by two forces acting on a body from different directions. A is a ball, which, having received a blow at B, is proceeding onward to C. At the point A, while on its course, it receives a blow equal to the former, which second blow would have been alone capable of carrying it to E in the same time that the first blow would have carried it to C. This new force, by changing the direction of the original motion, causes the ball to move in a line towards F, and the effect is the same as if the ball had been at first sent in the direction of A F by a single force. Practically, it would be difficult to regulate blows with such nicety as to produce this line of motion, but in the theory of forces the law is as it has been stated. The line A F in the figure here drawn is termed the *diagonal of the square.*

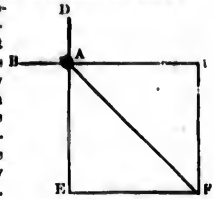


Fig. 12.

Should the constituent forces be of different magnitudes, then the figure described may be a parallelogram, or oblong, as in the annexed cut, fig. 13. The force here, in the direction A B, is double that of the cross force C D, by which means the ball describes a diagonal line to F, and so forms a parallelogram, when we draw all the lines connected with the experiment. The parallelogram thus formed is called the *parallelogram of forces.* The two given forces acting in the directions E B, E D, are called *components,* and the single force in the direction E F is the *resultant.* The process of finding a single force equivalent to two or more forces, is called the *composition of forces.*

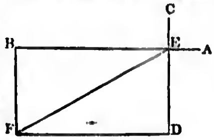


Fig. 13.

The process of finding forces which will produce a motion equal to that of a single force, is called the *resolution of forces.* The following are examples:—

If a boat D E M floating on a river be pressed downwards in the line M C by a current, two forces, P and Q,

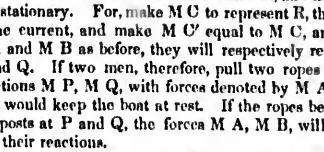


Fig. 14.

acting in the directions M P, M Q, may be found that will counteract the influence of the current, and keep the boat stationary. For, make M C to represent R, the force of the current, and make M C' equal to M C, and find M A and M B as before, they will respectively represent P and Q. If two men, therefore, pull two ropes in the directions M P, M Q, with forces denoted by M A, M B, they would keep the boat at rest. If the ropes be tied to two posts at P and Q, the forces M A, M B, will represent their reactions.

Let H M be a canal boat, M P the rope by which it is drawn by a horse attached to it at P. The force of

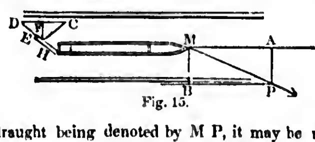


Fig. 15.

the draught being denoted by M P, it may be resolved into M A and M B, of which only M A is effective in drawing the boat forward; the other force M B tends to turn the head of the boat in the direction M B. This last force must therefore be counteracted, which is effected by means of the helm H E turned to an oblique position. When the boat is in motion, the water, being at rest, produces a resistance or pressure against the helm. If C D denote the resistance, it may be resolved into H D and H C, of which H D produces no effect on the helm; therefore C H is the only effective pressure. Again, C H may be resolved into C F and F H, the latter of which tends to turn the stern of the boat in the direction F H, and thus counteracts the force M B, by tending to turn the boat round in an opposite direction; and the part C F tends to move the boat backwards, and thus, counteracting a part of the force M A, it retards the progress of the vessel. The two forces F H, M B, would move the boat sideways, or laterally, to the side of the canal; but this can be prevented by giving the helm a little more obliquity, for, from the length and shape of the vessel, it is much more easily moved in the direction of its length than of its breadth.

Let T P be a ship, S L its sail, W A the direction of the wind and its pressure on the sail. W A can be resolved into A B perpendicular to the sail, and B W parallel to it, the latter of which has no effect in pressing on the sail; therefore A B is the effective pressure on the sail. Were the vessel round, it would move in the direction B A. Let B A be resolved into C A and B C, the former C A acting in the direction of the keel or length of the vessel, or in the direction C A, and the latter perpendicular to it, or in the direction of the breadth. The former pressure C A is the only pressure that moves the vessel forward, the other B C makes it move sideways. From the form of the vessel, however, this latter force B C produces comparatively little lateral motion; any that it does occasion is called *lee-way*. By turning the helm, the vessel may be made to turn round in any direction by the pressure of the water upon it, if the vessel has also at the same time progressive motion.

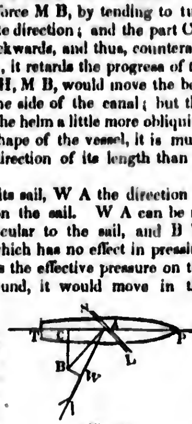


Fig. 16.

COMMON MOTION.

Motion, as has been stated, is called *common*, when participated in by two or more bodies. Thus, all things on the earth, including the atmosphere, have a motion in common with the earth; a person riding in a chaise has a motion in common with the chaise; a person in a moving vessel at sea has a motion in common with the vessel.

For convenience, we shall, in treating of this branch of our subject, use the terms larger and smaller body—the larger being understood to be the body on which the force to produce motion is immediately impressed, and the smaller being the body which is carried along by the body which has received this impression of force.

A large body is in motion; it is moving in a certain direction, at a certain velocity; every thing on it, or small body connected with it, partakes in its motion, and has a tendency to proceed in the same direction, and at the same velocity.

It appears strange that there should be a communication of motion from the larger body to the smaller, without the immediate intervention of impressed force on the smaller, but a little examination shows that such must necessarily be the case. The larger body has received the impulse to move, and this impulse is transmitted through the whole mass of the body, including all the small objects on its surface, and those which are any way connected with it in its propulsion. When a man is walking on the deck of a ship which is moving at the rate of ten miles an hour, he perhaps imagines that he has no more motion than if he were walking on the solid ground. But it would be incorrect for him to think so. His body, and every thing about his person, have received an impulse from the vessel; he possesses a velocity of ten miles an hour as much as the planks of the vessel do, and this onward motion he cannot divest himself of, as long as the ship continues to move at this rate of speed, or as long as he continues in connection with it.

On account of this participation of motion in all bodies moving in connected masses, it is observed that all objects whatever keep their proper places in or about the large moving bodies with which they are in contact, and hence no confusion takes place in the relative situation of objects on the earth by its motion. For example, when we leap from the ground, the earth does not slip away from below us; if we ascend in a straight line of direction, we fall down exactly upon the same spot whence we arose. When a man falls from the top of a mast of a moving vessel, he falls upon the deck upon a spot directly under the point whence he fell; the vessel does not leave him. When we are sitting in the cabin of a moving vessel, and let a small object drop from our hand to the floor, it falls on a point on the floor immediately below, the same as if it had been dropped in a house on solid ground; the floor does not leave it behind. When we are sitting in a rapidly moving coach, and in a similar manner let an object fall, it descends in the same manner to the bottom of the coach. The reason for these phenomena is that already mentioned—the small objects possess a motion derived from the larger; this common motion, or *motal inertia*, as some authors call it, is retained by the small objects during their descent, so that, while descending, they are also going forward; in other words, they display a composition of motion—a horizontal motion and a descending perpendicular motion.

One of the most beautiful examples of common motion, is that which is exhibited by an equestrian standing on a horse which is running round a circle, while he at the same time throws oranges from his hand and catches them in their descent. Notwithstanding his rapid motion, the oranges which are thrown into the air do not fall behind; they return regularly to his hand. To counteract centrifugal force, he leans greatly inward; but this does not alter the law of motal inertia, which causes the oranges to return. He throws them almost sidewise in an inward slanting direction, and yet they come readily back to him. The reason for these phenomena is, that the oranges participate in the forces by which he himself is impelled and sustained.

Small bodies which have derived a motal inertia from a larger, continue to possess this motal inertia after leaving the larger, until they meet with some new impression of force sufficient to alter their condition. If they were not pulled to the earth by attraction, and were not opposed by the atmosphere, they would go on moving in a straight line for ever. When we drop a ball from the window of a moving coach, it continues to go forward as if it were still in the coach, till it meet the ground when it is stopped; thus, its motal inertia is destroyed. If we attempt to leap from a moving body, such as a coach or a boat, we continue to possess the motion which we previously had, until we touch the earth, when we receive a shock by the destruction of our motal inertia. But if we leap from one moving body to another moving body which is going near it, on the same level, in the same direction, and at the same velocity, we sustain no shock, because the body upon which we leap possesses the same condition of motion as that which we possess.

When a man, standing on the ground, shoots at a bird on the wing, he requires to follow its motion by keeping his gun moving when presented at it; but if he be standing on the deck of a ship sailing at the rate of ten miles an hour, and point his gun at a bird flying in the same direction and at the same velocity as the ship, then he placed in the same condition as the bird; he does not require to move his gun, as if following the bird. In taking aim at a bird on the wing from the solid ground, it requires considerable skill to prevent the shot from proceeding to a point behind the bird, because the shot is entirely destitute of motal inertia on being fired, unless it be previously put in motion. But a bullet on leaving a gun which is moving at the same rate as the bird, and in the same direction, keeps going on in the direction of the bird, because it retains the motion it had in common with the gun. The bullet in this case does not go in the direction of the gun, but obliquely, so as to keep up with the motion of the bird, so that the same effect is produced as if the shot had been fired from a fixed gun on land to a fixed point in the air in advance of the bird. Should the bullet be fired from a gun in a moving vessel, for instance a ship sailing westward to a fixed point on land, then a certain allowance must be made for the motal inertia of the bullet; it must be fired a little eastward, and the motal inertia will carry it westward to the object.

Objects falling from bodies moving in an onward direction to those which are at rest, are regulated by the same law that governs projectiles. The falling objects, as formerly mentioned, are affected by two motions—one in a horizontal and the other in a descending direction. When these motions are unequal, the falling body describes a curve in its descent, the convex side of the curve being uppermost. Thus motal inertia and the motion produced by projectile impulse are the same thing; and hence, powerful centrifugal force in the sun, sufficient to disengage a portion of its mass, would be equivalent to a projectile impulse from it as a fixed body.

In consequence of the general participation of common motion in all things connected with a moving body, there can be no consciousness of motion in the living beings carried about by it, provided the motion be perfectly smooth, and there be no means of observing bodies which are at rest. Thus, on account of our possessing a motion in common with the earth, which moves with perfect smoothness, we can neither see nor feel the earth moving. We, however, see the sun, which seems to us to be in motion in reference to the earth, but which, by various means, we know to be at rest; and hence we are assured of the earth's diurnal rotation on its axis, and its annual or planetary motion round the sun. In the same manner, a person sitting in the cabin of a smooth-sailing ship, and not looking out at the windows, cannot, by his mere sensations, tell that the vessel is moving; but if he look at the shore, which is at rest, he is immediately sensible of the progressive motion of the vessel.

In looking from a moving body, as from the earth to the sun, from a ship to the shore, or from a coach to objects on the wayside, a delusive feeling prevails that it is not the body you are upon, but the body which is at rest, that is really moving—going in a direction contrary to that of the body you are connected with. This is in consequence of our possession of motion in common with the moving body. We are under an influence, or in a condition, that renders us incapable of seeing our own motion; and hence the error which the sense of vision leads us to commit, is left to be rectified by an exertion of the understanding.

[WORKS ON NATURAL PHILOSOPHY.

One of the best general views of this subject is Herschell's admirable "*Discourse on the Objects, Advantages, and Pleasures of the Study of Natural Philosophy*," originally published as a part of Lardner's Cabinet Cyclopædia; and reprinted in a cheap form by the Harpers. Among the best works on the history of Natural Philosophy are, Fischer's "*History of Physics since the Revival of Letters*" (in German, Gottingen, 1801, 6 vols.), and Playfair's "*Dissertation on the Progress of Mathematical and Physical Science since the Revival of Letters*," prefixed to the Encyclopædia Britannica, and continued by Leslie. Arnott's "*Elements of Physics*" (Am. ed. with additions by Dr. Hays, Philadelphia, 1829), is a well written and excellent popular treatise. "*The Scientific Class Book*," edited by Walter R. Johnson, Esq., is an excellent compendium. Dr. Reynell Coates's "*First Lines of Natural Philosophy*" (Philadelphia, 1846), is a very ably written popular treatise, illustrated by 264 well engraved embellishments. This book has the advantage of bringing the science down to its present state, and giving the result of all its recent improvements and discoveries. Daniell's "*Illustrations of Natural Philosophy*," and Euler's "*Letters on Natural Philosophy*," edited by Brewster, are highly interesting and delightful works, uniting the attractions of elegant style and great felicity of illustration with thorough scientific knowledge.

In prosecuting the study of Natural Philosophy, the learner will find his progress greatly facilitated by the use of Brande's "*Encyclopædia of Science and Art*," lately reprinted by the Harpers, in which the terms of science are accurately explained and illustrated.—*Am. Ed.*]

MECHANICS—MACHINERY.

GENERAL DEFINITIONS.

THE application of the laws of motion and forces to objects in nature or contrivances in the arts, forms the branch of Natural Philosophy usually treated under the head MECHANICS, MECHANICAL POWERS, or ELEMENTS OF MACHINERY.*

Machines are, under all denominations or circumstances, only instruments through which power may be made to act. They only convey, regulate, or distribute, the force or power which is communicated to them from some source of motion, and never create or generate power. But although a machine does not create power, or give more power than it has received, it practically applies the power which has been communicated to it, in so convenient and easy a manner, that a result ensues almost as surprising as if it had actually generated the whole or a portion of the power it exhibits.

The main purpose required in mechanical operations is to overcome, oppose, or sustain, a certain resistance or force. This purpose is obtained by applying another species of force. According to the usual phraseology, the resistance or force to be overcome is called the *weight*, and the force which is applied is called the *power*.

The ability of applying force by the human hands, without the aid of instruments or machines, is very limited. In almost all our operations of art, it is found necessary to call in the aid of instruments or machines of some kind. All the instruments which mankind have adopted for their use—from the piece of stick with which the savage scratches the ground as a plough, to the most elegantly finished piece of mechanism—act upon certain fixed principles in nature, which a long course of experience and scientific investigation has developed.

The mechanical powers which exhibit the working of these principles, are strictly only three in number, namely,—1. the *Lever*; 2. the *Pulley*, or *Cord*: 3. the *Inclined Plane*. These may be called the Primary Mechanical Powers; and from two of them, the Lever and Inclined Plane, other three are formed, as follow—1. *Wheel* and *Axle*, from the *Lever*: 2. *Wedge*, from the *Inclined Plane*; 3. *Screw*, from the *Inclined Plane*. These may be called the Secondary Mechanical Powers. The six altogether form the elements of every species of machinery, however complex.

OF LEVERS.

The lever is one of the most important and extensively used of all the mechanical powers, and its operation exhibits some of the leading principles in mechanics.

A lever is a rod, or bar of iron, wood, or any other material, which is movable upon or about a prop or fulcrum, or about a fixed axis. It is called a *lever*, from a French word, signifying to raise, and has been applied to instruments for raising or lifting weights.

Three elements contribute to the operation of the lever—the *power*, the *fulcrum*, and the *weight*. The power is the force applied, the fulcrum is the prop or support, and the weight is the resistance or burden to be lifted. The terms *power* and *weight* have merely a reference to the manner in which the machine is used; strictly, both the power and weight are *forces* the same in character and action.

There are three kinds of levers, differing according to the relative situation of the power, fulcrum, and weight. Each of these kinds consists of a straight bar, and in theoretical calculations is supposed to be in itself destitute of any gravity or degree of heaviness. In theory, also, the forces which are applied are supposed to act at *right angles* to the fulcrum.

In the first or most simple kind of lever, "the fulcrum is disposed between the power and the weight." In the second kind, "the weight is disposed between the power and the fulcrum." In the third kind, "the power is disposed between the weight and the fulcrum."

In the first kind of lever, "the fulcrum is disposed between the power and the weight." Figure 1 is an example. A to B is a straight bar, resting on a prop or fulcrum F. From A to F is the long arm of the lever, and from F to B is the short arm. P is the power, or a certain force drawing down the extremity of the long arm at A. W is the weight suspended from the extremity of the short arm at B. The object is to cause P, which is supposed to be a small weight, to balance or overcome W, which is supposed to be a weight much heavier. Practically, the force of a man pressing upon the extremity of the handle of the lever at A, will effect with ease, in lifting the heavy weight W, what it would require a much greater force to accomplish by pressing upon the long arm at a point half way betwixt A and the fulcrum.

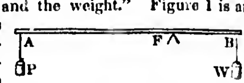


Fig. 1.

This is more clearly exemplified in fig. 2, which represents a lever placed conveniently for raising a square block W, which is the weight. On pressing down the extremity of the long arm of the lever at A, the point of the short arm B raises the block. F is an object lying on the ground to press against as the fulcrum. As in the case of fig. 1, "the force of a man pressing upon the extremity of the handle at A, will effect with ease, in lifting the weight W, what it would require a much greater force to accomplish by pressing upon the long arm at a point half way betwixt A and the fulcrum."

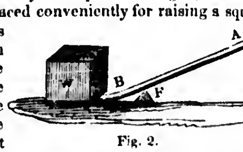


Fig. 2.

The principle in mechanics which produces this phenomenon is very simple, and is explained by what is called the Law of Virtual Velocities, or, from its general application, the Golden Rule of Mechanics.

This law or rule is, *That a small weight, descending a long way in any given length of time, is equal in effect to a great weight descending a proportionally shorter way in the same space of time.* In other words, what is gained in velocity or time, is lost in expenditure of power.

Another way of stating this important law is as follows:—*In the case of equilibrium, if a motion be given to the mechanical power, then the power multiplied by the space through which it moves in a vertical direction, will be equal to the weight multiplied by the space through which it moves in a vertical direction.*

This principle, which applies to every mechanical movement in the case of equilibrium, has been illustrated by a reference to the property of attraction of gravitation. What is called weight is only an effect of

* In scientific works, the term *mechanics* is usually restricted to the action of *solids*, while *mechanical* or *mechanically* is applied to the action of both solids and fluids. For example, the wearing away of stone by the action of the water, is said to be *mechanical action*, or that the water acts *mechanically*.

gravity on the atoms of matter. In figurative language, every atom is drawn towards the earth by an invisible line or cord of attraction; and when one atom rises or falls ten inches, the same quantity of attraction is drawn out from, or sent back to the earth, as if ten atoms were to rise or fall only one inch.

Thus, by a proper mode of applying the power, we may cause a weight of one pound, by moving through a space of ten feet, to raise another weight of ten pounds, moving through a space of one foot; or (the reverse) by a weight of ten pounds moving through the space of one foot, we may make a single pound move through the space of ten feet. But by none of the mechanical powers shall we be able, by moving a weight of ten pounds through one foot, to move a single pound through eleven feet; nor, by a single pound moving through a space of nine feet, shall we be able to raise a weight of ten pounds through one foot.

Neither by the power of the lever, therefore, nor by any other of the mechanical powers, can we make any absolute increase of the power which is applied. In other words, the quantity of power expended in any great and instantaneous effort, is exactly the amount of the power which has been previously accumulated. All that we can do to procure mechanical advantage, is to accommodate the velocity, force, or direction of the applied power, to the purposes which we may have in view.

To apply this principle to the lever: in figs. 1 or 2, a small force at A is equal to double the force exerted at a point halfway betwixt A and the fulcrum, yet, in both cases, the same amount of mechanical power is expended. A slight push downwards at A, by being continued for one minute, is equal to a push of double the force at a point halfway towards the fulcrum, continued for the same time. Any amount of force, therefore, can be exerted with ease at the extremity of the long arm of the lever, provided we choose to make the arm long enough and strong enough.

It may possibly be said that it would be as expeditious to push down the extremity of the long arm of the lever, as to push down the arm at the point nearer the fulcrum. Practically, in small levers this may be the case; but when levers of considerable length have to be used, and a succession of depressions and raisings are necessary, it will be found that more time is spent in working with a long than a short lever. For when the sweep of the lever is inconveniently long, the person using it has to move his body quickly up and down over a larger space, and is sooner fatigued. For this reason, although a boy with a long lever may balance as great a weight as a man with a shorter one, yet, in raising weights successively by it, the boy would be sooner fatigued.

It is a general rule that "the force of the lever increases in proportion as the distance of the power from the fulcrum increases, and diminishes in proportion as the distance of the weight from the fulcrum diminishes." In making calculations to ascertain the proportions to be observed betwixt the power and the weight, regard must be paid to the respective lengths of the long and short arms of the lever. We must also fix what are to be the units of weight and distance, and let them be the same on both ends. If we state inches to be the unit of length of the short arm, inches must be the unit of length of the long arm; and in the same manner, if ounces be made the unit of weight of the short arm, ounces must be made the unit of power of the long arm.

Rule.—Multiply the weight by its distance from the fulcrum; then multiply the power by its distance from the same point; and if the products are equal, the weight and the power will balance each other.

Example First.—Suppose a weight of 100 pounds on the short arm of a lever, at the distance of 8 inches from the fulcrum, then another weight or power of 8 pounds would be equal to this, at the distance of 100 inches from the fulcrum. Because 8 multiplied by 100 produces 800, and 100 multiplied by 8 produces 800—and thus the weight and the power would mutually counteract each other.

Example Second.—Suppose we wish to calculate what power should be employed at the end of the long arm of the lever to balance a given weight at the end of the short arm. We multiply the weight by the length of its arm. This gives us a product; then divide that product by the number of inches in the long arm, and the result or quotient is the power. Thus, a weight of 10 pounds, multiplied by 10 inches as the length of the short arm, gives a product of 100. If the length of the long arm be 20, we find how many twenties are in 100, and there being 5, consequently 5 pounds is the power. In this instance, the mechanical advantage is two to one—that is, the power is twice as small as the weight.

The common spade used in delving in gardens offers a similar example of simple lever power, when employed in raising the earth from its place to turn it over. Fig. 3 represents an equally familiar example, namely, a wood-sawyer or carpenter moving a log of

Fig. 3.

timber from its place, by means of a long pole or beam of wood. Stone masons use a lever of iron of this description, called a crow-bar.

The power of the first kind of lever is frequently seen to operate in machines or instruments having two arms. The most common examples of this nature are pincers, scissors, and similar instruments. In the pair of scissors here represented, the two limbs are seen to be joined together with a rivet at the centre, which is the fulcrum of both.

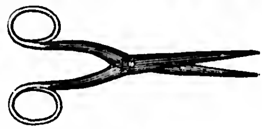


Fig. 4.

A common scale beam for weighing, used by shopkeepers, is an example of the first kind of lever, formed with two arms of equal length, and suspended over the centre of gravity, so that the two extremities balance each other. See fig. 5. S is a string or line suspending the beam A B at a central point F, which is the fulcrum. The point of suspension, or pivot, is sharpened to a thin edge, so as to allow the arms to rise or fall with as little friction as possible when any thing is put in the scales.

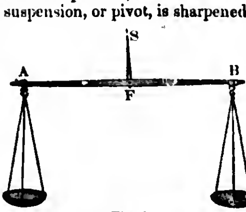


Fig. 5.

There is another kind of balance called a *steelyard*, which consists of a lever with arms of unequal length, and acts upon the principle of distance from the fulcrum on the long arm compensating for weight on the short arm, as already defined. Fig. 6 is a representation of the steelyard balance. C is the fulcrum or pivot by which the beam is suspended, and freely plays as on an axis. A is the short

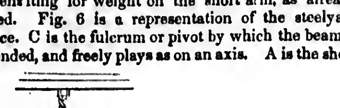


Fig. 6.

arm, and the opposite end is the long arm. W is the scale for the reception of the article to be weighed. The long arm is graduated into divisions by marks, each mark denoting by a figure a certain number of pounds or ounces. P is a weight of a certain heaviness, and being movable by a ring, it can be slipped along the bar to any required point. The same weight is always used, and thus constitutes one of the principal conveniences of this kind of balance. In proportion as the article to be weighed in the scale W is heavy, so is the weight P slipped along to a greater distance from the fulcrum; and when it is brought to a point where it balances the article, the figure on the bar at that point indicates the amount of the weight. If P be one pound, and if, when suspended from the division at 6, it balance the weight at W, it is evident that the weight will be six times P, or 6 pounds. And so on with all the other divisions.

The steelyard, though not so ancient as the common balance, is of considerable antiquity. It was used by the Romans, and has long been in use among the Chinese. Neither the common balance nor the steelyard are suitable for showing the varying weight or heaviness of an article at different latitudes of the earth's surface, because the weights employed are equally affected with the attraction of gravitation and centrifugal force, as the article to be weighed. For this reason, the difference of weight resulting from the causes mentioned, can only be demonstrated by a balance formed of a spring of elastic metal. By suspending the article from the spring, it pulls it out to a certain extent, and so indicates the weight on a graduated scale on the instrument. As the spring acts the same in all latitudes, it serves as a fixed and unalterable power, while the article to be weighed is liable to an alteration in its weight or heaviness according as it is brought near or carried from the equator.

In the lever of the second kind, the weight is placed between the power and the fulcrum, as in fig. 7. The line from A to B is the long arm, B to F is the short arm. W is the weight, and P is the power. The object required by this lever is to lift the weight W by raising the extremity of the lever at A. In this, as in the case of the first kind of lever, the power is increased in proportion to its distance from the fulcrum.

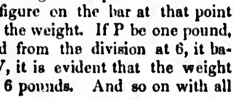


Fig. 7.

Examples of this kind of lever power are common. One of the most familiar is that of a man pushing or lifting forward a bale of goods, as represented in fig. 8, in which the bale or weight W presses against the lever between the power P and the fulcrum F.

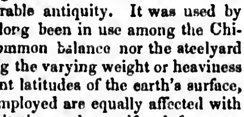


Fig. 8.

Another example of the second kind of lever is that of a man using a wheelbarrow, as represented in fig 9. A point in the wheel of the barrow where it presses on the ground, is the fulcrum. The body of the barrow, with its load, is the weight. And the two handles, lifted or held up by the man, form the power.

Fig 9.

In proportion as the man shortens or lengthens the handles in holding them, so does he increase or diminish the weight he has to sustain.

Two men carrying a load between them on a pole, is also an example of the second kind of lever. The load may either rest upon or be dependent from the pole. In the case of two porters carrying a sedan chair by means of two poles, the load or weight is partly above and partly below the line of the lever. In the case of porters carrying a barrel slung from a pole, as in fig. 10, the weight is altogether below the lever. In both instances the principle is the same. Each man acts as the power in moving the weight, and at the same time each man becomes a fulcrum in respect to the other.

Fig. 10.

If the weight hang fairly from the centre of the pole, each man will bear just a half of the burden; but if the weight be slipped along to be nearer one end of the lever than the other, then the man who bears the shorter end of the pole supports a greater load than the man who is at the long end. The weight increases precisely in proportion as it advances towards him. Sometimes, when a man and a boy are carrying a handbarrow between them, the man, in order to ease the weight as much as possible to the boy, holds by the arms of the barrow near to where they join the loaded part.

In yoking horses to the extremities of cross bars in ploughs, coaches, or other vehicles, care requires to be taken to hook the cross bar to the load at its centre, otherwise one horse will have to pull more than the other.

An inflexible beam resting on supports or fulcra at its two extremities, acts similarly as a lever of the second kind. Should no weight be appended to its centre, the weight of the material itself, when the extension is considerable, will be enough to bend it down, and even to break it. Extended flexible cords or chains are from this cause always bent down in the middle, no power of extension being able to overcome the gravity of the materials, which will give way before they can be rendered perfectly straight. The bended string of a boy's paper kite is an example of this powerful influence of gravity of materials.

The instrument used for cracking nuts (fig. 11) is an example of the second kind of lever with two arms or limbs. The fulcrum is the joint which connects the two limbs; the nut between them is the weight or resistance; and the hand which presses the limbs together, in order to break the nut, is the power. As each limb is a lever, a double lever action takes place in the operation.

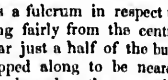


Fig. 11.

The oar of a boat in rowing is a lever of the second kind. The hands of the sailor who pulls constitute the power; the boat is the weight to be moved: and the water against which the blade of the oar pushes, is the fulcrum.

The second kind of lever is sometimes employed as an instrument of pressure. The point of the short arm is, for example, pushed into a crevice or hole in the wall, the fulcrum is the object to be pressed, and at the extremity of the long arm a heavy weight is applied. In this rude but efficacious manner are cheeses pressed in some parts of the country.

In the lever of the third kind, the power is placed between the weight and the fulcrum (fig. 12). The fulcrum is at the extremity of the short arm at F; the weight W is dependent from the extremity of the long arm at A; and P is the power.

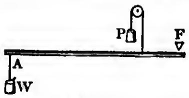


Fig. 12.

In this kind of lever, the power acts with considerable disadvantage, or with small effect; but this disadvantage is compensated by an opposite advantage, which is frequently of great importance in the operations of both nature and art. The advantage consists in the velocity with which a small power will cause the extreme point of the long arm of the lever to move over a great space. This lever, therefore, whether in nature or art, is used only when a great space has to be traversed quickly by the long arm; but in this case the power must always be greater than the weight.

An example of this kind of lever is found in the footboard of the turning-lathe (fig. 13). The foot of the workman presses lightly on the board or plank near the end which rests on the ground, or fulcrum, and causes the opposite extremity of the board to move in a downward direction over a considerable space. A spring over head, or a crank, pulls the board up again by means of a string S; the workman again presses it downward, and so a constant action of the string or cord which works the lathe is easily produced.

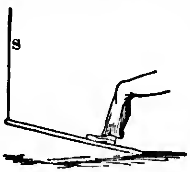


Fig. 13.

A man wielding a flail with two hands, and similar instances of using weapons, are also examples of the third kind of lever action. A similar action was observable when we use fire-tongs; a small motion of the fingers near the joint of the instrument causes the legs, which are two levers, to open or shut over a considerable space.

Before the peculiar advantages of this kind of lever became known, or were appreciated, it was called the *losing lever*.

The movements in the limbs of animals are generally produced by the action of this kind of lever power.

When several levers of the simple kinds are connected together, and are made to operate one upon the other, the machine so formed is called a compound lever. In this machine, as each lever acts with a power equal to the pressure on it of the next lever between it and the power, the force is increased or diminished according to the number or kind of levers employed.

Fig. 14 represents a compound lever, consisting of three simple levers of the first kind, placed in a line, and each working on its own fulcrum. The desired object of the machine is for a small force or power at P, to move or balance a large weight at W. The same rule applies, in calculating the action of this combined lever, which has already been given for the simple lever—namely, "Multiply the weight on any lever by its distance from the fulcrum; then multiply the power by its distance from the same point, and if the products

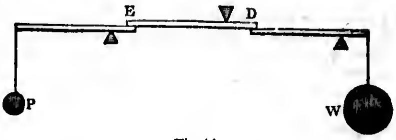


Fig. 14.

are equal, the weight and the power will balance each other." Or, for the form of lever in the figure, "Multiply the length of the long arm by moving the power, and multiply that of the short one by the weight, or resistance."

It is supposed that the three levers in the figure are of the same length, the long arms being six inches each, and the short ones two inches each; required—the weight which a moving power of 1 pound at P will balance at W. In the first place, 1 pound at P would balance 3 pounds at E; we say 3, because the long arm being six inches, and the power 1 pound, 6 multiplied by 1 is 6; and the short one being 2 inches, we find that there are 3 twos in 6, therefore 3 is the weight. The long arm of the second lever being also 6 inches, and moved with a power of 3 pounds, multiply the 3 by 6, which gives 18; and multiply the short arm, being 2 inches, by a number which will give 18; we find that 9 will do so (9 twos are 18); therefore 9 is the weight borne at the extremity of the short arm of the second lever at D. The long arm of the third lever being also 6 inches, and moved with a power of 9 pounds, multiply the 9 by 6, and we have 54; and multiply the short arm, being 2 inches, by a number which will give 54; we find that 27 will do so (twice 27 is 54); therefore 27 is the weight borne at the extremity of the short arm of the third lever. Thus 1 pound at P will balance 27 pounds at W; or 1 ounce at P will balance 27 ounces at W—the proportions being always alike, whatever denomination of weight we employ.

In this instance, the increase of power is comparatively small, because the proportion between the long and short arms is only as 2 to 6, or 1 to 3. If we make the proportions more dissimilar, as 1 to 10, or 1 to 20, the increase of force becomes very great. For example, let the long arms be 18 inches each, and the short ones 1 inch each, and 1 pound at P will balance 18 pounds at A, and the second lever would be pushed up with a power of 18 pounds. This 18 being multiplied by the length of the lever 18, gives 324 pounds as the power which would press down the third lever. Lastly, multiply this 324 by the length of the lever 18, and the product is 5832 pounds, which would be the final weight at W which 1 pound at P would raise.

The following is a general rule for calculating the advantages of a compound lever consisting of any number of levers, whether equal or not:—Call the arms of the different levers next the power the *arms of power*, and the other arms the *arms of weight*; then, if the lengths of the arms of power and the power itself be successively multiplied together, the product will be equal to the continued product of the arms of weight and the weight, when the power and weight are in equilibrium.

A similar result to that of a combination of levers might be produced by only one lever, provided it were long enough, but the operation would be both clumsy and inconvenient. By combining levers, and making them act one upon another, great weights may be balanced within a small compass, and with an exceedingly small power. On this account, machines are constructed with combinations of levers, for weighing loaded carts and other heavy burdens. The cart is wheeled upon a sort of table placed level with the ground, beneath which the levers are arranged; and a small weight placed on a scale attached to the extreme point of the first lever, balances the load, which rests on the table above the last lever. This species of weighing-machine is often to be seen at toll-bars.

In the foregoing examples of lever powers, the levers or bars are supposed to be straight, and the powers and weights, or forces, are supposed to act at right angles with them.

Levers are frequently *bent* in their form, for purposes of convenience, and the powers and weights often act *obliquely*, or not at right angles.

In calculating the mechanical advantage of bent levers, the chief matter of consideration is *obliquity* in the direction of the applied power and weight. Obliquity in the action of the forces generally diminishes the mechanical advantage.

Whatever be the form of the lever, or the direction of the power and the weight, the mechanical advantage of the power or the weight is always represented by *a line drawn from the fulcrum, at right angles to the direction in which the forces are respectively exerted.*

Fig. 15 is a bent lever, with the power of P hanging from A, and the weight W hanging from B. In this case, both the power and the weight act at right angles to an ideal line, drawn as from E to G across the fulcrum, which strikes the lines of direction of the forces at right angles.

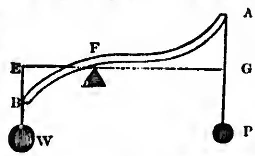


Fig. 15.

OF THE WHEEL AND AXLE.

A lever has been defined to be "a rod or bar of iron, wood, or any other material which is movable upon or about a prop or fulcrum, or about a fixed axis." The illustrations which have been given, show the lever only in its character of a simple bar, which is movable in some part "upon or about a prop or fulcrum." It is now to be shown how it acts when movable upon or about a fixed axis. When a lever is movable upon an axis, and is susceptible of being turned completely round, it assumes the character of the diameter of a wheel.

In fig. 16, the simple rudiments of a wheel are represented. A and B are the two arms of a bar or lever playing upon a fixed axis at F, and which axis is the fulcrum. If we push down A, we raise B, or if we push down B, we raise A. In this manner the situation of the power and the weight is transferable from one end to the other, as in the beam of a common balance, without altering the equilibrium.

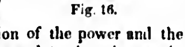


Fig. 16.

Fig. 17 is a representation of a wheel in a state more advanced to completion. Here the arms A B are connected with the arms D C, both at the centre F, and by means of the circumference or rim of the wheel. By reason of this union of parts, the central axis at F becomes the common fulcrum for every portion of the wheel; therefore, from the centre to any point of the circumference is an arm of a lever, although the line of that lever be not marked or seen, as in the case of a distinct spoke.

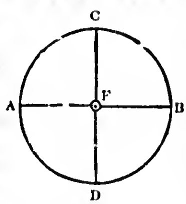


Fig. 17.

A line through the centre from one side of the circumference of a wheel to the opposite side, is a diameter; from the centre to any part of the circumference, is the semi-diameter or radius. The arms or spokes are said to radiate from a centre. The circumference is sometimes called the periphery.

Besides wheels with axes in the centre, there are wheels with axes not in the centre, called eccentric wheels. At present, however, we are treating only of wheels having their axes in the centre.

Wheels with a central axis may be rendered available as levers in various ways, according to the placing of the weight or resistance. The plan commonly pursued consists in giving to the wheel an axle which is fixed to its arms, and placing a weight near the axle or fulcrum, to work against another weight at the circumference.

Thus a machine is formed called the Wheel and Axle, which constitutes one of the simple mechanical powers founded on the lever.

The machine termed the wheel and axle consists of a wheel fixed upon an axle or spindle, which axle turns horizontally on its two ends in upright supports. See fig. 18. The fulcrum of the machine is common to both the wheel and the axle, and is the centre of the axle. A is the wheel, B is the axle, and H is a handle with which the machine may be turned. By turning the wheel, the axle is also turned, and a rope being fixed to the axle, with the weight W hanging at its extremity, the turning of the wheel causes the axle to wind up the rope, and so lift the weight. If, instead of turning the wheel with the hand, we wind a rope round the circumference of the wheel, in a contrary direction from that in which the axle rope is wound, and also hang a weight of a certain heaviness, P, to its extremity, then the draught or pulling of the wheel rope in unwinding, will turn the axle, and so wind up the axle rope with its weight. In this manner, one power works against another, exactly as in the case of the lever. By properly apportioning the two powers in correspondence with the diameters of the wheel and the axle, the one power or weight may be made to balance the other power or weight, so as to produce an equilibrium of the machine.

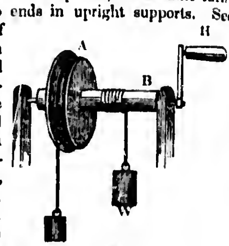


Fig. 18.

The wheel and axle form what is called a *perpetual lever.* Common simple levers act only for a short space, or by reiterated efforts, so as to be adapted for lifting an object from one place to another on the ground. The perpetual lever, formed by the wheel and axle, turns round without intermission, and is therefore suitable for lifting weights attached to a rope, through a considerable space upward from the ground without stopping.

Fig. 19 is a representation of the machine endwise, and shows how the lever operates. The line going across the machine from A to B represents the line of the lever. A is the situation of the power, F is the centre or fulcrum, and B is the situation of the weight; therefore, from A to F is the long arm, and from F to B is the short arm of the lever. In other words, the long arm is half the diameter of the wheel, and the short arm is half the thickness or diameter of the axle.

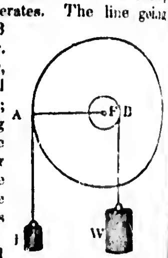


Fig 19

By widening the wheel, and so lengthening the long arm of the lever, the smaller will be the power necessary to overcome the weight on the axle or short arm; but what is gained by this mechanical advantage is lost by the circumstance that the power must descend through a pro pr rtionally greater space in order to raise the same weight through the same space in the same time.

To find what forces will balance each other, let the same rules be followed as those formerly given for the simple lever. Multiply the weight by its distance from the fulcrum (that distance is half the diameter of the axle); then multiply the power by its distance from the same point (that is, half the diameter of the wheel), and if the products be equal, the weight and the power will balance each other. Thus, a power of one pound at or depending from the circumference of a wheel of twelve inches in diameter, will balance a weight of twelve pounds at or depending from the circumference of an axle one inch in diameter.

Note.—No allowance is made in these calculations for the overlaying of the rope in winding, which affects the length of both the long and the short arm; but this is a matter of practical, not of theoretic import.

The principle of the wheel and axle, or perpetual lever, is introduced into various mechanical contrivances which are of great use in many of the ordinary occupations of life. One of the simplest machines constructed on this principle, is the common windlass for drawing water by a rope and bucket from wells. Coal is lifted from the pits in which it is dug, by a similar contrivance, wrought by horse or steam power.

The capstan in general use on board of ships for hauling or drawing up anchors, and for other operations, is an example of the wheel and axle, constructed in an upright or vertical, instead of a horizontal, position. In fig. 20, one of these capstans is represented. The axle is placed upright, with the rope winding about it, and having a head pierced with holes for spokes or levers, which the men push against to cause the axle to turn. This is a powerful and convenient machine on shipboard; when not in use, the spokes are taken out and laid aside.

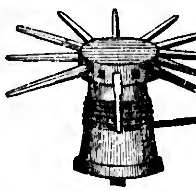


Fig. 20.

An illustration of the wheel and axle, in a combined form, is afterwards given in the case of the crane.

OF CORDS AND PULLEYS.

The pulley, or cord, is one of the primary mechanical powers. A pulley is a wheel, with a groove in its circumference, and is suspended by a central axis. In fixed pulleys, a flexible cord, which is made to pass over and hang from the upper part of the groove, has at one extremity a certain weight to be raised, and at the other extremity a power is attached for the purpose of pulling.

There are two kinds of pulleys, the fixed and movable. The annexed cut, fig. 21, represents a fixed pulley. A is the wheel, B is the beam or roof from which the wheel is suspended. P is the power hanging at one end of the rope, and W is the weight at the other end. This kind of pulley is called a fixed pulley, because it does not shift from its position.

Fig. 21.

The fixed pulley possesses no mechanical advantage. The wheel is merely a lever with equal arms, and therefore the cord which passes over these arms gains no advantage. To raise a pound weight from the ground at the one end of the cord, the power of one pound must be exerted at the other.

The object of the single fixed pulley is not to save power, but to give convenience in pulling. For instance, by pulling downwards, a weight may be raised upwards, or by pulling in one direction, a load may be made to proceed in another. The same object might be gained by drawing a cord over a fixed post or pivot, but in this case the friction of the cord would chafe or injure it; the wheel or pulley is therefore a simple contrivance to prevent friction, for it turns round along with the cord.

The movable pulley is in form the same as the fixed pulley, but instead of being placed in a fixed position from a beam or roof, it hangs in the cord which passes under it, and from it the weight is suspended. In fig. 22, a movable pulley is represented. A is a hook in a beam to which one end of a cord is fixed. B is the movable pulley, under which the cord passes and proceeds upwards to C, a fixed pulley, from which it depends to P, the power or the hand pulling. The fixed pulley C is of no further use than to change the direction of the power. W is the weight hanging from B.

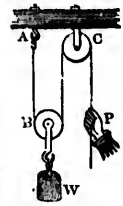


Fig. 22.

The movable pulley possesses a mechanical advantage. The first point to be observed is, that the weight hangs in the cord; second, that the weight presses down each side of the cord equally—that is, it draws as hard at A as at C or P; third, that the consequence of this equal pressure is the halving of the weight between the two ends of the cord. The *halving of the weight* is therefore the mechanical advantage given by the movable pulley.

Example.—If the weight W be ten pounds, five pounds is borne by A, and five pounds by P. The case is precisely the same as that of two boys carrying a basket between them. The basket is the weight, and each boy, with his hand upholding the handle, bears only half the load, whatever it may be. If, instead of holding by the handle, the boys slip a cord beneath it, and each take an end of the cord, the case is the same.

In order to save expenditure of power in lifting weights by pulleys, it is always contrived to cause some inanimate object, as for instance a beam or roof, to take a share of the weight, leaving only a portion to be borne by the person who pulls. But in this, as in all cases of mechanical advantage, the saving of power is effected only by a certain loss of time, or a longer continuation of labour. To lift a weight one foot from the ground, by the movable pulley, a man must pull up the cord two feet; therefore, to lift a weight, it will take double the exertion to draw it up a given height in a given time without the pulley, than it would require with the intervention of the pulley.

As the power which a man can exert by his hands, is able to overcome a weight greater than the weight of his own person, this circumstance may be taken advantage of in a very peculiar manner, through the agency of the fixed pulley. As represented in fig. 23, a man may seat himself in a loop or seat attached to one end of a cord, and passing the cord over a fixed pulley above, may pull himself upwards by drawing at the other end of the cord. By adding a movable pulley and another fixed pulley to the apparatus, the exertion of pulling would be diminished one half. An apparatus of this nature, having two fixed pulleys and one movable pulley, is used by house masons and other artisans, in making repairs on the fronts of buildings.

Fig. 23.

The principle upon which pulleys act, is the distribution of weight throughout the different portions of the cord, so as to lessen the power necessary to be exerted by the operator. And along with this principle is the changing of the direction of the power for the sake of convenience in pulling.

According to ordinary language, the mechanical power of which we are treating is called the power of the pulley; but, in reality, as has been just shown, the pulley has no power in itself. The power of the machine is in the cord. *It is in the equal tension of the cord through its whole length, by which the weight is distributed upon intervening points, that the machine offers any mechanical advantage.*

In all cases in which cords are drawn tightly, so as to hold objects in close contact, the same species of power or mechanical advantage is exemplified. For instance, in drawing a cord in lacing, or a thread in sewing, this distribution of power is observable. If all the power which is distributed throughout the sewing of a single pair of strong shoes, were released and concentrated in one main draught, it would, in all likelihood, be a power sufficient to lift one or two tons in weight.

Technically, the wheel of a pulley is called a *sheave;* for protection and convenience this sheave is ordinarily fixed with pivots in a mass of wood called a *block;* and the ropes and cords are called a *tackle.* The whole machine, fully mounted for working, is termed a *block and tackle.* By causing a wheel and axle to wind up the cord of a block and tackle, the power of the lever is combined with that of the pulley in the operation.

There is no assignable limit to the power which may be exerted by means of pulleys. The machine may be constructed to raise with ease any weight which the strength of materials will bear, provided the combination is not so complex as to exhaust the power by the friction produced.

The power of pulleys is increased by a combination of wheels or sheaves in one tackle. There are different kinds of combinations or systems of pulleys. In some there is only one fixed pulley, and in others there are several.

The following are examples of different combinations of pulleys:—

Figure 24 represents a compound system of pulleys, by which the weight is distributed through four folds of the same cord, so as to leave only a fourth of the weight, whatever it may be, to be raised by the operator. In this illustration, the cord number 1 bears one-fourth of the weight; the cord number 2 bears a second fourth; the cord number 3 bears a third fourth; and the cord number 4 bears a fourth fourth. Here the mechanical advantage ceases. For although the cord number 4 passes over the topmost fixed pulley down to the hand of the operator, no more distribution of power takes place; this topmost pulley being of use only to change the direction of the power. The person who pulls has thus only a quarter of the weight to draw. If the weight be one hundred pounds, he has the labour of pulling only twenty-five pounds.

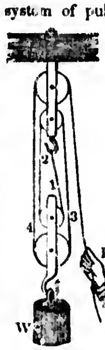


Fig. 24.

Thus it is observable that the diminution of weight is in proportion to the number of movable pulleys. To calculate the expenditure of power or diminution of weight, therefore, we have only to multiply the number of movable pulleys by two, and the product shows the power to be exerted. Two movable pulleys multiplied by two, gives 4; therefore a fourth of the weight is the power required, and so on. The addition of a single movable pulley to any system of pulleys, at once lessens the apparent weight one-half, or, in other words, doubles the effect of the power; but every such addition causes more time to be spent in the operation, there being at every additional fold of the cord more cord to draw out, and also more friction to overcome.

In the annexed system of pulleys, Fig. 25, a series of movable pulleys, with different cords, are made to act successively on one another, and the effect is doubled by each pulley. At the extremity of the first cord, a power of one pound depends. This cord, marked 1, by being drawn below a movable pulley, supports two pounds—that is, 1 pound on each side. The next cord, marked 2, in the same manner supports four pounds, or 2 pounds on each side. The next cord, marked 4, supports 8 pounds, or 4 pounds on each side. Thus, 1 pound at P supports 8 pounds at W. If another movable pulley were added, the 1 pound at P would support 16 pounds, and so on.

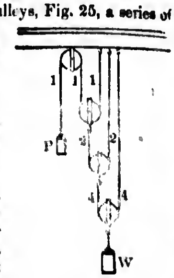


Fig. 25.

In working pulleys, the power must be applied in a line perpendicular to, or parallel with, the weight; that is, straight above the weight, in order to produce the full efficiency of direct force. If the power be applied obliquely —do not draw fair up—there will be a loss of power in proportion as the line of draught departs from the perpendicular.

Pulleys are used chiefly on board of ships, where blocks and tackle are in constant requisition for raising and lowering the sails, masts, and yards. They are likewise in considerable use by house-builders and others, in connection with the wheel and axle, for raising or lowering heavy masses of stone and other articles.

Fig. 26 is a representation of a system of pulleys, commonly used in practical operations. Three movable pulleys are enclosed in the block A, and three fixed pulleys are enclosed in the block B. Suppose, therefore, that the weight W, in this case, is six hundred pounds, the hand P pulls it upwards by exerting a force of one hundred pounds. A combination of pulleys resembling this is used in turning kitchen jacks. The weight in sinking draws off the cord from a spindle, by which motion the jack is turned. In order that a considerable weight falling slowly through a comparatively small height may keep the jack in motion for a long time, as many as ten or twelve movable and fixed pulleys are used.

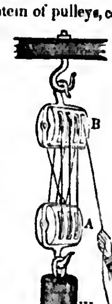


Fig. 26.

OF THE INCLINED PLANE.

A horizontal plane is a plane coinciding with that of the horizon, or parallel to it; when the plane is not level or horizontal, but lies in a sloping direction, with one end higher than the other, it is said to incline, or is called an inclined plane. Fig. 27 is an example.

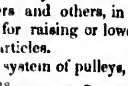


Fig. 27.

The inclined plane, as already stated, is a primary mechanical power. The object which is accomplished by it is the raising of weights to considerable elevations, or the overcoming of resistance by the application of lesser weights and resistances; or, making a small power overcome a greater.

To raise a load of a hundred pounds to an elevation of fifty feet by a direct perpendicular ascent, and without using any mechanical advantage, the power exerted must be a hundred pounds, or equal to the weights to be overcome. If, instead of raising the load directly upwards, we raise it by the gradual ascent of an inclined plane, the power required is less than a hundred pounds, and the diminution is in proportion to the smallness of rise in the inclined plane. But this saving of power, as in all other instances of mechanical advantage, is accomplished only by a corresponding loss of time.

In drawing a load, as, for instance, a loaded carriage, along a horizontal plane, the resistance to be overcome is chiefly the friction of the load upon the plane. If there were no friction or impediment from inequalities of surface, and if the load were once put in motion, it would go on moving with the smallest possible expenditure of power.

In drawing a load up an inclined plane, ordinary friction has to be overcome, and also the gravity of the body, which gravity gives it a tendency to roll down to the lowest level. In this constant impulse to descend, it is not at liberty to pursue the same line of descent as bodies falling freely from heights. It falls or rolls down as much less speedily than a free falling body (omitting the loss by friction) as the length of the inclined plane is greater than its height. A freely descending body falls about 16 feet in the first second; and a body rolling down an inclined plane, rolls just as many feet the first second as the number of feet of inclination is in sixteen feet. If the inclination be one foot in sixteen, the body rolls down one foot, and so on.

Any body in being drawn up an inclined plane, by a power parallel with the plane, presses at right angles with the plane. The common expression is, that the reaction of the plane upon the object is perpendicular to the plane. When an object, as a ball, rests upon a horizontal plane, its pressure is at right angles with the plane; or, what is the same thing, the reaction or resistance of the plane is at right angles with it. This is seen in Fig. 28, in which a ball is represented lying on a level plane, with the line of pressure A passing down to B, which line is at right angles with the plane.

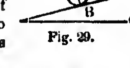


Fig. 28.

Suppose, then, that the end of the plane at C is elevated to D, as in Fig. 29, so as to form a slope; in this case the line of pressure of the ball on the plane is also moved, so as still to be at right angles with the inclination.

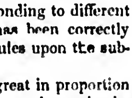


Fig. 29.

The power which is required to be sustained for the purpose of overcoming friction or inequalities of surface on level planes, is for the purpose of drawing the load up or over the inequalities.

The amount of the power corresponding to different weights and inclinations of the plane has been correctly ascertained, and the following are the rules upon the subject:—

First.—The quantity of weight is great in proportion to the inclination of the plane; consequently, so is the difficulty of raising greater, and the rate of elevation or motion slower.

Second.—To overcome the weight or resistance and the slowness of movement, a corresponding increase of power must be given.

Third.—The smaller the inclination, so is the pressure of the weight on the plane the greater.

Fourth, or Special Rule of Calculation.—Whatever is the unit of inclination in a given length, the same is the unit of weight that can be lifted, and the unit of power to be exerted.

If the inclination of a road be *one* foot in ten, *one-tenth* is called the unit of inclination; hence, *one-tenth* part of the nominal weight of the load has to be lifted; and a power to draw this one-tenth part of the load has to be exerted. Or, to put the case in other words:—If the road rise one foot in ten, there is in the ten only one foot of perpendicular height to be lifted through; and the weight at any point of the ten feet is only a tenth of what it would be if it were to be lifted through a perfect perpendicular ascent of ten feet.

The reason is now perceived why a small power overcomes a greater in the case of draughts upon inclined planes. The load is, as it were, lifted by instalments. Partly supported as it advances, and always supported more completely the smaller the inclination, the weight of the burden is apparently lessened by merely taking the rise gradually and slowly.

If we suppose a case of two roads, the first rising one foot in twenty, and the second rising one foot in fifty, a loaded carriage will be found to go over the fifty feet of the one with precisely the same expenditure of power that would be required to make it go over the twenty feet of the other—that is, always providing that friction and other circumstances are alike.

Figure 30 represents a supposed case of two inclined planes of the same height, but different slopes, meeting together at the top, with a weight resting on each, P and Q, hanging by a string, which passes over the pulley M. If the length of the longest plane from A to M be two feet, and that of the shorter from B to M be one foot, then two pounds at Q, on the short side, will balance four pounds at P, on the long side, and so on in this proportion, whether the planes be longer or shorter.

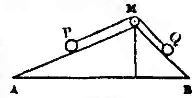


Fig. 30.

In this manner, weights moving on two adjoining inclined planes may be adjusted so as to balance each other, although the inclinations be different; and they are so made to act on various sloping railways connected with public works, where one wagon descending on one plane is made to draw up another wagon on another plane.

An inattention on the part of our forefathers to these exceedingly simple principles of mechanical science, led them to form roads over steep hills, pursuing, as it was imagined, the best routes, because they were the straightest in a forward direction. In modern times, this error has been avoided by enlightened engineers, and roads are now constructed with as few risings and fallings as possible. When roads have necessarily to be carried to the summits of heights, they are very properly made either to wind round the ascent, or to describe a zig-zag line of direction.

The drivers of carts are aware of the saving of labour to their horses by causing them to wind or zig-zag up steep roads instead of leading them directly forward.

The inclined plane is resorted to for a saving of labour in many of the ordinary occupations of life. By it loaded wheelbarrows are with comparative ease wheeled to considerable elevations in house building and other works of art; hogsheads are rolled out of or into wagons, and ships are launched into or drawn from the water, the inclined plane being as useful in giving facilities for letting down loads as in drawing them up.

It is also by inclined planes that we reach the higher floors of a house from the ground, or attain other elevations. For all such purposes, the inclined plane is formed with steps to ensure our safe footing. All stairs or flights of steps are inclined planes. A ladder forms a steep inclined plane.

OF THE WEDGE.

The inclined plane has been described as being fixed or stationary, as, for instance, a common ascending road, or a sloping plank, upon which the weights are moved. It has now to be viewed as a *movable plane*, in which form it suits many useful purposes.

When an inclined plane is movable, and the load or weight which it affects is at rest, it receives the name of a wedge. The wedge is, therefore, a mechanical power, founded on the principle of the inclined plane.

The wedge is an instrument or simple machine, consisting of a solid body of wood, iron, or some other hard material, and is triangular in form. See Fig. 31. Here the wedge is seen to taper from a thick end or head at B to a thin edge or point at A. This, however, is only the more common form of the wedge. It is made with sides of various angularities or degrees of slope, and, in some cases, it possesses a flat and a sloping side. When it slopes on both sides, it consists of two inclined planes joined together; and when one of its sides is flat, it acts as only one inclined plane. The wedge is employed as an instrument for cleaving solid masses asunder, to compress bodies more closely together, and to move great weights through small spaces. Fig. 32 is a front view of a wedge in the act of splitting asunder a piece of timber. The power employed to force the wedge forward, is either repeated blows with a mallet or hammer, or the gradual pressure of a weight. In general, the power is applied by rapid strokes, or quick applications of some kind of external pressure.

Fig. 31.


Fig. 32.

The rules for calculating the power of the wedge are similar to those for the inclined plane. In proportion as the inclination or angularity is great, so is the resistance greater, and the power must be greater to overcome it. Thus, if the wedge be of short dimensions and thick at its head, it will require a greater power to move it than if it be long and thin in its form.

The resistance offered to the wedge of equal sides, when the pressure is equally applied, is, as in the case of the inclined plane, at right angles with the sides. See fig. 33, in which the oblique cross lines represent the direction of the pressure passing at right angles through the sides, and meeting at the centre.

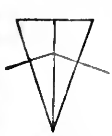


Fig. 33.

It is difficult to calculate the precise power of the wedge, for much depends on the force or the number of blows which may be given to it, together with the obliquity of the sides, and the power of resistance in the object to be split. In the splitting of timber, for instance, the divided parts act as levers, and assist in opening a passage for the wedge.

The wedge is the least used of the simple machines, but the principle upon which it acts is in extensive application. Needles, awls, bodkins, and driving nails, are the most common examples. Knives, swords, razors, the axe, chisel, and other cutting instruments, also act on the principle of the wedge; so likewise does the saw, the teeth of which are small wedges, and act by being drawn along while pressed against the object operated upon.

The principle of the inclined plane, which is the basis of that of the wedge, is particularly observable in the action of the razor and the scythe, both of which cut best by being drawn along the materials against which they are applied. When the edge of a scythe or razor is examined with a microscope, it is seen to be a series of small sharp angularities of the nature of the teeth of a saw.

The principle of the wedge operates in the case of two glass tumblers, one placed within the other, as in fig. 34. A very gentle pressure applied to the uppermost tumbler would be sufficient to burst the lower. At every little advance of the uppermost tumbler, it acts more and more as a lever power on the rim of the lower, and at last overcomes the resistance, and fractures the vessel.


Fig. 34.

OF THE SCREW.

The screw is the fifth, and usually the last mentioned mechanical power. Like the wedge, it is founded on the principle of the inclined plane.

The screw consists of a projecting ridge winding in the form of an inclined plane, and in a spiral direction, round a central cylinder or spindle, similar to a spiral rod winding round a precipitous mountain. Fig. 35 is a representation of a common strong screw used in various mechanical operations. The projecting ridge on the spindle is technically called the *thread*. The thread is not always made in this square projecting form; it is frequently sharpened to a single thin edge, as in fig. 38, but does not affect the principle of the machine.

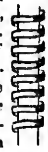


Fig. 35.

One circumvolution or turn of a thread of a screw is, in scientific language, termed a *helix* (plural *helices*), from a Greek word signifying winding or wreathing. The spiral winding of the thread is called the *helical line*.

The helices of a screw do not necessarily require to have a central spindle. They may form a screw of themselves, and do so in the case of the common corkscrew (fig. 36). A screw of this pointed or tapering form, in penetrating a substance, possesses the advantage of the inclined plane in three ways—first, by the gradual thickening of the substance of the thread from a sharp point; second, the gradual widening; and, third, the gradual ascending, of the thread.


Fig. 36.

The screw acts on the principle of the inclined plane, and this is obvious from the consideration of the nature of the threads. If we were to cut through the turns of the threads straight from top to bottom, and draw them out to their full extent, each separate and retaining its own inclination, we should find that they were so many inclined planes. In the annexed cut, fig. 37, one entire turn of the thread is thus drawn out, reaching from *b* to *a*, and is seen to form an inclined plane. If not drawn out it would wind down to *c*; therefore, while a weight is raised by one turn of the screw over the limits of one thread, or from *c* to *b*, it has actually been carried up the inclined plane from *a* to *b*.

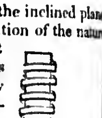


Fig. 37.

The screw has no power by itself. It can operate only by means of pressure against the threads of another screw which overlaps it and holds it. This exterior screw, which is technically called a *box* or a *nut*, consists of a block with a central tube cut out in spiral grooves so as to fit with perfect exactness to the screw which has to work in it. Fig. 38 represents both screws in combination. M is the box or nut through which the screw passes. L is a lever inserted in the head of the screw, for the purpose of turning it.

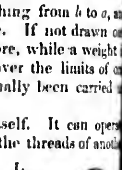


Fig. 38.

The object required by the use of the screw is to apply force or pressure. To produce the intended effect, either the outer or inner screw, that is, either the nut or the screw, must be fixed. If the screw be fixed at one extremity, say at the top, to a solid body, the nut may be turned round it so as to move from the bottom to the top; and if the nut be fixed, held fast by some solid body, the screw in the same manner may be turned round till it reach its extremity. Thus, either the point of the screw, or the nut, may be forced in such a way as to squeeze or press any object presented to them.

Practically, the screw is never used as a simple machine; the power being always applied by means of a lever, passing either through the head of the screw, or through the nut. The screw, therefore, acts with the combined power of the lever and inclined plane; and, in investigating the effects, we must take into account both these simple mechanical powers, so that the screw now becomes really a compound machine.

In the inclined plane, as has been seen, the less it is inclined, the more easy is the ascent, though the slower is the process of rising to a certain elevation. In applying the same principle to the screw, it is obvious that the greater the distance is betwixt the threads, the greater or more rapid is the inclination, and consequently, the greater must be the power to turn it under a given weight. On the contrary, if the thread inclines downwards but slightly, it will describe a greater number of revolutions in a given space, so as to diminish the distance betwixt the threads, and the smaller will be the power required to turn the machine under a given weight. Therefore, the finer the screw, or the nearer the threads to each other, the less the power will require to be for a given resistance.

Suppose a case of two screws, one having the threads one inch apart, and the other half an inch apart; then, the force which the first screw will give with the same power at the lever, will be only half that given by the second. The second screw must be turned twice as many times round as the first, to go through the same space. At the lever of the first, two men would raise a weight to a given height, by making one revolution; while at the lever of the second, one man would raise the same weight to the same height, by making two revolutions.

It is apparent, that the length of the inclined plane up which a body moves in one revolution, is the circumference of the screw, and its height the interval between the threads. The proportion of the power would therefore be—"as the circumference of the screw is to the distance between the threads, so is the weight to the power." By this rule, the power of the screw could alone be found, provided the action of the machine was not affected by the lever which works it. As that is the case, the circumference described by the outer end of the lever employed is taken instead of the circumference of the screw itself.

The rule by which the true force of the screw is calculated, is, by multiplying the circumference which the lever describes by the power. Thus—*The power multiplied by the circumference which it describes, is equal to the weight or resistance multiplied by the distance between the two contiguous threads.* Hence, the efficacy of the screw may be increased, by increasing the length of the lever by which it is turned, or by diminishing the distance between the threads. If, then, we know the length of the lever, the distance between the threads, and the weight to be raised, we can readily calculate the power; or, the power being given, and the distance of the threads, and the length of the lever known, we can easily find the weight which the screw will raise.

Suppose the length of the lever to be forty inches, the distance of the threads one inch, and the weight 8000; required—the power, at the end of the lever, to raise the weight. The lever being 40 inches, the diameter of the circle which the lever describes is double that, or 80 inches. Reckoning the circumference at thrice the diameter (though it is a little more), we multiply 80 by 3, which gives 240 inches for the circumference of the circle. The distance of the threads is one inch, and the weight 8000 pounds. To find the power, multiply the weight by the distance of the threads, and divide by the circumference of the circle.

$$\begin{array}{r} 8000 \text{ weight} \\ 1 \text{ distance} \\ \hline 240)8000 \\ \hline 33\frac{1}{3} \end{array}$$

Thirty-three and a third is the product, and it would require that power or number of pounds to raise the weight. This, however, is only in theory. In practice a third of the amount of power would require to be added to overcome the friction of the machine.

In the ordinary working of the screw, velocity is incompatible with great power. This is a truth, however, which applies only to a screw with one thread. There is a way of making a screw, by which great velocity and power may be combined. This is done by forming the screw with two, three, or more threads. To understand how this is accomplished, we have only to conceive the idea of a screw with one thread, very wide betwixt its turns, and then imagine one or two other threads placed so as to fill up the intervals; thus composing a fine close screw. And as by this means all the threads descend with equal rapidity, we have a screw which will not only descend with great velocity but which will apply a very great degree of pressure. A screw of this nature is used in the printing press, by which a pressure of a ton weight is applied instantaneously by a single pull of a lever.

The most common purpose for which the screw is applied in mechanical operations, is to produce great pressure accompanied with constancy of action, or retention of the pressure; and this quality of constancy is always procurable from the great friction which takes place in the pressure of the threads on the nut, or on any substance, such as wood, through which the screw penetrates.

The common standing-press used by bookbinders for pressing their books, affords one of the best examples of the application of the screw to produce great pressure (fig. 39). The screw A has a thick round lower extremity B, into holes in which the lever is inserted. This extremity B is attached by a socket joint, to the pressing-table C, so that when the screw is turned in one direction, the table sinks, and when turned in another, the table rises. The books D lie upon a fixed sole S, and are thus between the table and the sole. H is a cross beam above, in which is the box or overlapping screw to give the necessary resistance.

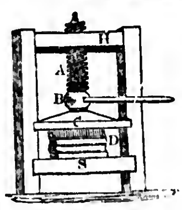


Fig. 39.

MECHANICAL COMBINATION AND STRUCTURE.

Mechanical action is applied to the action of forces that produce no change in the constitution of bodies, and is therefore distinguished from chemical or any other species of action, in which change of constitution is less or more effected.

Great changes are continually taking place in nature and art by mechanical action. Mechanical action generally implies movement or change of place, and is most cases alteration of external features and circumstances. The whole of the planetary movements are mechanical; the motions of water and winds are mechanical; and the new appearances produced in art by placing different objects together, are mechanical.

The action of forces upon solids, or mechanical action, is taken advantage of by mankind for the production of numerous useful results in the arts. And success in attaining these results depends in a great measure upon the knowledge we have of the principles of mechanics, and the skill and care we use in applying them.

When skill, care, and ingenuity, are brought fully into operation for these results, very great wonders are in many instances achieved. But where ignorance or negligence, the object in view may not only be defeated, but very mischievous consequences may take place.

Example first.—If a tall mast or beam break through at two-thirds of its height, and the two fractured ends be simply placed together and tied with a rope, the upper piece will, by the action of a small force, again fall. It will act like *the arm of power of a lever* against the rope, which is the *weight;* and as this weight is inconsiderable, the arm of power will preponderate. But if we take the two pieces and saw each of them lengthwise, so as to make four pieces, and then, as represented in fig. 40, lay a short piece alongside of a long piece, and another long piece on the top of the first short piece, with the second short piece opposite to this second long piece, the whole will be effectually *spliced* together; in such a case, with the aid of an overlapping rope, the beam will in all likelihood be stronger than it was before it was fractured. The cause of its being stronger, at least of its remaining firm, is, that the weaker part at one side is supported by a stronger part on the other side. Thus by skilfully taking advantage of certain forces acting in connection with solids, we are able to rear a structure of the utmost possible strength.

Fig. 40.

Example second.—If a man, in making repairs upon the outside of a building, project a plank from a window for the purpose of standing upon it, and if he proceed to place himself near the outer extremity of the plank, without having placed a sufficient counterbalancing weight at its inner extremity, he will assuredly be precipitated to the ground, and perhaps killed; because the *gravity* of his body acted like a *power* on the arm of a lever, while the lever was without a sufficient *weight* to preserve the apparatus in equilibrium. From such neglects of the operation of forces in nature, dreadful consequences frequently ensue.

The study of the operation of mechanical forces, along with experience, teaches that there are certain bulks, positions, and forms of bodies, which produce the greatest strength for purposes of art.

The strength of beams or masses of the same kind and bulk, and fixed in the same manner, in resisting a transverse force which tends to break them, is simply as their breadth, as the square of their depth, and inversely as their length—that is, the thicker and shorter they are, they are the stronger. Thus, if a beam be twice as broad as another, it will also be twice as strong; for the increase of breadth doubles the number of the resisting particles. By making the beam double the depth, the strength is four times as great; because the number of fibres is double and the lever by which they act is also increased.

But this increase of strength, by increasing bulk, has a practical limit. It is found that in increasing the dimensions of a body, or combination of bodies, preserving all proportions the same, *the weight increases more rapidly than the increase of strength, or power of endurance.* This is one of the most important principles in mechanical science, and ought to prevent undue extension in structural arrangements.

Take a block of stone, and fix one end of it into a wall, leaving its other end projecting. By this arrangement of position, each particle of matter in the block acts as a weight pulling downwards as with a lever, the fulcrum of the lever being at the point of support, and the particles of matter in the mass forming at once the arm of power and the weight. Hence, every particle we add to the length of the block beyond a certain length (whatever may be its constitutional strength), we shall certainly cause the mass to break, and fall, from the effect of gravity, upon the outer extremity.

A similar lever action takes effect in the case of blocks or beams supported on both ends, the only difference being, that, in extending them to an undue length, they will break in the middle, or at the weakest point between the two supports.

The strength of a beam supported at both ends is twice as great as that of a beam of half the length, which is fixed only at one end; and the strength of the whole beam is again increased if both ends or fulcra be firmly fixed, as [illegible].

In the case of fibrous or grained materials, as, for instance, wood, the body sustains the greatest pressure when the weight is applied to the grain endwise, or to the beam longitudinally. The nearer that the pressure can be applied to any beam endwise the better. Thus, a beam supports most weight on its upper end, the other end being fixed to the ground, and its strength is next greatest when the pressure is applied to it leaning at top against another beam. This is exemplified in the angular roofs of houses, in which two beams lean against each other like the two sides of the letter A. In arranging beams to support great weights, as in building bridges, each beam is made to push obliquely upward with one end, while it pushes obliquely downward with the other, and thus an extensive combination of beams is firmly supported.

In rearing structures consisting of beams, it is an important point to convert, as far as possible, by mode of erection, cross or transverse strains into longitudinal strains, or into forces acting on the ends of beams, in the direction of their length.

Nature appears to have designed that strength of structure should be accomplished with the least expenditure of material. It is obvious, that, if trees and animals were made many times larger than we now find them, and of the same kinds of substance, they would be borne down by their own weight. Small animals endure greater comparative violence, and perform greater feats of strength, in proportion to their size, than large ones. The largest bulk which a human being can possess in his person, at the same time retaining activity of motion, is not more than is usually seen in well-grown men. Thus, from a simple natural cause, men of very gigantic figure never could have existed on our earth. Men must always have been about the size which they are at present; or, if they were considerably larger, they must have been constituted of much stronger materials, without a corresponding increase of weight.

The same principles relative to mechanical strength apply to contrivances in the arts. As already stated, the strength or power of endurance in a material does not increase in proportion as the weight increases. Hence there is a practical limitation of the magnitude of machines and other structures. For example, a bridge or roof of beams may be very strong when of small or moderate size, but if the dimensions be extended beyond a certain limit, the structure will fall, by not being able to support its own weight.

The strength or power of endurance of pressure up-fixed body, is greatly increased by giving the body a certain form. The strongest form in nature or art is that of an *arch*.

An arch is a skilful disposition of parts, forming a convex and concave side, the convex side being that upon which the pressure is applied. The arch, which takes its name from *arcus*, a Latin word, signifying a *bow*, may be either a portion of a circle or ellipse, or entirely rounded in form. Whether shaped like a bridge, or round tube, or the shell of an egg, the principle which causes the power of endurance of pressure is the same.

The principle of endurance consists in the particles of the arched body bearing upon each other like a series of wedges, thus causing a compression of particles on the concave side of the circle, which enables the mass to bear an enormous pressure on the convex side. Indeed, the greater the pressure is (to a certain extent), perpendicular to the convexity, so also the compression and power of resistance become the greater.

PRACTICAL MACHINERY.

Machines are usually formed of wood, iron, steel, brass, or other durable materials, with sometimes leather and cordage as part of the apparatus. In the construction of every machine, four objects are particularly desirable —1st, Strength or durability of materials; 2d, Simplicity of arrangement of parts; 3d, Exactness of fitting of one part to another; and, 4th, Easiness and correctness of motion. It is a general and well-recognised principle in mechanics, that the *fewer the parts* are in a machine, and the *more simple its construction*, the better.

Machines act from the impression of a certain power or force communicated to them. Whatever be the amount of power they receive, that amount they expend in their action. They cannot in the smallest degree increase the power. They can only convey, regulate, and distribute, the quantity of power which has been communicated to them.

The power communicated to machines is derived from various sources; as, human labour, the power of horses or other animals, the force of wind, water, or steam, or any other active agent which may be found suitable. Sources of power are technically called *moving forces*, or *first movers*.

Of the original impressed power, each moving part of the machine uses a certain portion. If the whole power which enters a machine be supposed to consist of 1000 parts, this large quantity is dispersed in various small quantities through the mechanism; some wheels taking perhaps 10 parts, others 5 parts, a third kind 1 part, a fourth a fractional part, friction another part, and so on, till the whole 1000 parts are expended. In some large cotton, flax, or silk spinning establishments, a single water-wheel or steam-engine turns several thousands of spindles; each spindle, consequently, consumes a minute fraction of the originally impressed power.

Whatever be the nature of the moving forces, it is generally sufficient for all purposes that they produce in the first instance *rotary* or *circular motion*, and either in a horizontal or vertical direction. It is, however, indispensable that the power be of that magnitude which will cause each part of the machine to fulfil its designed office. If the power be too small or weak, the machine will move languidly and ineffectually; and if too great, it will either cause the machine to move too rapidly, or at least power will be expended uselessly. In the application of moving forces, it is always a matter of importance to regulate the power to the precise wants of the machinery.

The circular motion communicated in the first instance to a machine, is, by means of certain contrivances, diffused through the whole organization, and changed into every conceivable direction; some parts being caused to revolve, others to rise and fall, a third kind to move horizontally to and fro, and so forth, in all possible ways. The various parts may also be made to move with any degree of velocity; there being methods of transforming quick into slow motion, or slow motion into quick. Most minute and complex operations are thus performed by machines with a precision which often exceeds the skill of the most expert artisan; but these operations are all necessarily marked by the quality of *uniformity of action*. As machines cannot reason, or act arbitrarily in stopping, moving, or altering their process, according to circumstances, they proceed in a blind routine, whether right or wrong, *mechanically* as it is called, and in every case less or more require the superintendence of reasoning beings. This apparent defect, however, is really advantageous. A machine, by being composed of inanimate matter, destitute of feeling and unsusceptible of fatigue, proceeds unswervingly in its assigned duty, and may be forced to accomplish tasks which it would be both inhumane and impolitic to demand from living creatures.

The purpose of machinery, therefore, is to *lessen and aid human labour*. At an inconsiderable expense, and with a small degree of trouble in supervision, a machine may be made to do the work of ten, fifty, or perhaps as many as five hundred men; and the work so simply effected by inanimate mechanism, serves to cheapen and extend the comforts and luxuries of life to the great body of the people.

The following are the chief elementary parts of machinery:—

WHEELS.

A wheel moving on a central axis is a lever with equal arms radiating from the fulcrum at the centre, and is thus called a perpetual lever.

Wheels may be used in machines simply to transmit power from one point to another. This is done by means of toothed wheels. Projecting teeth or *cogs* are placed all round the circumference of a wheel, and when the wheel is turned, these teeth work upon or press against the teeth of another wheel, and so cause it to turn also, but in an opposite direction. Fig. 42 represents two wheels so working upon each other. As both of these wheels are of the same size, and consequently are levers with equal arms, they do not alter the effect of the power communicated to them.

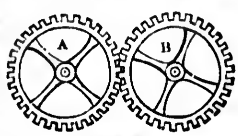


Fig. 42.

The motion of the axle in the wheel B is the same as the motion of the first axle in the wheel A. Thus, power may be *transmitted* from one point to another.

A long and large axle, in wheel-work, is called a *shaft*, and shafts of small dimensions are termed *spindles*. The terminating point of axles, shafts, and spindles, where they rest and turn upon supports, are called their *pivots* or *gudgeons*. The *sockets* upon which the gudgeons bear in turning, are sometimes termed *bushes*

WHEELS AND PINIONS.

When power has to be *accumulated* or increased in its effect in the course of its transmission, a large wheel is made to play upon a small wheel, by which means there is a diversity in the lengths of the levers. Fig. 43 is a representation of a large wheel W, working on a small wheel or pinion P. The wheel is turned by the handle C. In all arrangements in which large wheels are

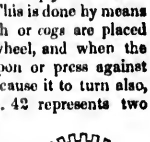


Fig. 43

moved by small wheels, or small wheels by large, the small wheels are called *pinions;* and when these pinions are broad in their dimensions, they are termed *trundles*.

In this combination of a wheel and pinion, a long perpetual lever works against a short perpetual lever, by which a considerable mechanical advantage is gained. The wheel may be supposed to possess 48 teeth and the pinion 6 teeth; hence, by one revolution of the wheel, the pinion turns 8 times, which gives the axle of the pinion eight times the velocity of the axle of the wheel; and if we suppose that the diameter of the wheel is ten times the diameter of the pinion, the power is increased in effect ten times.

Any degree of velocity greater than that of the first rotary motion, may be imparted to the parts of a machine, by making these parts so much smaller than the primary moving parts. Thus, if a large wheel, having a thousand teeth in its circumference, work upon and turn a small wheel having only ten teeth in its circumference, the small wheel will go round one time for every ten teeth of the large wheel which it touches; or in other words, it will go round one hundred times for one time of the large wheel. The respective velocities of wheels in a machine are, in this manner, always proportionate to their diameters, or size, unless when specially arranged to be otherwise.

A combination of wheels acting as perpetual levers, is represented in fig. 44. Three wheels are placed in a row close to each other, and it is supposed they are fixed by three axles to some upright object. On the side of the first wheel A, there is attached a small toothed pinion or wheel F, which, by the pressure of its teeth on the teeth of the second wheel B, causes this second wheel to turn round. The power applied to produce this motion is at the circumference of the first wheel at D. From D then, to the centre of the pinion F, is the long arm of a lever, of which the centre of the pinion is the fulcrum; and from the centre to the ends of the teeth of the pinion is the short arm. The second wheel B having received its motion, the toothed pinion G, which is similarly attached to its side, presses against the teeth of the third wheel C, and so causes it also to turn. In this way a second lever is put in action. And the third wheel, from its circumference to the point from which the weight W depends, is a third lever. As the power or small weight P falls, therefore, from the circumference of the first wheel, the resistance W is raised, with the accumulated force of three levers acting on each other. The line across the figure represents the three levers in action.

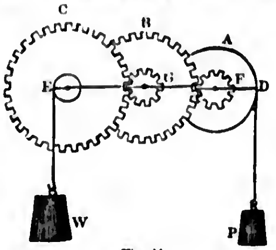


Fig. 44.

To calculate the power or mechanical advantage to be gained by such a machine, suppose the number of teeth on the first wheel to be six times less than the number of those on the circumference of the second wheel, then the second wheel would turn round only once, while the first wheel turned six times. And, in like manner, if the number of teeth on the circumference of the third wheel be six times greater than those on the axle of the second wheel, then the third wheel would turn once, while the second wheel turned six times. Thus, the first wheel will make 36 revolutions, while the third wheel makes only one. The diameter of the first wheel being three times the diameter of the axle of the third wheel, and its velocity of motion being 36 to 1, three times 36 will give the weight which a power of 1 pound at P will raise at W. Three times 36 being 108, one pound at P will balance 108 pounds at W.

WORKING OF TOOTHED WHEELS.

In the working of toothed wheels one upon another, or of wheels working on pinions, it is essential to set them in opposition with such exact adjustment, that the teeth of one will fall into the hollows between the teeth of the other. When the teeth of each do not work with this nicety, they are apt to jar upon and break each other, and so damage the machine. In some cases teeth are made of a round or pointed form at their extremities, by which a very small degree of grinding or pressing on each other takes place. Fig. 45 is an example of a wheel and pinion with rounded and pointed teeth. From the centre of the axis of the pinion L to the centre of the wheel C, a dotted line is marked, called by mechanics the *line of centres*. The dotted circle O O round the pinion, and the dotted circle P P round the wheel, indicate the true point of working or contact of the teeth upon each other. These two circles are seen to join with exactness at A.


Fig. 45.

ALTERING THE DIRECTION OF MOTION.

Motion often requires to be *altered in its direction* in the course of its transmission. For example, rotary horizontal motion requires to impart rotary vertical motion, or rotary vertical motion to impart horizontal motion. By means of a peculiar mode of setting the wheels, and a corresponding peculiarity in the shape of their teeth, any alteration may be effected in the direction of the motion.

Fig. 46 represents a plan of changing the direction of motion. A is a pinion or trundle working with its shaft horizontally on a wheel B, whose shaft is turning vertically. As the case may happen to be, the horizontal movement is causing the vertical movement, or the vertical movement is causing the horizontal movement.

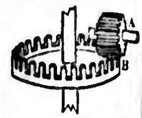


Fig. 46.

BEVEL WHEELS.

Fig. 47 represents a more common plan of changing the direction of motion. The wheels in this case are bevelled. A *bevel* wheel is a wheel with teeth placed in a sloping or oblique direction on its circumference. When two bevel wheels are placed at right angles to each other, their respective teeth work against each other, and so a harmonious joint motion ensues. This is exemplified in the figure, in which a horizontal shaft with a bevel wheel is seen turning a smaller bevel wheel above it, placed on a vertical shaft.

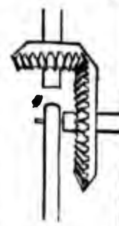


Fig. 47.

TRANSMISSION OF POWER BY BELTS.

A common plan of transmitting power from one point to another, when the interval is considerable, is by a flat leather band, strap, or belt, communicating from a wheel at the source of power to a wheel connected with the machine.

The wheels upon which straps work are usually called *pulleys*. They have flat and broad rims, and these rims have sometimes narrow ledges, to prevent the belt from slipping off. The rims must also be rather rough on their surface, so as to give the belt a sufficient friction or power of pulling in performing its revolutions.

Fig. 48 represents the transmission of power by a belt. A is the first pulley, which has received the power from its source, and C is the second pulley, moved by a belt, which passes over both pulleys. In this case, the motion of A is transmitted by the belt to C, which it causes to turn in the same direction as A. If these two pulleys were of precisely the same diameter, and the belt did not relax or slip, the second pulley would unavoidably go at the same velocity as the first, because the belt has exactly the property of a toothed wheel, and simply transmits the power it has acquired. As C appears to be somewhat smaller than A, it would consequently turn more frequently than A; therefore, we have here an example of the mode of increasing the velocity while transmitting power.

Fig. 48.

SHAFTS AND PULLEYS.

When power requires to be carried to a distance beyond that which belts can conveniently manage, the transmission is effected by a long shaft; and, if it be necessary to change and re-change the direction of the motion, bevel wheels are added. Or the transmission may take place by a long flat chain acting like a belt, but caused to travel over small wheels or pulleys, to prevent the chain hanging down in any part of its course. A chain of this nature is called an *endless chain*.

Motion is often required to be communicated to many different machines, *at different points*, from one source of power. This is effected by means of a shaft and pulleys. From the pulley which receives the first motion, a belt is sent to a pulley fixed upon a shaft, which shaft is generally hung horizontally from the roof over the machines. As the shaft turns through its whole extent, it is able to turn pulleys fixed at any point upon it, and from these pulleys, belts are sent down to pulleys at the respective machines.

Fig. 49 represents an apparatus of a shaft and pulleys. A is the pulley receiving motion from the source of power, and, by means of the belt L, turns the pulley B on the end of the shaft S. At the same time, the pulley D at the opposite end of the shaft is turned. From a pulley on the shaft situated close to B, a belt descends to turn C, and from D another belt descends to turn E. Thus, an extended axle or shaft from C will turn a machine, and an extended axle or shaft from E will turn another machine. The apparatus can turn two machines. Shafts with pulleys, working on the plan now stated, are to be seen at almost every considerable manufactory in which machinery is employed; and the power, by means of bevel wheels and upright connecting shafts, is carried upwards from story to story in a building, giving motion to hundreds of wheels, spindles, and other parts of the mechanism.

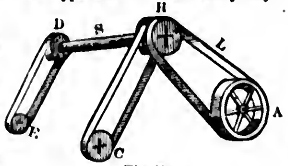


Fig. 49.

CHANGING VELOCITY.

It is sometimes necessary that a machine, or part of a machine, should be propelled with a velocity which is not equable, and is continually changing from fast to slow and slow to fast. This happens in cotton-mills, where it is necessary that the speed of certain parts of the machinery should continually decrease from the beginning to the end of an operation. To effect this, an apparatus is used, as represented in fig. 50. Two cones, or conically shaped drums, are used, having their larger diameters in contrary directions. They are connected by a belt, which is so governed by proper mechanism, that it is gradually shifted along from one extremity of the cones to the other, thus acting upon circles of different diameter, causing a continual change of velocity in the driven cone with relation to that which drives it. The shifting of bands from large to small wheels, and from small to large, has similar effects.

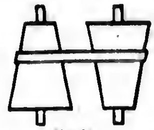


Fig. 50.

PRESERVING REGULARITY OF MOTION BY A VARIABLE FORCE.

In some mechanical contrivances, the force which is applied varies in its intensity, while the wheels of the machinery require to be kept at a uniform speed. This is generally the case when the force is communicated from a steel spring, which, after being wound up, is suffered to relax. Fig. 51 is a spring suited for operations of this kind. It is represented in a state of relaxation, and is wound up into a compact form by means of a spindle fixed to its inner extremity. The coiling of a strip of paper round the finger, and allowing it to unwind itself, is a familiar illustration of the action of a spring of this description.


Fig. 51

The force communicated by the relaxing of the spring varies in its intensity. The force is greatest when it begins to relax, and it gradually weakens till its expansive energy is exhausted. To compensate this defect, a very ingenious plan is adopted, and which is put in operation in the apparatus of the common watch.

Fig. 52 represents the apparatus of motion of a watch, somewhat magnified. The spring is confined in a brass cylinder or barrel B. To this barrel the spring is attached by a slit at its outer extremity. The inner extremity of the spring is fixed by a similar slit to the central axis or spindle. F is a brass cone, broad at bottom and narrow at top, with a path winding spirally round it as an inclined plane. This cone is called the *fusee*, and has also a central axis or spindle K, to which it is fixed. To a point on the lower inclined path of the fusee, a small steel chain C is attached, and the other extremity of this chain is attached to the top part of the barrel. When the spring is relaxed, the chain is almost altogether round the barrel. To set the apparatus in motion, the watch-key is made to turn the spindle K, by which the chain is drawn from the barrel to the fusee, filling up the inclined path to the summit. The chain in leaving the barrel causes it to turn, and consequently to wind up the spring inside. The process of unwinding or relaxing ensues, and now the ingenious plan for regulating the motion is to be remarked. At first, when the force of the spring is greatest, the chain acts upon a small round of

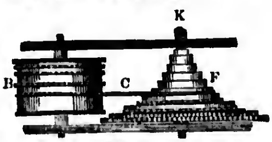


Fig. 52.

the fusee; in other words, it pulls with a small lever—for, as already explained under the head Wheel and Axle, a wheel or round object on an axis is simply a perpetual lever. In proportion as the intensity of the force weakens, and the barrel takes off the chain from the fusee, and winds it about itself, so does the chain act upon a longer lever, or so does it gain a greater lever advantage, by drawing at a wider part of a cone. Thus, the gradual loss of force is counterbalanced by a gradual increase of lever advantage. (The case resembles that of a strong man working with a short lever, and a weak man working with a long lever; both are equal in effect in balancing any resistance.) The wheelwork of the watch is moved by teeth on the lower circumference of the cone.

ALTERNATE OR RECIPROCATING MOTION—ECCENTRIC WHEELS.

Alternate or reciprocating motion is applied to movements which take place continually backwards and forwards in the same path. In most complex machines, both rotary and reciprocating motion occur, and these motions may be converted into each other by various contrivances.

A common contrivance for gradually raising and depressing an object by machinery, is that of an eccentric wheel.

An eccentric wheel is a wheel with an axis not in its centre, but at a point nearer one side than the other. Fig. 53 represents the action of a wheel of this kind. W is the wheel, and A the axis upon which it is fixed. When the axis turns, the wheel turns with it. As the axis never moves out of its place, the wheel necessarily describes a path of gradual rising and falling in its revolutions.

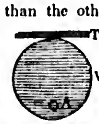


Fig. 53.

Suppose an object, as T, pressing upon the upper edge of the wheel, so as to accommodate itself to the motion, it is obvious that, by the action of the wheel, this object will be alternately raised and allowed to fall. Or suppose that a rod is hung from a point of the wheel near where T rests, it is similarly obvious that the rod would be raised or depressed, according as the wheel turned. Thus a rising and falling motion may be effected by an eccentric wheel.

Eccentric wheels are made of different forms. According as they may be required to act, they are circular, oval, heart-shaped, or pointed at one end, and so forth—the object in each case being to produce alternate motion, by continually altering the distance of some movable part of the machine, from the axis about which they revolve. Technically, the projecting parts of eccentric wheels are called *cambs*.

In some cases, eccentric wheels are not required to perform entire revolutions on their axis. It is perhaps sufficient for the purpose of the mechanism, if they gradually rise to the height of their power, and then, without turning round, gradually descend by retracing their course.

When alternate rising and falling is required *thrice*, by only *one* revolution of an axle, an eccentric wheel is used having three projecting cambs on its circumference, and as each camb comes round, it lifts and lets fall any object presented to it. An example of this apparatus is given in fig. 54. The object required is to work a heavy hammer upon an anvil for beating iron. W is the wheel with the three cambs, and it turns by an axle in upright supports. In turning, each camb, with its rounded or convex side, presses down the end of the handle of the hammer, so as to raise the heavy head H at the opposite end. After pressing down the handle and escaping, the head of the hammer falls with a heavy blow on the anvil A. There it remains till raised up and let fall by the next camb and so on.

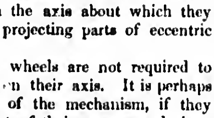


Fig. 54.

OBLIQUE ACTION.

A mechanical advantage, which is frequently of a very serviceable nature, is obtained by causing the points of two straight bars to meet each other, but fixed loosely, so as to be free to move from an oblique to a straight direction, and the reverse. The power consists in bringing the bars to the straight, by which they force asunder or press hard upon any object presented to their outer extremities. In the adjoining figure, the bars are seen first in their oblique position, and next when brought towards a straight. Betwixt the two points a small hollowed piece of metal is inserted, in which the points work, and against which the power is exerted to produce the action. The straightening and bending of the apparatus resembles the action of the knee-joint in animals. The pressure produced by the forcing downwards of the outer extremity of the lower bar (the upper working against a fixed beam), is very easily and rapidly accomplished, and is almost unlimited; and these advantages, as well as the extreme simplicity of the mechanism, have led to the application of the power to the printing-press wrought by the hand, instead of screw pressure.

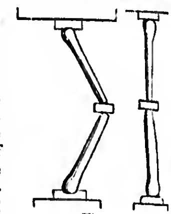


Fig. 55.

CRANKS.

The crank affords one of the simplest and most useful methods of changing an alternate rising and falling motion into rotary motion.

A crank resembles a common handle or winch for turning a machine by the hand; the chief difference being, that a rod or shaft jointed to the handle, and going up and down, works the machine. If the crank be made double, it will turn two wheels or machines.

Fig. 56 represents a double crank in action. S is the rod or shaft ascending and descending, and attached by a joint to the lower part of the crank C, which it alternately pulls up and pushes down, so as to cause the axles W W to turn a wheel at each side. Take away one of the sides of the crank and its support, and the apparatus becomes a single crank.

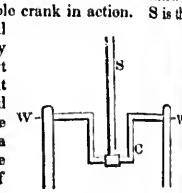


Fig. 56.

Turning-lathes, knife-grinders' machines, and similar apparatus, are usually turned by cranks wrought by an alternate pressing and raising of the foot of the operator; a rod going upwards from the foot-board to the crank, causing the wheel or spindle to go round. The crank has been hitherto indispensable in the action of the steam-engine.

ACCUMULATION.

Power is susceptible of accumulation—that is, of increasing little by little—and of being expended either gradually or in one or more violent efforts; the effort being entirely the concentrated amount of the previous accumulation. The apparently wonderful powers displayed through the agency of levers and other simple machines, are all a natural consequence of an accumulation of any degree of force into a small space;

which effects take place that could never have been accomplished by the original force.

In consequence of this convenient accumulation of power in machines, plans have been devised for establishing *reservoirs of power*, as they may be called, in connection with moving machinery.

A well-known method of accumulating power consists in suspending a heavy body by a chain or strong rope of considerable length—forming, what is called by young persons, a *swing*. This body may be put in motion by a very small degree of power, and will acquire a vibrating motion like a pendulum. By continuing the impulse as the body returns, it will continually acquire greater and greater force, the arcs through which it moves becoming continually larger, until at last it might be made to overcome almost any obstacle. Upon this principle, the battering-rams, or engines for beating down the fortifications of towns in ancient times, were constructed, and the force of their blows was as great as that of a cannon ball; nevertheless, the power of their blows never could exceed the accumulated power of the impulses given to them in order to produce these blows.

The forcible expenditure of accumulated power in the swing apparatus, resembles that which is observable in the case of a person occupying several minutes in bending a spring—that is, accumulating power—and allowing the spring to unbend itself by one violent effort, which effort is nothing more than the giving out of the accumulated power.

A boy taking a race to gain force before making a leap, is another familiar example of accumulating power and expending it instantaneously. The boy is gathering up power at every step he runs, and the force of his leap corresponds exactly with the quantity of the power he has acquired.

In the same manner, the lifting of a hammer, axe, or other instrument, to an elevation as far as our arm can reach, in order to give a blow with good effect, is a method we naturally pursue to gain an accumulation of power.

In contrivances in the arts, power is sometimes accumulated in order to be given out in the form of a rapid and effective blow. This may be done by means of a horizontal bar or lever, poised on a central axis, and loaded at each end with a heavy ball of lead or iron. After communicating to the machine a sufficient power of rotation, it will proceed with an enormous accumulated energy and momentum, till it expend its force either by friction in turning, or upon some fixed obstacle presented to it.

EQUALIZATION—FLY-WHEELS.

In most machines, both the moving force and the resistance to be overcome are liable to fluctuations of intensity at different times, during the operation of working. For instance, when a man turns a winch or handle of a piece of machinery, he is apt to relax in his efforts for an instant from loss of strength, or from an inability to keep his attention closely and uniformly fixed to the labour he has to perform. These relaxations cause an irregularity of motion in the machinery, which are detrimental to the machine and to the work performed. Other moving forces are liable to similar irregularities.

The irregularities in the motion of machinery, from whatever cause they arise, are remedied by giving to each machine a *reservoir of power*, from which force may be given at all times to equalize the motion according as it may be required. These reservoirs of power are usually in the form of *fly-wheels*.

A fly-wheel is generally made of iron, and consists of a heavy rim or circumference, joined to a central axis by cross bar or spokes. In most cases it is placed in close connection with the first moving force, the effect of which it equalizes in its passage to the machine.

FRICTION.

Moving bodies, as machines and wheel carriages, are less or more retarded in their velocity by friction, and the resistance of the atmosphere, while vessels moving on water are retarded by the resistance both of the atmosphere and of the liquid in which they are buoyant.

Friction is an effect of the action of rubbing of bodies one upon another.

This effect is produced by inequalities of surface. No such thing is found as perfect smoothness of surface in bodies. In every case there is, to a lesser or greater extent, a roughness or unevenness of the parts of the surface, arising from peculiar texture, porosity, and other causes; and, therefore, when two surfaces come together, the prominent parts of the one fall into the hollow parts of the other. This tends to prevent or retard motion. In dragging the one body over the other, an exertion must be used to lift the prominences over the parts which oppose them, and this exertion is similar to that of lifting or drawing of bodies up inclined planes or over upright protuberances.

Friction acts as a retarding influence in the action of all mechanical contrivances, and a due allowance must in every case be made for it. In many instances it destroys more than half of the power employed, and seldom destroys less than a third. However small it may be, it sooner or later causes the wearing down and destruction of mechanism, and therefore forms an insurmountable obstacle to the lasting duration of bodies and the perpetuity of motion.

Friction is found to depend on the following circumstances:—1st, The degree of roughness of the surfaces. 2d, The weight of the body to be moved. 3d, The extent of surfaces in certain bodies presented to the action of rubbing. 4th, The nature of the bodies. 5th, The degree of velocity of the motion. 6th, The manner of the motion.

Roughness.—It is of the utmost importance to smooth the surfaces. An apparently insignificant piece of matter, or even particles of dust, will greatly retard the motion of a body. But there is a limit beyond which it would be imprudent to smooth the surfaces of bodies having a close texture. If the surfaces be highly polished and levelled, the bodies will adhere by the effect of attraction of cohesion, even when the atmospheric air is not entirely expelled from between them, and more forcibly when the air is completely expelled. Practically, roads, railways, and similar bodies, cannot be made too smooth.

Weight.—Friction from weight differs in different bodies, and depends on concurring circumstances, as nature of surface, and so forth. Friction always increases in exact proportion as the weight increases, when all other circumstances remain the same. The parts of machinery, therefore, should be made as light as possible, consistent with strength and durability.

Extent of surfaces.—Rough bodies are more easily drawn along when their surface of contact is narrow than when they are broad. For example, it is easier to draw two narrow brushes across each other, than two broad ones of the same weight. Friction may, therefore be diminished in rough bodies by lessening the extent of surfaces in contact. But there is a limit to this diminution. If the moving surface be very thin, and the other soft, the thin surface will plough a groove in the soft one, and thus the friction will be increased, and the machine injured.

Nature of bodies.—It is a remarkable truth that two bodies which are of the same nature, or homogeneous, produce greater friction in movement than bodies which are different in their nature, or heterogeneous. Thu iron working against iron, steel against steel, or brass against brass, causes in each case greater friction and wearing of parts, than when iron or steel is made to work against brass. This circumstance is always attended to in the construction of machinery. Frequently, a small piece of leather is adjusted round an axle, to prevent the metals from coming in contact.

Degree of Velocity.—Friction is a uniformly retarding force, except in the case of small velocities, when it is greater in proportion. The reason for it being greater in small velocities is, that in these cases time is allowed for the prominences of the moving body to sink deeply into the hollows of the surface on which it is moving, which has a retarding effect.

Manner of the Motion.—The least advantageous manner in which one body can be moved upon another, is to cause it to slide or drag. The most advantageous manner is to cause it to roll or turn. The causing of a body to roll instead of to slide, is one of the chief means of diminishing friction. The opposition presented by inequalities of surface to a rolling wheel, is overcome with ease, in proportion to the extent of diameter of the wheel. On a perfectly horizontal plane, the friction of wheels on the plane is very inconsiderable; the chief seat of friction in such cases being in the axles working in their sockets.

Friction is greatly diminished by lubricating the rubbing surfaces with an oily or greasy substance, which substance forms a medium of small soft particles betwixt the bodies, and so prevents the tendency to grind or wear down the surfaces. Water or any similar fluid will also act as a medium to prevent friction, but the effects are only temporary, and would frequently be injurious, as the substance speedily evaporates, and would corrode metals. Practically, fine pure oil is found to be the best unguent for machinery.

One of the first considerations on the part of contrivers of mechanism, should be how to provide for and diminish the effects of friction in their machines. For want of forethought on this important point, thousands of ingenious schemes, which seemed perfect in the form of models and drawings on paper, have been completely frustrated when attempted to be brought into use.

Whatever may be the retarding and frequently inconvenient effects of friction, in reference to the action of mechanism, it is certain that friction is indispensable in the economy of both nature and art, and serves as an essential auxiliary to gravitation. It is a property which is frequently necessary, in order to allow one kind of matter to possess a hold upon another, without actual cohesion. We walk and maintain our erect posture by means of gravitation and action and reaction—in other words, we are held to the earth by gravitation, and our pressure with our feet exemplifies action and reaction; but if there was no such property as friction, we should either stick to the earth by attraction of cohesion, or slide along it as upon the smoothest ice. In order to keep our feet from sliding when on ice, if we received any impulse, we either tie rough substances on our shoes, or scatter ashes in our path; and thus we receive the benefit of friction. It is by friction that rains wear down hills, and that rivers wear away their banks, by which ceaseless process the external configuration of the globe is constantly undergoing a change. The operations in art, of washing, cleaning, scouring, sharpening, polishing, cutting, bruising, beating, and so forth, are all effected less or more by friction. The hold which one fibrous substance has on another, or mutual friction, permits the operations of weaving cloth, twisting ropes and threads, and the tying of one body to another. Thus, friction is of universal service; and the only known instance in nature in which it is not required, and therefore not present, are the movements of the heavenly bodies, which revolve in a vacuum, and are consequently not impeded in their motions.

RESISTANCE OF AIR AND WATER.

Atmospheric air and water are fluids of different densities, and both present an obstacle to the motion of solid bodies through them.

There is a rule in respect to the resistance presented in moderate velocities, which applies both to air and water. It is, that *the resistance is proportional to the square of the velocity.* For example, a velocity of twenty miles an hour causes a resistance four times greater than a velocity of ten miles an hour, for the square of twenty (which is 20 times 20, or 400) is four times the square of ten (which is 10 times 10, or 100). Thus, by increasing the velocity of bodies through the air or water, we must increase the power in a greater proportion, in order to compensate the loss caused by resistance.

Although the above rule is nearly correct for moderate velocities, it deviates considerably from what is observable in the case of great velocities, such as that of a cannon-ball. When the velocity is upwards of 1000 feet per second through the air, the quick passage of the body is believed to cause a partial vacuum behind it, which causes a retardation of its motion.

Resistance to motion in fluids is greatly modified, also, by the form of the moving body. The form that gives least resistance is nearly that of a parabola, or a form somewhat resembling the breast of a duck, the head of a fish, or the rounded bow of a vessel, sharpened to cleave the fluid through which the body passes.

[BOOKS ON MECHANICS, MACHINERY, &c.

One of the most comprehensive works on this subject is Hebert's "*Engineer's and Mechanic's Encyclopædia,*" 2 vols. 8vo, London, with numerous engravings. Haswell's "*Engineer's and Mechanic's Pocket-book,*" is a cheap and useful compendium. Mosley's "*Illustrations of Mechanics,*" edited by Professor Renwick, is excellent on all the branches which it treats. Professor Renwick's "*Application of Mechanics to Practical Purposes,*" is one of the most useful books of its class, and is consulted with great advantage by working mechanics. The "*Treatise on Mechanics,*" translated from Boucharlat and edited by Professor Courtenay, (Harpers New York,) is a regular scientific view of the whole subject. Ewbank's "*Hydraulics and Mechanics*" is interesting, from its giving the history of these sciences, and the progress of the arts dependent on them, among the ancients. As a book of general reference Dr. Ure's "*Dictionary of Arts, Manufactures, and Mines,*" published recently by the Appletons of New York, is excellent. It classifies the subjects in alphabetical order; is very extensive and complete; and brings each subject down to the present state of science. The treatise of Lardner and Kater is excellent authority, but not so recent as Dr Ure's Dictionary, and not a tenth part so extensive.]

HYDROSTATICS—HYDRAULICS—PNEUMATICS.

GENERAL DEFINITIONS.

MATTER exists in three principal forms—solid, liquid, and gaseous or aëriform. These forms respectively, and the various modifications of them, are the immediate result of certain principles of attraction and repulsion operating on the atoms or particles of which matter is composed

The solid, liquid, and aëriform varieties of matter, assume a position on our globe corresponding to their heaviness or density in a given volume. The solid sinks lowest, and composes the chief mass of the earth; above the solid lies the liquid variety, in the form of the ocean, rivers, and lakes; and above all is the atmosphere, consisting of an expanse of aëriform matter, which wraps the whole earth round to an elevation of from forty-five to fifty miles above the highest mountains. In this great ocean of air, loaded less or more with particles of moisture from the liquids beneath, we live, breathe, and move, and plants grow and receive an appropriate nourishment.

Though differing both in substance and appearance, the liquid and aëriform varieties of matter resemble each other in many of their properties and tendencies, and constitute the class of bodies termed *fluids*. Fluids signify bodies which will flow, or whose component particles are easily moved among each other. Some fluids are so thick and viscous, or sticky, that they can scarcely flow, as tar, honey, and some metals in a state of fusion; others flow with ease, as water and distilled spirits; while others are so light and volatile, as to be impalpable to the touch and invisible to the eye, as pure atmospheric air and various gases.

It is common to divide fluids into two kinds—non-elastic fluids and elastic fluids; that is, fluids which cannot be compressed into a smaller bulk, and those which are susceptible of compression. The non-elastic fluids are water and all other varieties of liquid bodies; but recent experiments prove that the term is not strictly applicable to them. It has been found that water may be compressed in a confined vessel, to a small extent, by means of a very great pressure, and it is certain that water at a considerable depth in the ocean is more dense or compressed than at the surface; water, consequently, is an elastic substance; but as it can be compressed only with very great difficulty, the term non-elastic fluid is not altogether inappropriate.

Atmospheric air and all gases are elastic. They can with little difficulty be compressed into a much smaller volume than they ordinarily possess; and when the pressure is removed, they return to their original bulk. Some gases may be compressed to such an extent as to assume the form of liquids and solids; in other words, from the condition of being perfectly invisible to the eye, they can be made to appear as a piece of solid matter, which may be touched and handled.

In treating the subject of fluids, it is convenient to refer in the first place to those which are of the liquid form, and afterwards to those which are elastic or aëriform. Pure water, at an ordinary temperature, furnishes the most suitable example of liquid bodies. Water also gives the name of the department of science which includes the laws of liquids. Thus *Hydrostatics*, from two Greek words signifying *water* and *to stand*, treats of the weight, pressure, and equilibrium of liquids in a state of rest; and *Hydraulics*, from two Greek words signifying *water* and *a pipe*, treats of liquids in motion, and the artificial means of conducting liquids in pipes, or raising them by pumps.

HYDROSTATICS.

In ancient times water was believed to be an element or simple substance in nature. It is now ascertained by experiment that water is not an elementary body, but is a substance composed chiefly of two gases in a state of chemical union, and into these gases it can be resolved by an artificial process. The investigation of this subject belongs to *Chemistry*.

As a liquid, water consists of exceedingly small particles or atoms of matter in mechanical combination.

The exact nature and form of the atoms composing water are not satisfactorily known, in consequence of their exceeding smallness. They may be compared to very small particles of sand, cohering slightly, and easily slipping or sliding over each other. Whatever may be the nature and form of these exquisitely fine atoms, it is certain that they can adhere firmly together so as to assume the form of a solid, as in the case of ice, and be made to separate from each other, and disperse through the thinner fluid of the atmosphere, in the forms of steam, clouds, or mist.

Thus, *imperfect cohesion of atoms or particles* is a property common to all fluids. The atoms composing water, being in closer union than those of air, are observable as a mass, and palpable to the touch. When the hand is dipped into them, and then withdrawn, a certain quantity of the atoms is brought away on the surface of the skin; and this adhesion of the particles of water (caused by attraction of cohesion) is what we in ordinary language call *wetness*. Certain substances, as is well known, absorb water to a great extent; in such cases, the minute particles of the water merely penetrate and fill up the crevices in the substance.

Solid bodies, as a stone, or piece of metal, or wood, have a natural tendency to press only in one direction, that is, downwards, or in the direction of the earth's centre, in obedience to the law of terrestrial attraction.

Water has a similar natural tendency to press downwards, and from the same cause; as, for example, when a jug of water is spilled, the water is seen to fall in a stream to the ground.

Water, however, is governed by a law of pressure, independently of this general law of gravitation. This peculiar or independent law consists of a tendency in the particles of any mass of water to press equally in all directions.

Pressure equally in all directions may be considered as the first or great leading law in reference to water, and generally all fluids, liquid and gaseous.

The pressure equally in all directions is a result of the exceeding smallness of the individual particles, and of the perfect ease with which they glide over or amongst each other.

To exemplify equal pressure, fill a leathern bag with water, and then sew up the mouth of the bag so closely that none of the water can escape. Now, squeeze or press upon the bag so as almost to make it burst. The pressure so applied does not merely act upon the water immediately under the point of pressure, but acts equally upon every particle of water in the mass—the particles at the centre being as much pressed upon as those at the outside; and it will be observed that the water will squirt out with equal impetuosity at whatever part you make a hole in the surface.

In this, as in all similar cases, there is a transmission of pressure throughout the mass. Each particle presses on those next it; and so, by the force communicating from particle to particle, the whole are equally affected.

In the case of water lying at repose in an open vessel, the tendency to press equally in all directions is not observed to act upward, because the gravity of the mass keeps the water down; but on pressing upon the surface of the liquid, we observe that it rises against the compression, or tries to escape in any way it can. To take another example—if we plunge our hand into a vessel of water, we displace so much liquid, and cause it to rise higher up the sides of the vessel. In this case the water is observed to rise without any reluctance; it as readily presses upward as downward.

Although it is a property in fluids to press equally in all directions, the degree of intensity of pressure in any mass of fluid is estimated by the vertical height of the mass, and its area at the base.

Pressure of water in proportion to its vertical height, and its area at the base, is therefore a second leading feature in the laws of water. In other words, the pressure of a column of water does not depend on the width or thickness of the column, but on its height and the extent of its base or lower part.

The whole of any fluid mass may be imagined to consist of a number of columns of an inconsiderable thickness, which stand perpendicularly on the horizontal base of the containing vessel, and press the base of the vessel with their respective weights. The pressure, then, if the height of the fluid be the same throughout, is as the number of columns, and this number is according to the area of the base. Consequently, in vessels whose bases differ as to area, and which contain fluids of the same density, but different heights, the pressure will be in the compound ratio of the bases and heights.

If the columns of which a fluid mass was supposed to consist, were formed of particles lying in perpendicular lines, the pressure of the fluid would be exerted on the bottom of the vessel only; but as they are situated in every irregular position, there must of consequence be a pressure exerted in every direction, which pressure must be equal at equal depths. For if any part of the whole mass were not equally pressed on all sides, it would move towards the direction in which the pressure was least, and would not become quiescent till such equal pressure was obtained. The quiescence of the parts of fluids is therefore a proof that they are equally pressed on all sides.

Several interesting experiments may be made to prove that the pressure of water is in proportion to its height and width of base.

Figure 1 represents a vessel with a broad top EE, tapering to a narrow base CD. The dotted enclosure A B C D represents an ideal column of water the width of the base. The vessel is supposed to be filled with water to the surface EE. Yet the base or bottom sustains no more pressure than that described by the ideal column ABCD; for the other parts of the contained fluid can only press the column ABCD, and also the sloping sides, laterally, and therefore do not contribute to the increase of the weight or pressure on the bottom CD.

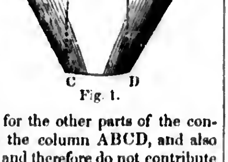


Fig. 1.

If we take a vessel of the same capacity, but with a broad base, as in fig. 2, the pressure on the bottom is very different. In this case, the base EF sustains a pressure equal to the weight of a column whose base is EF, and height equal to AC; for the water in the central column ABCD presses laterally or sidewise, with the same force as it does on the part on which it stands; and thus a uniformity of pressure is established over every part of the bottom.

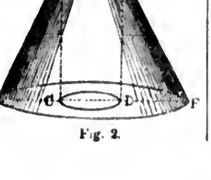


Fig. 2.

From these two cases combined, the reason is evident why fluids contained in the several parts of vessels remain everywhere at the same height; for the lowest part where they communicate may be regarded as the common base, and the fluids which rest thereon are in equilibrio then only, when their heights are equal, however their quantities may vary.

We may prove the truth of these propositions in various ways. Let ABCD, fig. 3, represent a cylindrical vessel, to the inside of which is fitted the cover G, which by means of leather at the edge, will easily slide up and down in the internal cavity, without permitting any water to pass between it and the surface of the cylinder. In the cover is inserted the small tube EF, open at top, and communicating with the inside of the cylinder below the cover at G. The cylinder is filled with water, and the cover put on. Then if the cover be loaded with the weight, suppose of a pound, it will be depressed, the water will rise in the tube to E, and the weight will be sustained. In other words, a very small quantity of water in this narrow tube will press with a force as great as if the vessel were of the dimensions KLCD, instead of ABCD. By filling the tube to F, a force will be gained sufficient to balance additional pound weights on the cover G, and as great as could be conferred by a vessel of equal breadth all the way up to F.

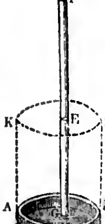


Fig. 3.

Water, in its pressure equally in all directions, presses upwards as well as downwards. This is seen in the above experiments. Take fig. 3 as an example. The water in the vessel ABCD, when the tube is filled, presses, as has been said, with a force equal to that of a column of water of equal breadth all the way up to F. This can only be in consequence of the water in the vessel ABCD pressing violently upwards against the cover G, which violence causes a corresponding reaction on the bottom of the vessel. This reaction, then, is equivalent to vertical height. To use a figure of speech, the water in the vessel is in the condition of a man pressing equally upwards with his shoulders and downwards with his feet at the same time; and the more he is acted upon by weight above, the more powerfully does he exert his pressure in both directions.

An instrument called the hydrostatic bellows has been constructed to exemplify the effect produced by the pressure of a small column of water. As represented in fig. 4, it consists of two circular stout boards connected together with leather, in the form of a pair of strong bellows. A tube A communicates with the interior between the boards. Supposing the instrument to be strong enough, a person standing on the upper board may raise himself by pouring water into the tube, and filling it along with the bellows. It is usual to estimate the pressure by means of weights, W. If the tube hold an ounce of water, and has an area equal to a thousandth part of the area of the top of the bellows, one ounce of water in the tube will balance a thousand ounces placed on the bellows.

Fig. 4.

This remarkable property in liquids, which is called the *hydrostatic paradox*, is analogous in principle to that which in mechanics is called the Law of Virtual Velocities. According to this fundamental rule, a small weight descending a long way, in any given length of time, is equal in effect to a great weight descending a proportionally shorter way in the same space of time. The rule, as applied to liquids, may be stated thus:—A small quantity of water descending in a long column is equal in effect to a proportionately great pressure exerted by a large volume of water in a short column.

The law of pressure in proportion to height of column is shown in the annexed representation, fig. 5, of a vessel with a uniformly level base, and full of water. Dividing the depth into 10 equal sections, to represent feet, as marked from 1 to 10, it is found, that, at the depth of 1, there is a pressure of one foot of water, at 2, two feet, and so on to 10 at the bottom, where there is a pressure of ten vertical feet of water. The average pressure of the whole is at the middle, at 5. These degrees of intensity of pressure have no reference to the horizontal breadth or length of the mass. The same pressure is sustained, whether the vessel be a foot or a mile in breadth.

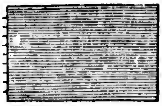


Fig. 5.

As in this example, whatever deficiency of pressure there is upon the perpendicular sides of a vessel of water *above* the middle or point of average pressure, is compensated by a corresponding excess of pressure *beneath* the middle; consequently, the entire pressure diffused over the side is equal to that at the middle or point of average pressure. A perpendicular side of a cubical vessel, according to this statement, sustains a lateral pressure precisely equal to the half of that which is endured by the bottom.

We may calculate the degree of lateral pressure in vessels having perpendicular sides and flat horizontal bottoms, by first finding the number of square feet in the sides below the surface of the liquid; then multiplying that by the number of feet in half the depth of the liquid; by which calculation, the product will express the number of solid feet of the liquid, whose weight is equal to the lateral pressure. We may find the number of square feet in the sides, by multiplying the number of feet in the circumference of the bottom by the number of feet in the depth of the liquid.

Example.—To find the degree of pressure on the perpendicular sides of a vat 24 feet deep from the surface of the liquid, and 40 feet in circumference.—Multiply the 24 by 40, and the product 960 gives the area of the sides; then multiply the 960 by half the height, that is 12, and the product is 11,520 cubic feet of water, or the volume of liquid whose weight is equal to the pressure on the sides. We next find the weight per cubic foot, which is reckoned to be 1000 ounces; then 11,520 multiplied by 1000, gives 11,520,000 ounces, which is the pressure of the water on the sides.

In consequence of the pressure of liquids being as the vertical height and area of the basis, it may happen that the lateral pressure on the sides of a containing vessel is greater than the whole weight of the liquid; this will be the case when the surface of the sides in contact with the liquid exceeds the ratio of double the magnitude of the bottom—at double the magnitude, both lateral and perpendicular pressures are alike, and each is equal to the weight of the liquid.

The circumstance of pressure increasing in proportion to depth, suggests the valuable practical lesson of greatly increasing the breadth of embankments for dams and canals from the top downwards, so as to give much greater strength to the base than the summit; also of increasing the strength of the lower hoops of large vats, to prevent their bursting. It likewise demonstrates the propriety of making dams, ponds, canals, and vessels for liquids generally, as shallow as is consistent with convenience or their required purpose. In each case, it is important to recollect that the degree of pressure on the sides is irrespective of shape or size of the contents, and depends exclusively on the height of the liquid from its upper surface to its base.

That pressure in water is not according to volume, but the height above the point of pressure, is obvious from many facts both in nature and art. Whether we plunge an object a foot deep in the ocean or in a jar of water, the pressure upon it is the same. The mere extent of the volume of liquid is of no consequence. Therefore, a precipitous shore pressed upon by the sea to the height of any given number of feet, suffers no more pressure (supposing the sea to be at rest) than the side of a canal of the same number of feet in length.

If the law of pressure of fluids were otherwise than that now stated, no species of embankment, no strength of shore, could withstand the pressure of the ocean, particularly in a high state of the tide. In consequence of the law of pressure being simply as the vertical height, we are enabled by artificial means to stem the volume of a far-spreading ocean, and to secure the dry land from its invasion. A knowledge of this important law might induce the attempt to secure many thousand acres of land which are now covered by the tide.

If a vessel, as for instance a barrel, be filled with water, and three apertures be made in its side at different heights, as in fig. 6, the liquid will pour out with an impetuosity corresponding to the depth of the aperture from the top. The jet A nearest the top of the barrel, having little pressure above it, will be projected but a short way; the jet B, having a greater pressure, will perhaps go to double the distance; and the jet C, having the greatest pressure of all, will go to a greater distance still. Jets of this kind obey the laws which govern solid projectiles in their flight; they describe a curvilinear motion, the width of curve being proportional to the impressed force.

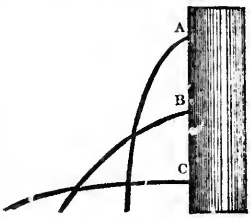


Fig. 6.

Practically, the discharge of liquids from apertures is partly affected by the shape and width of the aperture; for water is retarded by friction, and by its own impetuosity or cross currents in a small channel. It is reckoned that the pressure of water on any body plunged into it, or on the bottom or sides of the containing vessel, is about one pound on the square inch for every two feet in the depth.

Pieces of wood sunk to great depths in the ocean become so saturated with water by the pressure of the superincumbent mass, that they lose their buoyancy, and remain at rest at the bottom. The depth to which divers can descend is limited by the increased pressure they experience in their descent. If a bottle be firmly corked and sealed, and sunk to a great depth in the ocean, the cork will either be forced in or the bottle broken by the pressure. An air-bell rising from a depth, expands as it approaches the surface. At the depth of a thousand fathoms, water is estimated to be about a twentieth part more dense in the bulk than at the surface.

The great effects which may take place by the action of a small but high column of water, are sometimes exemplified in the rending of mountains. In fig. 7, a mountain or high rocky knoll is represented, with a small vertical crevice A reaching from the summit to an internal reservoir of water near the base. If there be no means of outlet to the liquid, and if rain continue to keep the crevice and its terminating reservoir full, the lateral force exerted by the upright column will be very considerable. Supposing the crevice to be an

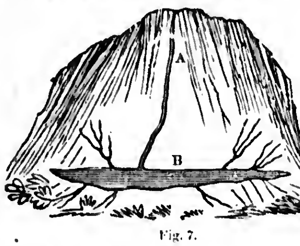


Fig. 7.

inch in diameter, and 200 feet deep, the pressure would be equal to nearly half a ton on every square inch; such a force continually acting on the sides of the mountain (laying out of view the great additional force given by expansion of the liquid in freezing during winter) would probably in time overcome the cohesiveness of the mass, and burst the whole asunder. In this property in water, therefore, we see one of the many provisions of nature for producing changes on the surface of the earth.

Effects of a similar character, but on a less scale, are observable in the bursting of walls behind which earth has been piled, and in which no proper outlets for water have been provided; also in the bursting upwards of drains upon a declivity, when they become choked.

The easy motion of the particles among each other causes them to accommodate themselves to the shape of any vessel. The force of gravity also causes them to seek the lowest level for repose—each particle tries to get as low as it can. The result of this general tendency throughout the mass is a perfect levelness of surface—the top of the water is smooth.

A uniform levelness of surface takes place in every connected mass of water, whatever be its magnitude or its shape. This forms the third leading feature in the laws of water, and is the cause of many of the phenomena in nature.

One of the most familiar examples of the equal height and levelness of surface of water, is that observable in a common teapot. In the representation of a teapot, fig. 8, the surface of the liquid in the pot is seen to be at A, and also at the very same height at B in the spout. A straight dotted line is drawn from the one to the other, to show that both surfaces are of the same level. It is customary to say that the small column of water in the spout balances the large mass of water in the pot, but, in reality, there is no balancing in the case. The water

Fig. 8.

necessarily possesses the same surface level in all its parts; one portion cannot stand higher than another; all portions, great and small, are only distributed parts of a single mass.

The tendency which water has to stand at the same surface level in all parts of its mass, is usually referred to by the phrase "water finding its level."

It is this inherent tendency in water to find its level that produces the various phenomena of the trickling down of rain and moisture into the ground, the flowing of all kinds of streams, from the small brook to the mighty river, and the shooting of rapids and cataracts over precipices. In each case, the water, in obedience to the natural law or tendency which governs it, is only trying to find its level. In pursuit of this object, the water, by the rubbing force which it exercises, wears down all the solid objects which present an obstacle to it in its course. Thus, the substances of which hills and plains are composed, are carried away by streams into the ocean—the ground of continents and islands diminishes in bulk—new land rises in the sea; and so, by the effects of a simple natural cause, great alterations are produced in the external features of the globe.

There are two kinds of levels—the *true level* and the *natural level.** The true level is a perfectly horizontal plane, as for instance an even line, thus ——— or a perfectly even surface of a floor.

The natural level is a surface, every point of which is at the same distance from the centre of the earth. The surface level of water is always the natural level.

The character of a natural level is understood by a reference to the spherical shape of the earth and the pressure of gravitation. The globe is a ball, and any piece of water which lies upon it, lies in the form of a plaster round the ball. Water, therefore, cannot possibly have a true surface level; its level partakes of the sphericity of the ball. Every piece of water, in a state of entire or partial repose, is in this manner convex in its surface.

The degree of convexity of the earth is, as nearly as it can be stated in figures, 7 inches and 9-10ths of an inch, or nearly 8 inches in each mile. The convexity, however, is somewhat less towards the north and south poles, because the earth is a spheroid, or a sphere flattened at the ends.

Fig. 9 represents a segment of the earth's surface, with the appearance of a true and natural level marked

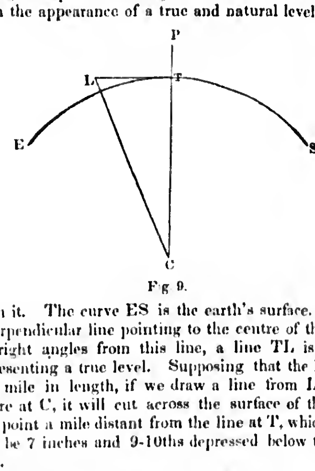


Fig. 9.

upon it. The curve ES is the earth's surface. PC is a perpendicular line pointing to the centre of the earth. At right angles from this line, a line TL is drawn, representing a true level. Supposing that the line TL is a mile in length, if we draw a line from L to the centre at C, it will cut across the surface of the earth at a point a mile distant from the line at T, which point will be 7 inches and 9-10ths depressed below the part at L.

The convexity of the earth's surface is not observable in small quantities of water. The surface of a glass of water is not a true level, but the degree of convexity is so small that it cannot be practically estimated or measured. It is only when a sheet of water is stretched out to an extent of several miles, that the convexity becomes conspicuous. It is very perceptible on the ocean when a ship is seen approaching on the horizon; first the masts and sails of the ship are seen, and lastly the hull. In order to catch the first glimpse of vessels at sea, the point of outlook for them is placed high

* In mathematics the term *apparent level* is used instead of true level, and the term *true level* instead of natural level.

above the water. By this means the person who looks is able to see over a part of the convexity, and give information of the approach of vessels to those placed below.

The convexity of the land is not so conspicuous, in consequence of the many risings and fallings in the surface. It is only in some extensive alluvial plains in different parts of the world that the convexity can be perceived in the same manner as at sea.

In forming roads, railways, and canals, it is necessary to make allowance for the convexity of the earth's surface. The first thing done in such cases is to survey the land by means of an instrument called a *theodolite*. One of the varieties of the theodolite is a small telescope fixed on a stand, which must, when looked through, be placed perfectly horizontal, or in a true level. To find a true level, an instrument is fixed below it, called a *spirit level*, and by that it is regulated.

A spirit level is in universal request in works of art requiring levelness of foundation or surface. It consists of a cylindrical glass tube, as in Fig. 10, containing a quantity of spirits of wine sufficient to fill it, except a small part, in which the air is left. The tube being completely closed or sealed, the small vacancy where the air is left shows an air-bubble at whatever part of the tube is uppermost. The tube being set in a small wooden case with a level bottom, this case is laid upon the block of stone, wood, or other object to be levelled, and when the air-bubble is seen to rest in the middle of the upper side, it signifies that the object on which the instrument lies is a true level. In the accompanying figure, the air-bubble is seen at the middle at *b*; the slightest unevenness would cause the bubble to proceed to *a* at one end, or *c* at the other.

Fig. 10.

A true level being found for the theodolite, the surveyor looks through the glass or telescope towards a pole, the lower end of which rests on the ground, and is held in a perpendicular position by a man at (we shall suppose) the distance of a mile, previously measured. The pole having figures marked upon it, a certain figure on a level with the eye is ascertained; 7 inches and 9-10ths are then reckoned down the pole from the figure, and at that depth we have the natural level from which the surveyor makes his subsequent calculations. If a road were to be made on the plan of preserving a true level, it would proceed in its course at a tangent from the earth's convexity, like the line T L in Fig. 9, and, consequently, would reach a point above that to which it was destined to go. It would be impossible to make the water in a canal pursue a true level; in the attempt to do so, the water would not remain at rest in the channel prepared for it, but would rush towards the lower end.

As most countries are less or more irregular in surface, canals are usually constructed with different levels, so much of the length being on one level, and so much on another, as the case may be. At every change of level there is a lock, or portion enclosed with gateways, to keep the water at the proper level, and to allow the passage of vessels. The locks of a canal, therefore, are like steps of a stair, one at a greater height than another, and by their means vessels may be made to proceed up or down hill.

SPECIFIC GRAVITY.

The more dense in substance that a body is, it is the more heavy or weighty, because it contains the more particles to be operated upon by attraction of gravitation. In reference to the density of bodies, the term *specific gravity* is employed to denote the comparison which is made Thus, the weight of a lump of lead is greater than an equal bulk of cork; therefore its specific gravity is greater; and so on with all other substances, when compared together. For the sake of convenience, pure distilled water, at a temperature of 62 degrees, has been established as a standard by which to compare the specific gravity or relative weight of solid and liquid bodies. Every such body is said to be of either a greater or less specific gravity than water, bulk for bulk.

We have an example of a difference in the specific gravities of liquids, in mercury, water, oil, and spirits. Mercury is considerably more dense or heavy than any of the others; the next in density is water, then oil, and lastly spirits. If we put a quantity of each of these liquids into a glass vessel, one after the other, in the order here mentioned, we shall observe that all keep their respective places without intermixture, the heaviest at the bottom and the lightest at the top. Should they even be jumbled together in the vessel, it will be noticed that they in time rectify the disturbance, each assuming its own position.

Sea or salt water, in consequence of being loaded with foreign matter, is of greater density or specific gravity than pure fresh water of the same temperature. If we therefore pour a quantity of salt water into a glass vessel, and then gently place some fresh water above it, we shall observe the same phenomenon, of each kind of liquid retaining its position, the heaviest to the bottom, and the lightest to the top. After being jumbled together, the two liquids will, as far as possible, return to their former relative position.

If we fill a bottle with water, and dip it with the open mouth downwards into a jar or barrel of spirits, the water, in virtue of its density, will be emptied and sink into the spirits, and the spirits will immediately rush up into the empty bottle, and supply the place of the water.

The force which liquids exert in opposing each other in a state of equilibrium, corresponds to their specific gravities; in other words, a small quantity of a heavy liquid will balance a much greater quantity of a lighter liquid. For example, take a bent glass tube, as in Fig. 11, and pour as much water into it as will extend from the bottom at E to A. This quantity of water will be balanced or kept to its summit level at A by a quantity of mercury measuring from E to B, or by a quantity of oil from E to C, or by a quantity of spirits from E to D. Each of these experiments may be performed one after the other. The pressure of liquids being as the vertical height, and not as breadth, it would make no difference in the result of the experiments, if the limb of the tube for the mercury, oil, or spirits, were increased to a foot, a mile, or any other diameter.

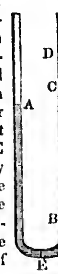


Fig. 11.

Water, at its ordinary temperature of 62 degrees, has a specific gravity of 1000 ounces to the cubic foot. Platinum is 22½ times heavier, or 22½ times the specific gravity of water; gold is 19¼, mercury 13½, copper 8¾, iron 8, common stone about 2½, and brick 2. Alcohol is a little more than 8-10ths of the heaviness or specific gravity of water, or 0.815; and oil of almonds is a little more than 9-10ths, or 0·913. Atmospheric air at the earth's surface is 1-800th part, or 0·00125; in other words, while a cubic foot of water weighs 1000 ounces, a cubic foot of air weighs one ounce and a quarter.

Sea-water generally possesses a specific gravity of 1·035—that is, to 1000 parts of fresh water there are in addition 35 parts of saline substances.* Sea-water being, therefore, 35 parts for every 1000 of water more dense

* This is given only as a general rule The sea is not uniformly salt.

than fresh water, it possesses a proportionally greater power of buoying up bodies. A vessel which will carry 1000 tons on fresh water, will thus carry 1035 tons on the sea.

FLUID SUPPORT.

The immersion of solid bodies in liquids develops some important principles in hydrostatics.

Any body of greater specific gravity than water, bulk for bulk, will sink on being thrown into water; but a body will float if its specific gravity be less than that of water.

The mode of stating the law in reference to the immersion and floating of solid bodies in any kind of fluids, is as follows:—

First.—Any solid body immersed in a fluid displaces exactly its own bulk of fluid, and the force with which the body is buoyed up is equal to the weight of the fluid which is displaced; therefore, the body will sink or swim, according as its own weight is greater or less than the bulk of displaced fluid. This refers to bodies of less density than water.

Second.—Any solid body of a greater density than water, when wholly immersed in that fluid, loses exactly as much of its weight as the weight of an equal bulk of the water—that is, of the water which it displaces.

It is of great importance that these propositions should be fully comprehended, for they explain innumerable phenomena in nature, in reference to the floating or swimming of bodies in water or in the atmosphere.

Water, as has been explained, consists of innumerable small particles, pressing in all directions, or upwards as well as downwards. Let us fix our attention on a supposed single particle in the mass: while the liquid is in a condition of repose, we may imagine the particle to be sustained between contending forces—the force of a column of particles above, and the equally strong force of particles beneath, pushing to get upward or away from this column.

Let us now substitute any solid object for the supposed particle; for example, the quadrangular object A B represented in a vessel of water, Fig. 12. This object, supposed to be of the same density as water, which we see is sunk in a buoyant condition in the water, has displaced a mass of particles, all of which were operated upon in the manner of the supposed single particle. This object, then, by taking the place of the mass of particles, has become subject to the same contending forces, and is consequently floated or sustained to the same extent as they were.

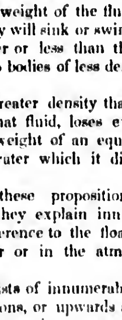


Fig 12

If we suppose that the weight of the object is two pounds, liquid to the amount of two pounds is displaced, and the object is pressed upwards with the force of two pounds. Or, to vary the example, suppose that only the lower half beneath the line C is the solid object, and that the space occupied by the upper half is water, the object is still pressed upwards with a force of two pounds; but being one pound weight in itself, and having a pound of water above it, it remains suspended in equilibrium.

These examples refer to bodies which are of the same density or weight as water, bulk for bulk; we shall now take an example of a body specifically lighter than water, by which it will be observed that the buoyancy is governed by the same principle.

Fig. 13 represents a solid object A B half immersed in a vessel of water. In this, as in all cases in which there is a portion of the object above the water, the weight of that portion is borne by, and therefore conveyed to, the portion which is immersed. Thus, in the example before us, the portion B, though less than a pound weight in itself, by supporting A becomes, we shall say, a pound, and displaces a pound of water; it is therefore buoyed up with the corresponding force of a pound.

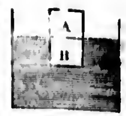


Fig. 13.

Whether a body be large or small in bulk, in proportion to its weight, its displacement of water depends exclusively on its weight, so long as it is not heavier than water. A vessel of cork, wood, or any substance lighter than water, weighing a thousand tons, displaces exactly the same weight of water, or is buoyed up with the same degree of force.

From these circumstances, it appears that the entire weight of any *floating* body may be calculated by measuring the quantity of water which it displaces.

On immersing a stone or any other solid object in water, it is found to be buoyed up in proportion as its specific gravity is less than that of water. If its specific gravity be greater than water, it will sink to the bottom, and if less it will swim. As the water of the ocean becomes of greater specific gravity the greater the depth, it may happen that an object which sinks at the top of the water, will remain suspended in equilibrium when it descends to a point at which the specific gravity of the water is equal to its own.

Whatever be the weight of any solid object when weighed in air, its apparent weight is lessened when weighed in water. Thus a stone may be moved with comparative ease in water, which cannot be lifted without considerable difficulty on land. The apparent diminution of weight in these cases is caused by the support afforded by the liquid. Attraction of gravitation, which is the cause of what we call weight, is counteracted more in water than in air, because the water has a tendency to buoy up the object. The weight of any object in water is thereby lessened to the extent of the weight of a bulk of liquid equal to the size of the object. If the object displace a pound of water, it will weigh a pound lighter in water than in air.

The circumstance of any solid object displacing its own bulk of liquid, and losing exactly as much of its weight as the weight of that bulk of liquid which it displaces, has led to the use of the hydrostatic or water balance, for ascertaining the intrinsic value of gold and other precious metals. For example, by knowing in the first place how much water a pound of pure gold displaces, and then weighing in water, as in Fig. 14, an object said to be a pound of gold, we should observe whether it displaced the proper quantity of water; if it displaced more than was proper, then we should be certain that it contained alloy or some inferior substance, being too bulky for a pound of gold. Such weights are used by goldsmiths.


Fig. 14.

Thus, if a piece of gold weigh 19¼ ounces in air, it would weigh only 18¼ ounces in water; the ounce of weight thus counteracted being just the weight of the water that the gold displaces. Therefore the weight of the gold would be to that of the water as 19¼ ounces to 1 ounce; that is, the specific gravity of gold is 19¼, if water is taken for the standard.

We may cause an object, such as light hollow ball or bladder, to displace much more water than what is equal to its own weight; but in doing so, we must press the ball into the water, and that degree of pressure compensates the deficiency of weight in the ball. Thus, extraneous pressure on a floating body, and weight in the body itself, are the same thing as respects buoyancy.

The human body in a state of health, with the lungs full of air, is specifically lighter than water, and more so in the sea than in fresh water. Persons, therefore, on going or falling into water, cannot possibly sink, unless they struggle so as to prevent the liquid from buoying them up. The body will float with a bulk of about half the head above the surface; and thus a person who cannot swim may live and breathe, until chilled or otherwise paralyzed, by simply stretching himself on his back, and lying with his face above the water. By throwing the arms out of the water, the body does not displace so much liquid; its weight is increased, and it naturally sinks. Ignorance of these facts in hydrostatics, and want of resolution, cause many deaths by drowning.

There are various kinds of apparatus for preventing drowning, called life-preservers. The most common are those which consist of pieces of cork or other very light material attached to the upper part of the body. But air-tight bags are preferable, as they may be said scarcely to encumber the body when empty, and, as danger approaches, they can be inflated with ease by being blown into. Life-boats have large quantities of cork in their structure, and also air-tight vessels made of thin metallic plates; so that, even when the boat is filled with water, a considerable portion of it still floats above the general surface. The bodies of some animals, as sea-fowl, and many other species of birds, are considerably lighter than water. The feathers with which they are covered add very much to their buoyancy. Quadrupeds swim much easier than men, because the natural motion of their legs in walking or running is that which best fits them for swimming. Fishes are enabled to change their specific gravity by means of an air-bag with which they are provided. When the air-bag is distended, they rise to the surface; and when it is contracted, they descend to the bottom.

The buoyant property of liquids is independent of their depth or expanse, for if there be only enough of water to surround an object plunged into it, the object will float as effectually as if it had been immersed in a large mass of water. Thus a few pounds of water may float an object which is a ton in weight. We account for these phenomena by the law of pressure in liquids being as vertical height, not as width of column, and by a body being buoyed up with a force exactly in proportion to the weight of water which it displaces.

These important truths in hydrostatics teach the practical lesson, that if canals be made only as deep or wide as will afford water to surround the vessels placed upon them, they will be sufficiently large for all purposes of buoyancy and navigation. A ship floats no better on the face of a sheet of water miles in width, than it would do on a mill-pond, provided there be enough of water in the pond to keep it off the bottom.

Every solid body possesses a *centre of gravity*, which is the point upon or about which the body balances itself, and remains in a state of rest, or equilibrium, in any position.

The equilibrium of floating bodies is regulated in the same manner. The floating body has a centre of gravity, about which the whole mass will balance itself in the liquid, the heaviest side will sink lowest, and the more light will be uppermost.

In reference to floating bodies, there is a point called the *centre of buoyancy*; this is the centre of gravity of the liquid which is displaced. If the floating body be of the same specific gravity as water, then the centre of buoyancy will be at the same point in the floating body as it would have been in the water; but there is seldom this uniformity, at least not in vessels used for purposes of navigation. It is necessary that all such vessels should be of a less specific gravity than water, in order that a part of their weight may be composed of cargo, stores, passengers, &c., and that they may be sufficiently buoyant.

Heavy materials, called ballast, are usually placed in the bottom of the holds of vessels to insure a low centre of gravity. A ship of the largest capacity and burden, with its centre of gravity properly regulated, rests in the water with a stateliness and stability which cannot be destroyed except by some extraordinary violence.

HYDROMETERS.

If a substance be weighed in two fluids, the weights which it loses in each are as the specific gravities of those fluids. Thus, a cubic inch of lead loses 253 grains when weighed in water, and only 209 grains when weighed in rectified spirit; therefore, a cubic inch of rectified spirit weighs 209 grains, an equal bulk of water weighing 253; and so the specific gravity of water is about a fourth greater than that of the spirit.

The instrument called a *hydrometer* is constructed upon this principle. Its name is derived from two Greek words, signifying *measure of water*; but it is of course used for ascertaining the density of all kinds of liquids. There are various kinds of hydrometers. One of them consists of a glass or copper ball with a stem, on which is marked a scale of equal parts or degrees. When immersed in any fluid, the stem sinks to a certain depth, which is indicated by the graduated scale. The length to which it sinks in the standard of comparison being known, we can thus easily ascertain how much it is specifically heavier or lighter than the fluid.

Much in the same manner is constructed another hydrometer of great delicacy and exactness. It consists of a ball of glass about three inches diameter, with another joined to it, and opening into it, of one inch diameter, *b c*, fig. 15, and a brass neck *d*, into which is screwed a wire *a e*, divided into inches and tenths of an inch, about ten inches long and one-fortieth of an inch in diameter. The whole weight of the instrument is 4000 grains when loaded with small weights, such as shot, in the lower ball *c*. When plunged into water in the jar, this instrument is found to sink an inch if a single grain be laid upon the top *a*; hence a tenth of a grain sinks it a tenth of an inch. So great is the delicacy of this hydrometer, that the difference in specific gravity of one part in 40,000 can be detected. Its total weight of 4000 grains is convenient for comparing water; but the quantity of shot in the lower ball can be varied so as to adapt the instrument to measure the specific gravities of fluids lighter or heavier than the standard of comparison.

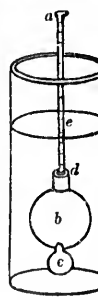


Fig. 15.

There is another very simple hydrometer, which consists of a number of glass beads of different weights, but whose proportions are known, and the beads marked accordingly. These are dropped into the fluid under examination, until one is found which neither sinks to the bottom nor swims upon the surface, but remains at rest wherever it is placed in the liquid; and this bead being numbered, indicates the specific gravity.

In making calculations of the strength and specific gravity of spirits, by the above or any other means, attention must be paid to the degree of temperature of the liquid. Heat expands the liquor, and renders it specifically lighter; all spirits are therefore more bulky, in proportion to their weight, in summer than in winter, and also *apparently* stronger, not really so.

HYDRAULICS.

Having detailed the laws and properties of water in a state of rest or equilibrium, we have now to mention some of the more important results of these laws, and also the effects which are produced upon liquids by the application of forces, whether natural or artificial.

WATER A MECHANICAL AGENT.

Water, as already explained in the Laws of Matter and Motion, may be made a useful agent of power, merely by allowing it to act with the force of its own gravity, as in turning a mill; and in this manner it is extensively employed in all civilized countries possessing brooks which are sufficiently rapid in their descent.

But water may be rendered otherwise useful as an agent of force in the arts. Although subtile in substance, and eluding the grasp of those who desire to handle and hold it, it can, without alteration of temperature, be made to act as a *mechanical power*, as conveniently and usefully as if it were a solid substance, like iron, stone, or wood. The lever, the screw, and inclined plane, or any of the ordinary mechanical powers, are not more remarkable as instruments of force than water, a single gallon of which may be made to perform what cannot be accomplished (except at enormous cost and labour) by the strongest metal.

To render water serviceable as an instrument of force, it must be confined, and an attempt then made to compress it into less than its natural bulk. In making this attempt, the impressed force is freely communicated through the mass, and in the endeavour to avoid compression, the liquid will repel whatever movable object is presented to it. The force with which water may be squirted from a boy's syringe, gives but a feeble idea of the power of liquids when subjected in a state of confinement to the impression of external force.

The mechanical force of water is exemplified by the hydraulic press. This is an engine employed by paper-makers, printers, and manufacturers of various kinds of goods, for the purpose of giving a high degree of pressure or smooth glazed finish to their respective articles. It has generally superseded the screw press, on account of its much greater power, with a less degree of trouble and risk of injury to the mechanism.

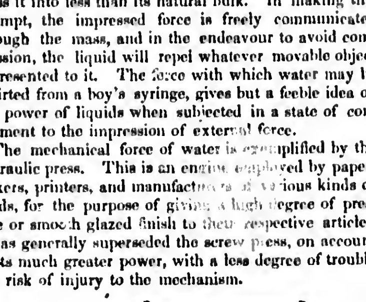


Fig. 16.

Fig. 16 represents the outline of a hydraulic press. A B is the frame, consisting of four upright pillars supporting a cross top of great strength, and against which the pressure takes place in an upward direction. C, the material to be pressed, is forced upward by D, a round iron piston. This piston is very nicely fitted into an iron case, E, which has a cavity F, for receiving the water: the neck of the case grasps the piston so tightly that no water can escape. A small pipe G conveys water into the hollow cavity from a forcing-pump H, which stands in a trough of water T. All that part of the apparatus below the base of the pillars is sunk out of sight in the ground. The pump apparatus is here represented as exceedingly simple, but in real machines it is very complex and of great power.

The pump, on being wrought, forces the water into the cavity. There the water, in endeavouring to escape, operates upon the movable piston, which it causes slowly to rise with its burden. The pressure thus exerted by the liquid almost exceeds belief; unless the case for the water be of enormous strength, it will be rent in an instant as if made of the weakest material. When the weight has been raised to the required height, a stopcock is turned upon the pipe, and the apparatus remains at rest. The opening of the cock allows the water to gush out, and the weight accordingly sinks.

The mode of calculating the power of the hydraulic press is analogous to that for calculating lever powers. Thus, the proportion is estimated between the small bore of the pump and the large bore of the cavity or barrel for the piston. Suppose that the pump has only one thousandth of the area of the barrel, and if a man, by means of its lever handle, press its rod down with a force of five hundred pounds, the piston of the barrel will rise with a force of one thousand times five hundred pounds, or more than two hundred tons. A boy working the pump by a long handle, and taking a sufficiency of time, will raise a pressure of thousands of tons.

In the hydraulic press, a force-pump is employed for the sake of convenience; the same end could be attained by a small column of water of a great elevation, on the principle of pressure in liquids being as vertical height.

AQUEDUCTS—FOUNTAINS.

The tendency in a liquid to find its level, has permitted the construction of apparatus, consisting of pipes and cisterns, for supplying towns with water. No species of hydraulic machine has been of such great use to mankind as this apparatus.

In ancient times, the fact of water rising to an uniform level in every part of its volume, was either not perfectly understood, or there was a deficiency of materials wherewith to construct the apparatus required for carrying water a great distance.

From whatever cause, towns were in these times supplied with water by means of open canals, either cut in the level ground, or supported on the top of arches built for the purpose. These structures, with their elevated channels, were called aqueducts. In Italy, and some other countries in the south of Europe, the remains of stupendous aqueducts, miles in length, still exist.

By a knowledge of the laws of fluids, and by possessing an abundance of lead and iron, we are enabled in the present day to construct apparatus for supplying towns with water in a manner the most effectual and simple; causing a cheap iron or leaden tube, sunk in the ground, to perform the office of the most expensive and magnificent aqueduct.

The method of supplying towns with water consists in leading a pipe of sufficient diameter from a lake, river, or fountain of fresh and pure water, to the place where the supply is required. The iron pipes used for this purpose are composed of a number of short pieces soldered together, and extending to any length, or in any direction. From these main pipes smaller tubes of lead are led into the houses requiring the supply of water; and by means of these minor tubes, the water may be carried to any point which is not of a higher level than the original fountain affording the supply.

Fig. 17.

Fig. 17 is a representation of the mode of supplying towns with water in this convenient manner. A pipe is observed to proceed from a lake on the top of a hill down into a valley, and thence to supply a house situated on the opposite rising ground. From the pipe, in its passage across the valley, a small tube is carried to supply an ornamental fountain or jet d'eau. The water spouts from this jet d'eau with a force corresponding to the height of the lake above.

In towns not commanding a supply of water from a sufficient height, the water is forced by an apparatus of pumps to an elevated reservoir, and from that the pipes are laid. When the water is impure, or loaded with muddy particles, it is usual to purify it by filtration at the reservoir; it is made to filter or ooze through a mass of fine sand, in which the particles of mud are [illegible].

Springs in the ground are natural hydraulic operations, and are accounted for on principles connected with the laws of fluids. One kind of springs is caused by capillary attraction, or natural attractive force, by which liquids rise in small tubes, porous substances, or between flat bodies closely laid towards each other. This species of power is a remarkable variety of the mutual attraction of matter, and is as unaccountable as the attraction of gravitation, or the attraction exercised by the lodestone.

Springs from capillary attraction are believed to be less common and of smaller importance than springs which originate from the obvious cause of water finding its level. The water which falls in the form of rain sinks into the ground in high situations, and finds an outlet at a lower level, though perhaps at a considerable distance.

Some springs are also accounted for by a reference to atmospheric action, but these will form a subject of notice under the head Pneumatics.

FRICTION BETWEEN FLUIDS AND SOLIDS.

The flowing of water through pipes, or in natural channels, is liable to be materially affected by friction. Water flows smoothly, and with least retardation from friction, when the channel is perfectly smooth and straight. Every little inequality which is presented to the liquid, helps to retard it, and so likewise does every bend or angle in its path. A smooth leaden pipe will thus convey more water than a wooden pipe of the same capacity. Practically, an allowance is made in the magnitude of pipes for the loss of speed by friction. Where the length of the tube is considerable, and there are several bendings, it is not unusual to allow a third of the capacity for retardation.

By increasing the capacity of pipes, a prodigious gain is secured in the transmission of water. The loss from friction on a small tube of an inch diameter of bore is so great, that one of twice the capacity will deliver five times as much water.

The rate at which water flows from an orifice in a reservoir, or containing vessel, is affected by the situation and the shape of the orifice.

The most favourable situation for the orifice is at the bottom of the vessel; but the velocity of the emission is not in the ratio of the height of the liquid, or of a perpendicular column of particles; for as the water presses in all directions alike, there is from all parts of the vessel a general rush as it were to the outlet, thus putting the whole mass in motion.

Although the rush of water at the outlet is not as the ratio of the depth, it depends upon the depth. Thus, if a vessel ten feet high be penetrated at the side on a level with the bottom, and the water stand at two feet and a half within, it will issue outwards with a certain degree of velo[illegible] If the height of the water be quadrupled, that [illegible] vessel be filled, the velocity will be doubled. In o[illegible]in a threefold velocity, a ninefold depth is [illegible]r a fourfold velocity, sixteen times the d[illegible]red, and so on. In fact, in whatever propor[illegible]city of efflux is increased, the quantity of [illegible]ed in a given time must be also increased in [illegible] proportion; hence the quantity of water discharged conjointly with its degree of velocity will be increased in proportion to the pressure. There is here a striking coincidence between the descent of water and the relation which exists between the height from which a body falls, and the velocity acquired at the end of the fall.

It has been ascertained that water rushes with most advantage from an orifice, when the orifice is in the form of a short round tube inserted into the vessel, and of a length equal to twice its diameter.

It has also been found, that if the pipe, instead of being flush or level with the bottom of the reservoir, entered into it to some distance, it had the effect of making the flow of water even less than that which issued through the simple hole without any pipe. The singular fact of a pipe and hole of the same diameter discharging different quantities of water under different circumstances, whilst the head or pressure remains the same, must be accounted for by cross or opposing currents being created by the rush which all fluids make to the orifice. Currents will thus form from the top and sides of the containing vessel, and by their inertia they will cross each other, and thus impede the descent of the perpendicular column, causing the water which issues to run in a screw-like form; this, however, is in a great measure obviated by the application of a short tube from the aperture. That the projection of the tube too far into the interior of the vessel should make the flow less than if there were no pipe at all, may be thus explained:—The columns which descend from near the outside of the vessel, by turning up again to reach the discharging orifice, come into more direct opposition to the motion of the central descending columns, whilst they are at the same time themselves compelled to turn suddenly in opposition to their own inertia, before they can enter the pipe. Thus, the discharge is more effectually impeded than if it were proceeding from a mere opening in the bottom of the vessel. The tube for the discharge of water should not only be short and round, but also trumpet-mouthed or funnel-shaped, both internally and externally, that being the form which admits the flow of liquid with the least possible retardation.

The effects of friction between liquids and solids are nowhere so conspicuous as in the flowing of rivers. The natural tendency in the water to descend at a certain speed, is limited by the roughness of the bottom, bends in the course of the stream, and small projections on the

banks. From these causes, the water in a river flows with different velocities at different parts in any vertical section across the current. It flows at a slower rate of speed at and near the bottom than at the surface, and also slower at the sides than at the middle.

The resistance which a body moving in liquid meets with, when it comes in contact with a solid, is as the square of the velocity of the moving body; in other words, the resistance is not twice but four times with a double rate of speed. This is easily explained:—

A vessel moving at the rate of one mile per hour displaces a certain quantity of water, and with a certain velocity; if it move twice as fast, it of course displaces twice as many particles in the same time, and requires to be moved by twice the force on that account; but it also displaces every particle with a double velocity, and requires another doubling of the power on this account; the power thus twice doubled, becomes a power of four. When the body is moved with a speed of three or four, a force of nine or sixteen is wanted, and so on. Thus, the resistance increases as the square of the speed.

This important law suggests practical hints of considerable importance. For instance, in steam navigation, if an engine of fifty horse power impel a vessel at the rate of seven miles an hour, it would require two of the same power to drive her ten miles an hour, and three such to drive her twelve miles an hour. Hence the enormous expense of fuel attending the gaining of a high degree of velocity.

ACTION ON THE WATER IN RIVERS.

In cases where it is desirable to preserve the banks of rivers from injury, either from the regular action of the current or from floods, the water ought to be allowed a free open channel, with banks of a very gradual descent. The utmost violence of water in a state of motion may be rendered comparatively harmless, by allowing the flood or torrent to expend itself on a sloping or shelving shore. Inattention to this simple fact in hydraulics frequently causes much destruction to property on the banks of rivers.

A very small fixed obstacle, such as a stone or pebble, may partially impede and turn aside a brook of a slow current. The water, by striking on a stone at one side, is bent aside to the opposite bank, a little farther down; there it strikes upon the bank, and is returned to the side it formerly struck. Thus, proceeding in currents from side to side, the banks become worn down at particular places, and in time a new and serpentine course is given to the stream. In the case of rivers flowing with considerable velocity, impediments of this kind are usually overcome, and the stream pursues its straight onward course, dashing down all obstacles to its progress. Thus, rivers are generally winding in their course in flat countries, and straight in mountainous regions.

It sometimes happens that the water at the surface of a river may be moving in one direction, while the water at the bottom is flowing in an opposite direction. This is an exceedingly interesting phenomenon, which is observed to occur in certain rivers communicating with the sea, and is caused by the action of the tides and the difference of specific gravity in salt and fresh water. When the tide is flowing inwards, the salt water rushes up the channel of the river, but not in such a manner as to stem the current of fresh water, which, being lighter, floats on the top of the salt water, and pursues its downward course to the ocean. In those instances in which there is no great disturbance of the two liquids, the fresh water, by its specific lightness, floats on the surface of the sea to a distance of many miles from the land.

WAVES.

Waves are the risings and fallings of the water, caused by some power, such as the blowing of the wind. The power, whatever it happen to be, communicates a force to the mass of liquid, and a series of undulations is the consequence.

These undulations, or waves, exhibit the transmission of the communicated force. The force does not advance or alter the lateral position of the water at any given point; it only alters the water in its vertical position, or in relation to its depth. When, therefore, waves advance, the water does not advance with them: the water but rises and falls, and assumes the figure of undulations on its surface. When the undulations approach the shore the water then acquires a progressive motion, where it is shallow, and by friction on the bottom or impulsion against the shore, the communicated force is exhausted. The shaking of a carpet affords an exact representation of the action of waves or undulations.

Waves are comparatively superficial; they seldom, even in the greatest storms, rise to a height of more than twelve feet above the level of calm water, and make an equal descent beneath, making altogether an appearance of twenty-four feet; at eight or ten feet below the hollow or trough of the waves the water is tranquil. Waves "mountains high" is only a figure of speech.

ALTERATION OF TEMPERATURE.

By altering the temperature of liquid bodies, they become liable to peculiar laws, and exhibit peculiar phenomena.

At a temperature of 40 degrees of Fahrenheit's thermometer, water is at the point of greatest density. When the temperature is reduced below this point, the liquid gradually increases in volume till it reaches 32, when it freezes. When the temperature is raised above 40, the volume increases till it reaches the boiling-point, at which it has expanded to the extent of 1-22d additional to its bulk.

In consequence of this expansibility in heating, hot or warm water is specifically lighter than cold water; therefore, in heating any mass of water in a vessel over a fire, the lighter or warm particles rise to the top, while the cold and heavy particles sink to the bottom, to be heated and to rise in their turn. In this manner the process of heating proceeds, until all the particles are of a uniform temperature, which is at the boiling-point, when the liquid gradually flies off in steam.

If water be heated by the action of the fire, or the sun's rays on its upper surface, the mass is longer in attaining the vaporific point than when heated below, because water is a bad conductor of heat, and therefore the heat penetrates with difficulty through the upper stratum of warmed liquid to reach that which is beneath; and if the mass be very large, as, for instance, the ocean, no intensity of heat applied above can warm it throughout, or to any considerable depth.

Certain currents or sets of the ocean are known to be produced by the effort to attain an equability of temperature throughout. The power of the sun's rays at and near the equator heats the sea in that part of its volume, to the depth of two or three hundred feet. This upper stratum of heated water flows in currents towards the north and south poles, and there to a certain extent tempers the severity of the cold. The waters of the northern and southern tracts of ocean, displaced by these currents, necessarily sink below them, and push on towards the equator, to supply the deficiency caused by the departure of the waters above. Thus, in the economy of nature we see a process in constant action precisely the same in principle as that upon which the artificial hot-water apparatus has been established.

Having now discussed Hydrostatics and Hydraulics, we come to the kindred subject of Pneumatics, for which, as will be observed, we have reserved a notice of certain hydraulic machines involving pneumatical agency

PNEUMATICS.

GENERAL DEFINITIONS.

Pneumatics, from the Greek word *pneuma*, breath or air, is the name of the department of science which relates to the weight, pressure, or motion of air, or of any aëriform or gaseous fluids.

It was anciently supposed that the air of the atmosphere was an element or simple substance in nature. It is now satisfactorily established that air is not an elementary body, but is composed of certain gases in intimate union, and these gases can be separated from each other by a process in art.

Air, in its common condition, is a thin transparent fluid, so subtile that it cannot be handled, and when at rest it cannot be felt.

That it is a body, however, is quite obvious, because we feel its impression or force when agitated as wind, or when we wave our hand quickly through it. In the quick motion of the hand, we feel that it is partially opposed by something; and in inhaling breath into the lungs, we feel that we are drawing something through the mouth—that *something* is air.

Air, like every other substance, whether solid or fluid, possesses a certain gravity or weight. The weight of air certainly, bulk for bulk, is much less than that of water; still the weight may be accurately computed. A bottle full of air weighs heavier in a balance than a bottle of the same capacity from which the air has been extracted.

A cubic foot of water, as has been mentioned, weighs 1000 ounces. A cubic foot of air weighs only 523 grains, being a little more than one ounce; water, therefore, is about 840 times heavier than the air of our atmosphere. Inasmuch as water is a standard for comparing the gravities of liquids, air is a standard in the same respect for all aërial substances.

The specific gravity of air being denominated 1000, oxygen gas is 1111; nitrogen gas 972; hydrogen gas 69; and carbonic acid gas 1529. The lightest of these kinds of gas, therefore, is hydrogen, and the heaviest carbonic acid. Hence, if indefinite quantities of these aëriform bodies were placed in a vessel, or in an apartment, we should find, that, after certain portions had gone into intimate union, according to the laws by which they combine, the surplus portions of each would assume relative positions according to their respective weights—the heaviest to the bottom, and the lightest to the top. Such an experiment would resemble that previously noticed, of the mixture of mercury, oil, water, and spirits.

Air and all kinds of gases are rendered lighter by the application of heat, for then the particles in the mass are repelled from each other, and occupy a greater space; this process of lightening or thinning is called rarefaction. Rarefied air, being specifically lightest, mounts above that of a common density. The warmest air is always at the top of a room, and the coldest at the bottom.

Air is distinguished from water not only by its extreme comparative lightness, but by the property of clasticity; it is a compressible and elastic fluid.

When any quantity of air is compressed into a smaller space than it naturally occupies, it will return to its natural bulk on the pressure being withdrawn.

A small bladder of air may be squeezed between the hands so as to be considerably reduced in size; and on opening the hands again, and withdrawing the pressure, it will instantly resume its former bulk. If a metallic tube or barrel be fitted with a movable plug or piston, which is made to work in it perfectly air-tight, the air which occupies the space between the top and the bottom of this barrel when the piston enters, can be compressed to a hundredth part, or even less, of its usual bulk. If the force, however, by which the piston is pushed down, be withdrawn, the air, by its elasticity, will force it up again with a power equal to that by which its descent was resisted.

In proportion as any given volume of air is diminished by pressure, its elastic force is increased; in other words, the elastic force or elasticity of air is proportional to its density.

THE ATMOSPHERE.

The air, as formerly expressed, is a great ocean wrapped round the earth to a depth of from forty-five to fifty miles above the highest mountains, and forms a menstruum which is essential to the existence of all animals and plants.

This ocean of air penetrates into all unoccupied places, in the same manner as water flows into all crevices and holes beneath the level of its surface; and it also finds a place in the bodies of animals, plants, and liquid substances; hardly any thing, indeed, that we see in nature or art, is free from air, unless force has been employed to extract it.

The height of the atmosphere, though usually estimated at forty-five or fifty miles, is in reality unknown. The highest point above the level of the sea, which has ever been reached by any human being, is 21,000 feet, which has been attained in a balloon.

It is only conjectured, from the refraction of the sun's rays and other circumstances, that the height of the atmosphere is about fifty miles. At and near the level of the ocean it is most dense, in the same manner as water at the bottom of the sea is more dense than it is at the surface, on account of the incumbent pressure. As we ascend mountains, or in any other way penetrate upwards into the atmosphere, the air becomes gradually less dense, and so thin is it at the height of three miles on the summit of Mont Blanc, that breathing is there performed with some difficulty. Beyond this limited height, the density of the air continues to diminish, and at the elevation of about fifty miles, it is believed to terminate.

The extreme height of the atmosphere is not observable from the situation in which we are placed on the earth. Our eye, on being cast upwards, perceives only a vast expanded vault, tinted with a deep but delicate blue colour; and this in common language is called the sky. The blueness so apparent to our sense of sight is the action of the rays of light upon the thin fluid of the upper atmosphere, and the brightness is in proportion to the absence of clouds and other watery vapours. In proportion as the spectator rises above the surface of the earth, and has less air above him, and that very rare, the blue tint gradually disappears; and if he could attain a height at which there is no air, say at above fifty miles in height, the sky would appear perfectly dark or black. Travellers who have ascended to great heights on lofty mountains, describe the appearance of the sky from these elevated stations as dark or of a blackish hue.

The atmosphere possesses the capacity of absorbing and sustaining moisture, but only to a limited extent. When saturated to a certain degree, it is relieved by the falling of the moisture in the form of rain. It is calculated that the whole atmosphere round the globe could not retain at one time more moisture than would produce about six or seven inches of rain.

By an elevation of temperature, the capacity of the atmosphere to absorb and sustain moisture is increased, and by a lowering of temperature, decreased. Cold breezes, by lowering the temperature of the air, cause the aëriform moisture to assume the appearance of clouds, and then to fall as rain.

LAWS OF AIR.

First—The pressure of the air is equal in all directions: *Second*—Its degree of pressure depends on the vertical height or depth, and at any place is proportional to its density: *Third*—Its surface is level in all parts of its volume: *Fourth*—It affords support according to its density and to the weight of the fluid displaced.

That air presses equally in all directions may be rendered evident by filling a bladder with that fluid, and then pressing upon it so as almost to make it burst. The pressure is freely communicated through the mass, as in the case of the bag of water, and it will be observed that the confined air will rush out with equal impetuosity at whatever part you make a hole in the surface.

The level of surface of air is less perfect than the uniform level of water, on account of the greater elasticity of the substance. In a series of strata of air of different densities, one above the other, a small portion of each mingles with those which immediately adjoin it—the particles of one commingle to a certain extent with those of another. There is thus, as respects aërial bodies, a modification of the law of uniform levelness of surface in all parts of the volume of fluid.

PRESSURE OF AIR.

The pressure depending on the vertical height or depth of air, is an important property in the atmosphere, and on it depends the explanation of numerous phenomena.

Air being a substance possessing gravity, it must of necessity press downwards in the direction of the centre of the earth, and therefore the degree of pressure on any given point will be equal to the weight of the column of air above the point, and proportional to the density of the air at that point.

The idea of the atmosphere possessing the property of gravity or pressure, is of comparatively modern date. No such notion was entertained by the ancients, in consequence of living animals being observed to move with perfect ease in all directions, and because there was no other appearance in nature calculated to suggest it to their minds.

It was however remarked, that, when the air was sucked out of a small glass tube, the lower end of which was immersed in water, the water rushed up into the tube and occupied the situation of the displaced air. In consequence of this and similar phenomena, it was alleged as a doctrine in physics, that "nature abhors a vacuum."

A vacuum is a place destitute of air or any other kind of matter; and the notion was, that whenever by any chance such an empty space was found, nature interposed with all imaginable haste to fill it. With this very rude idea, pumps were formed to raise water, the rising of the water in these instruments being ascribed simply to nature's abhorrence of a vacuum. At length it was discovered that water could not be drawn up by a pump above a height of about thirty-two feet, and that a vacuum above that elevation remained unfilled; whereupon the terms of the doctrine were changed, and it was said that nature abhorred a vacuum only to a height of thirty-two feet, but no farther.

This explanation was seemingly unphilosophical, and men's minds being carefully turned to the subject, various experiments were performed, and the important truth became manifest, that the atmosphere possessed gravity or pressure; also, that that pressure was the sole cause of the rushing of liquids into tubes exhausted of air—the height of the ascending liquids being in every case limited by the degree of pressure of the incumbent atmosphere. Thus the discovery of a simple truth in science at once abolished the fantastic doctrine of nature's abhorrence of vacuum, and all the laboured sophistry with which it was supported.* Nature has no dislike to a vacuum; a vacuum will occur in all situations from which solids or fluids are accidentally or artificially excluded.

The degree of pressure imposed by the atmosphere on any given spot on the earth's surface, as already noticed, is equal to the weight of the column of air above that spot, and is also proportional to the density of the air at the place. The atmosphere is deepest or of greatest vertical height at the level of the ocean, and there it exerts the greatest pressure. The pressure of the air at the level of the sea is usually reckoned to be about 15 pounds on every square inch.*

The pressure of 15 lbs. to the square inch refers to every shape of surface at or near the sea's level. The pressure is sideways, upwards, oblique, and in every other direction, as well as downward, because fluids press equally in all directions. Thus, in every crevice, nook, or vessel, in which air happens to be, the pressure is equally intense. The human being, for example, sustains the pressure of 15 lbs. to the square inch all over his person, and this is a load under which he could not possibly move,† unless the pressure was also exerted in the interior of his body, or through his whole system of muscles, viscera, and bones, by which means the external pressure is counteracted, and he feels no pressure whatever.

If, however, the air by any means be withdrawn from the interior of any object, that object becomes immediately susceptible of the external atmospheric pressure. There are many familiar examples of this pressure around us. One of the most common consists in causing a thimble to adhere to the hand by sucking the air from beneath it: the adhesion is the result of the pressure of the atmosphere on the exhausted space on the hand. Another consists in lifting a stone by means of a sucker, formed of a string and a wetted piece of leather, as in the accompanying figure. The wetted leather is in this case pressed down upon the stone, and the string is then pulled: if air were admitted under the end of the string, the sucker would come off; but none being admitted, the atmosphere presses on the sucker, a rigid adhesion of the sucker to the stone is produced, and the stone, if not too heavy, is lifted.


Fig. 18.

The surgical process of cupping is upon the same principle. A glass cup is held with its mouth near the part to be operated on, and the air being consumed within it by a lighted taper, it is instantly applied, and adheres with great force. The part having been previously lanced, the blood, rushing to fill the vacuum, enters the cup in copious small streams. The feeling endured in cupping is that of considerable weight.

The feet of flies and some other insects are formed on the principle of the sucker, by which means they are enabled to walk and run with security on the ceiling of an apartment, back downwards, or on an upright and smooth pane of glass. At each step in advance, they procure a hold by the formation of a vacuum or air-tight space beneath their feet. The rapidity with which these vacuums or air-tightnesses are formed and destroyed, is an exceedingly interesting phenomenon in the economy of the animal, and cannot be rivalled by the utmost efforts of human skill. On a very moderate computation, a fly, in travelling six feet in the space of a minute, creates and destroys as many as 10,000 vacuums. When deprived

* This great discovery in physical science was made by Torricelli, an eminent Italian mathematician, about the year 1644. It was suggested by an ineffectual attempt to raise water from a deep well near Florence, by means of a pump of a greater height than thirty-two feet.

* The actual pressure varies from 14 lbs. to 15 lbs. according to circumstances. By various authorities it is stated at 14⅞ lbs. For convenience, we state it throughout in the text at 15 lbs.

† The body of a man has a surface of 2000 square inches, and therefore the pressure upon him is equal to 30,000 lbs.

of the outer extremities of its legs, on which the apparatus for adhesion is situated, a fly can walk without any apparent difficulty on a horizontal surface, such as a table, but is quite incapable of adhering to the roof, or of climbing any upright surface.

Limpets, snails, and some other crustaceous animals, adhere to rocks and stones, by causing a vacuum within their shells, which they accomplish by shrinking into a smaller bulk; by this simple contrivance, nature has effectually provided for their safe adhesion to their appropriate places of residence.

THE AIR-PUMP.

Air may be artificially withdrawn from a containing vessel by means of an apparatus called the air-pump. This apparatus is usually small, for standing on a table, and consists chiefly of a glass jar called a receiver, placed mouth downwards over a flat surface, and with a small brass pump to draw the air from it. The annexed cut, fig. 19, represents an outline section of an air-pump, the working of which may be described. R is the glass receiver standing on a flat and smooth plate SS, and fitting so exactly that no air can penetrate between the edges of the receiver and the plate. In the plate SS, there is a channel A B issuing into the barrel of a pump. P is the piston of the pump, with its rod C above, which is moved upwards and downwards by a handle and winch. The rod C works in a tight collar D. At the bottom of the pump there is a valve V, by which the air escapes, and is prevented from again entering. On depressing the piston, a portion of the contained air is expelled by the valve, and on raising the piston again to its position at the top, another column of air is admitted from the receiver into the pump, which is expelled in its turn. Thus, by a process of expulsion, the air in the receiver becomes at every stroke downwards more rare, till at length a vacuum sufficient for all practical purposes is established. The valve V, which opens outwards, is kept forcibly shut at every rising of the piston by external pressure of the atmosphere.

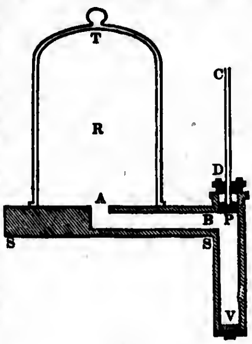


Fig. 19.

By means of the air-pump, a number of interesting experiments in pneumatics may be performed. For example, if a bladder half full of air, and tightly tied at the neck, be placed under the receiver, and a vacuum then produced, the air in the bladder will expand by the removal of the external pressure, and seem as if ready to burst. Dried raisins, during a similar operation, will expand, and have all the pulpness of new fruit; and an egg, by the expansion of its confined air, will explode. Any small animals, such as mice, placed below the receiver and deprived of air, will immediately die, both from want of breath and the expansion of their bodies.

The atmosphere serves to retard the falling of bodies of a light and porous nature; and, therefore, in the exhausted receiver of an air-pump, all such bodies descend with the same velocity as bodies of a heavy compact nature. A piece of coin and a feather let fall at the same instant of time, from a hook within the top of an exhausted receiver, will strike the bottom at the same moment.

That atmospheric air is useful for the transmission of sound, in the absence of other media, is also exemplified by the air-pump. If we place a small bell in a receiver, in such a manner as to admit of being rung easily from the outside without admitting air into the inside, whilst the receiver is full of air the sound of the bell will be distinctly heard; but after the receiver has been exhausted, and although the bell be struck with the same force, the sound will be inaudible, or nearly so. If a small portion of air be admitted, it will be faintly heard, and it will gradually increase according to the quantity of air which is allowed to enter the receiver. Thus, we are indebted to the air as a medium for conveying to us the sound of each other's voices, and all the melodious notes which constitute music.

The act of inspiring and expiring air resembles the alternating action of an air-pump. The air, on being drawn in through the appropriate tubes, fills the lungs, and the chest is expanded; having performed its office, the air is expelled in an impure condition, leaving a partial vacuum within, until another inspiration causes another expansion.

A machine called a condensing pump or syringe, is formed for the purpose of showing experiments with air more dense than that of the common atmosphere. The apparatus, which is represented in fig. 20, consists of a close glass jar or receiver fixed in a frame. A wire and hook serve to communicate with the interior during the performance of experiments. The syringe *i* is wrought by the piston with the handle *k*. From the bottom of the syringe there is a tube communicating with the interior of the receiver. When the piston is raised, a valve beneath opening inwards, admits air into the cylinder of the syringe, and when it is depressed, this quantity of air is forced into the receiver; by the alternate raising and depressing of the piston, an immense quantity of air is forced into the receiver.

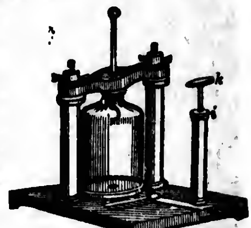


Fig. 20.

The elastic force of air so condensed is very great, and is employed for the projection of balls from an instrument called an air-gun. A certain quantity of compressed air is confined in a chamber at the inner end of the barrel, and when allowed to escape by touching a valve, a bullet is projected with a force resembling that of gunpowder.

The explosive force of gunpowder itself is nothing else than the sudden disengagement of air from the particles of the powder.

PRESSURE OF AIR ON SOLIDS AND LIQUIDS.

The pressure of the atmosphere affects all liquids as well as solid bodies. The load of the incumbent air is as sensibly exerted *within* any given mass of water as on the surface. Thus atmospheric pressure keeps water and other liquids at the density they are usually seen to possess.

If a glass be filled with water, and placed under the receiver of an air-pump, the abstraction of the air, by the removal of the atmospheric pressure, will cause the water to expand or become less dense, and it will overflow the vessel in which it is contained.

Water in its ordinary condition contains a certain quantity of particles of air mixed up with it. When the atmospheric pressure is lightened, these particles of air expand, and being of a less specific gravity than water, they mount to the top of the liquid in the form of small globules, and so fly off. The same effect is produced by expanding water by means of heat; the globules of air rise to the surface, and escape or remain attached to the inside of the vessel. Crystal bottles of water may be observed to be covered inside with small air-bells when the weather becomes suddenly light or warm. Water which has been boiled is comparatively free of air, and has an insipid flavour.

Certain gases are generated in some liquors, such as in porter, beer, and champagne wine, and unless the bottles in which they are contained be of sufficient strength to endure the expansive tendency, they will burst. On drawing the cork from a bottle of one of these liquors, the confined gas or air is suffered to expand, and the contents gush forth, a mixture of froth, and liquid. If the liquid remain in an open glass for a short time, a large portion of the long-confined gases escapes into the atmosphere, and the liquor seems flat or dead. A portion of confined air, however, still remains, in consequence of the atmospheric pressure. If we take a glass of ginger-beer which seems quite dead, and place it under the exhausted receiver of an air-pump, it will again froth and appear brisk.

Some mineral waters on springing from the ground sparkle like beer. These most likely rise from great depths, where the incumbent pressure is considerable, and on attaining the surface of the earth they expand, and give forth the air pent up in their mass.

If a bladder full of air be carried from a low situation to a great height, the contained air will expand, and the bladder will burst, the same as if placed under the exhausted receiver of an air-pump.

If a bladder be filled with air at a great height, where the fluid is rare, and brought to a low situation, the contained air will be compressed by the more dense fluid without, and the bladder will appear as if only half or partially filled.

The fluids in the animal and vegetable system are similarly affected by atmospheric pressure. Our bodies, for instance, would expand, and our blood-vessels probably be ruptured, if placed for a short time in a vacuum. On the same principle, any change in the density of the atmosphere has an effect on the animal frame.

The atmospheric pressure, in ordinary conditions of the air, and at the level of the sea, as already stated, is equal to 15 lbs. to the square inch. If by any means, such as digging into the earth, we should go below the sea's level, the weight will be found to increase. In deep coal mines, for instance, the pressure of the atmosphere is something more than 15 lbs. to the square inch.

The pressure diminishes in a similar degree as we ascend into the atmosphere. At every step upwards from the shore the burden of the superincumbent mass lightens. At the height of three miles, one-half of the weight is lost; or, in other words, at that height the air is only half the density of air at the sea's level.

The breathing apparatus of animals is suited to an atmospheric density and pressure such as is found at the sea's level, or at a moderate elevation above it. By ascending in the atmosphere, as in climbing hills, we are deprived of the quantity of air to which we have been accustomed; and when we reach a height of three miles, we in reality inhale only one-half of the weight of air into the lungs that we use at the sea's level. Consequently, those who ascend to great elevations experience difficulty in breathing, and feel an expansion in their blood-vessels and muscles by the removal of a portion of the ordinary pressure.* All the joints in our bodies, particularly those of the knee and shoulder, are in a great measure held together by the external pressure of the atmosphere; and thus a principle in pneumatics compensates for a loading of muscular ligaments.

A consideration of the effects of atmospheric pressure, and its variability at different elevations, also the alterations in pressure caused by the expansion or lightening of the air by heat, and its increased density by cold and moisture, tends to explain the remarkable influence which change of climate has upon the human constitution. Thus, the inhabitants of countries possessing a light dry atmosphere are usually more lively than those of countries with a heavy moist climate.

PRESSURE ON MERCURY—THE BAROMETER.

The pressure of the atmospheric column at any given point, may be weighed with considerable exactness, by balancing it against an opposite column of mercury, water, or other liquid.

The pressure of 15 lbs. to the square inch at the ocean's level is found by experiment to be equal to the weight of a column of mercury of 30 inches in height, a column of water 33 feet in height, or a column of oil 37 feet in height. In other words, the burden of the whole of our atmosphere is equivalent to an ocean of mercury covering the earth to a height of 30 inches, an ocean of water to a height of 33 feet, or an ocean of oil to a height of 37 feet.

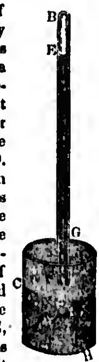


Fig. 21.

The fact of such being the degree of atmospheric pressure admits of easy proof, by means of a glass tube upwards of thirty-two inches in length, and a cup half filled with mercury, as represented in fig. 21. The tube is close at its upper end at B, but open at its lower extremity, which is immersed in the mercury below the surface level C P D. The tube having in the first place been filled with pure mercury, a finger is placed on its open end to prevent the egress of the liquid, and thus held, the lower end of the tube is turned downwards, and plunged into the vessel of mercury, when the finger is removed from the orifice. The mercury in the tube will now be observed to fall to E, or the height of about thirty inches above the surface C P D, and there it will remain.

The question now arises, Why the mercury in the tube does not run out altogether into the cup, instead of standing to the height of thirty inches in the tube? The explanation of the phenomenon is, that from E to B in the tube is a vacuum, and therefore the mercury at its upper extremity is entirely free of atmospheric pressure—there is no superincumbent weight to push it out. The column of mercury E P presses with nothing but its own weight on the mercury of the cup. This weight of thirty inches of mercury is counterbalanced by the pressure of air on the surface of the mercury in the cup; and thus it is evident that the weight of the atmosphere is equivalent to the weight of thirty inches of mercury. If by any means we remove the atmospheric pressure from the mercury in the cup, the mercury in the tube will immediately sink into the cup.

The circumstance of the column of mercury in the tube being narrow, and the surface of the mercury in the cup being broad, makes no difference in the experi-

* It is known that travellers, and even their practised guides, often fall down suddenly as if struck by lightning, when approaching lofty summits, on account chiefly of the thinness of the air which they are breathing, and some minutes elapse before they recover. In the elevated plains of South America, the inhabitants have larger chests than the inhabitants of the lower regions—another admirable instance of the animal frame adapting itself to the circumstances in which it is placed.—*Arnott's Physics.*

ment, because the pressure of elastic fluids is as their density, not as width of volume. The same result would occur if the surface of the mercury presented to the atmospheric pressure were only the width of the tube.

The height at which mercury stands in a tube of this kind, always bears reference to the incumbent weight of the atmosphere on the open and lower extremity of the column. If we increase the external pressure by artificial means, or by descending below the sea's level, the mercury rises; if we decrease it by artificial means, or by ascending into the atmosphere, or if the atmosphere is rarefied by heat, the mercury falls.

This very obvious connection between the rising and falling of mercury in a tube, and the atmosphere, has suggested the construction of an instrument called the *barometer* (a word from the Greek, signifying *weight* and *measure*), by which the effects of atmospheric pressure may be accurately known.

The barometer in common use consists of a narrow glass tube upwards of thirty inches in length, and bent upwards at its lower extremity, as represented in fig. 22. The mercury is introduced into the tube with great care, so that a perfect vacuum exists at the upper extremity. The surface of the mercury in the bent part is open to the action of the atmosphere, and buoys up a small plummet or float, F, to which a thread is attached; the thread proceeds upwards to a small pulley, G, over which it goes, and terminates in a small ball, W. The friction of the thread on the pulley turns a small index, H, which points to figures on the surrounding dial. Commonly, the whole apparatus, except the dial-plate, is concealed in an ornamental frame.

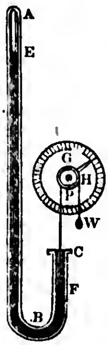


Fig. 22.

Barometers of this description are adjusted in such a manner that the smallest rising or falling of the mercury from atmospheric action affects the index on the dial, and shows the degree of pressure.

In common circumstances, the mercury ranges from 29 to 30 inches. It seldom sinks so low as 28, or rises to 31. When it falls, an indication is given of diminished pressure, and as diminished pressure causes the air to expand, and consequently to be sensibly cooled, moisture is liable to be precipitated in the form of rain. Hence a fall in the mercury of the barometer is considered a prognostic of rain or wet weather, and a rise the reverse. The dial of the barometer is marked accordingly.

The barometer, besides being a weather-glass, is used as an instrument for measuring the heights of mountains, or heights attained in balloons, above the level of the sea.

As the entire atmosphere sustains thirty inches of mercury in the tube, it follows that at every step as we ascend, the pressure will become less, and a less body of mercury be sustained. It is found that at the height of five hundred feet the mercury has sunk half an inch. But the fall does not proceed in this ratio as we go upwards, because a half of the whole atmosphere is within about three miles, and the other half expanded to an altitude of about fifty miles. Hence, on gaining a height of three miles, the mercury is found to have sunk to fifteen inches, or one half; and on gaining a height of four miles, to twelve inches.

Barometers for measuring heights are constructed with a determined scale, marked along the tube of mercury, and by consulting it as we ascend, we learn the height of any spot that we may reach. Perfect exactness, however, is not to be expected in this mode of measurement, because the atmospheric pressure is liable to variation from temperature, and the mercury is liable to contraction or expansion from the same cause. To guard against error, a thermometer, as well as a barometer, is consulted in ascending heights, and the indications of both instruments, according to a scale established by experiment, determine the degree of elevation. Thus, for a diminution of one degree of temperature between 0 and 32 degrees, the mercury in the barometer falls 0·0034 of an inch, and between 32 degrees and 52 degrees it rises 0.0033 of an inch

PRESSURE ON WATER—PUMPS.

The effect of atmospheric pressure on water is observable in various contrivances in the arts.

Fill a glass to the brim with water, and lay a piece of paper over the whole surface of the liquid: then turn the glass carefully upside down, holding on the paper by the hand; the water will now remain in the glass, being upheld by the pressure of the atmosphere against the paper.

Glass fountains of water for bird-cages, ink-holders, and reservoirs of oil for lamps, are constructed on the principle of the liquid being upheld by atmospheric pressure.

The apparatus for lifting water from wells, forming the common sucking-pump, acts on the principle of removing the atmospheric pressure from a column of the liquid, thus causing a vacuum in the pump, and allowing the atmospheric pressure on the surface of the liquid in the well to force up and balance the column of liquid.

Fig. 23 represents the outline of a common sucking-pump; it consists of a cylinder, furnished with a piston A made to fit air-tight. In this piston there is a valve opening upwards, not seen in the cut. When the piston is raised, the air is rarefied more and more at each stroke in that portion of the cylinder through which it has moved upwards, and the pressure of the air upon the surface of the water on the outside of the tube forces the fluid into it. The valve B is at the same time opened upwards, and the water after several strokes rushes in above it. When the upward stroke of the piston is complete, it is again depressed—the water passes through the valve in the piston, and on the next stroke, it is discharged at the spout. It is evident, that, when the piston is sunk downwards, the water cannot be again forced out of the pump, because the valve at the bottom is pressed down, and prevents its escape.

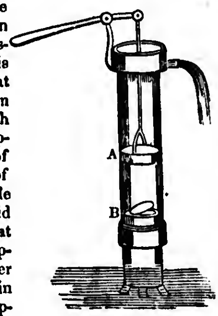


Fig. 23.

Water may in this manner be lifted by a pump to any height, but in each case the lower or fixed valve in the pump must be less than 34 feet from the surface of the water. It is, however, disadvantageous to lift water from great depths by this means. In such cases it is usual to employ a succession of pumps, one above another.

It is customary to call pumps hydraulic machines; properly speaking, they are both hydraulic and pneumatic machines, for water is raised by them in a great measure through the agency of atmospheric pressure.

The form of pump used for forcing water to a height above the ground, as in the case of fire-engines or portable forcing-pumps for gardens, is different from the common suction-pump. The object in the forcing pump is to lift water to a certain height by the formation of a vacuum, and then to inject it with violence into the air.

The action of the forcing-pump apparatus is represented in fig. 24. The piston A sucks the water by its upward motion; but on depressing it, the valve B is closed, and the water is consequently forced through the pipe C.

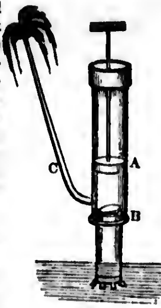


Fig. 24.

In the case of supplying water to the boiler of a steam-engine, it is necessary to employ a forcing-pump, in order to overcome the pressure of steam within the boiler. The force with which the water is injected overcomes the tendency which the steam has to rush out.

Cold or moderately warm water can only be lifted by a pump. If the water be above a certain temperature, about 150 degrees at the utmost, the sucker cannot form a perfect vacuum, because, in the attempt to do so, the water yields a steam or vapour which fills the space; in other words, by removing the atmospheric pressure by the piston, the water begins to vaporize as if about to boil. When a pump is made to operate upon hot water, it labours in vain to raise the liquid. This circumstance limits the heat of water injected into the boilers of steam-engines; or if the water is injected at a high temperature, it must receive its heat between the pump and the boiler. This is sometimes done, by causing the tube from the pump to pass through a vessel of waste steam.

SYPHONS.

Atmospheric pressure is very conspicuous in the case of the syphon.

A syphon is a tube bent in a particular manner, and is used for drawing off liquors from casks, or water from reservoirs. One kind of syphon is represented in fig. 25, and consists of a tube bent into two equal limbs, each open at the extremity. If such a syphon be filled with water and inverted, so as to turn the two orifices downwards, the liquid will not run out, but remain suspended in the tube, because the pressure of the column of water within is not so great as the pressure of the air without, and thus its escape outwards is prevented. If one end be put into a vessel of water, the vessel will be emptied down to a level with the orifice. It is evident that, when one end of the syphon is inserted in water, the pressure of the atmosphere upon the surface of the water impels the liquid through the tube, and it could be forced upwards to an elevation of above thirty feet, or the height to which water rises in a vacuum. The diagram represents an instrument of this kind furnished with two cups, firmly attached to the ends, which, by retaining a portion of the liquid, keeps the syphon always full and ready for use.


Fig. 25.

Syphons are more commonly made with a long and short limb, as in fig. 26. On inserting the short limb into a vessel of liquid, and drawing the air out of the tube at the mouth A, the liquid will rush out in a stream, and continue flowing till the vessel is emptied. The pressure upwards into the tube at A is the excess of the atmospheric pressure above the vertical pressure of the column of fluid A B; and the similar pressure at C is the excess of the atmospheric pressure above the vertical pressure of the column of fluid B C; but the latter excess is evidently the greater, and hence the liquid in the vessel is necessarily forced upwards through the tube from C to B; and thus the vessel is drained of its contents. By placing a stopcock on the tube above A, the stream can be checked, and permitted to flow at pleasure. There are instances of towns being supplied with water by means of large syphons of this kind. In these cases the syphon is brought over a rising ground from a lake or fountain at some distance. Certain kinds of springs are accounted for on the principle of the syphon; they act from the combined effects of a vacuum and atmospheric pressure.

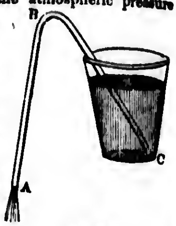


Fig. 26.

APPLICATION OF HEAT TO WATER.

The pressure of the atmosphere affects the boiling of water. At the common pressure of about 15 lbs. to the square inch, water will boil, or attain the vaporific point, at 212 degrees Fahrenheit. If we remove the atmospheric pressure by an air-pump, as is done in the boiling of sugar, we can produce the phenomenon of boiling at a much lower temperature. At the summit of Mont Blanc, where the atmospheric pressure is light, water is found to boil at 187 degrees.

Steam produced from boiling water is a transparent, colourless, and invisible substance, like air. If we could look into the boiler of a steam-engine, we should see nothing but the water in a state of ebullition. The white cloudy-looking matter which is emitted in the form of vapour, is moisture produced by the partial condensation of the steam in the atmosphere—taking the form of vapour is a step towards becoming liquid again.

A cubic inch of water produces exactly a cubic foot, or 1728 cubic inches, of steam, at 212 degrees of temperature; in other words, when water is transformed into steam, it occupies 1728 times its former bulk. In this expanded condition steam is of a less specific gravity than air. Its density is expressed by 0·625, that of air being 1.

The elastic force of steam in the process of heating—that is, the force with which it seeks to expand—differs at different temperatures; at first the force is inconsiderable, but it rapidly increases as the temperature is raised. At a temperature of 212 degrees, the elastic force is 15 lbs. on the square inch of the containing vessel, or equal to the external pressure of the atmosphere; at 250 degrees, it is 30 lbs.; at 272 degrees, it is 45 lbs.; at 290 degrees, it is 66 lbs.

BUOYANT PROPERTY OF AERIFORM FLUIDS.

The atmosphere, as has been stated, possesses the property of buoying up bodies which, bulk for bulk, are lighter than itself. The law governing buoyancy in liquids is precisely the same as that governing buoyancy in aëriform fluids, and may here be repeated in reference to air.

1st. Any solid body immersed in a fluid displaces exactly its own bulk of fluid, and the force with which the body is buoyed up is equal to the weigh of the fluid which is displaced. This refers to bodies of less density than air. 2d. Any solid body of a greater density than air, when wholly immersed in that fluid, loses exactly as much of its weight as the weight of an equal bulk of air—that is, of the air which it displaces.

The support afforded to bodies in the atmospheric fluid by its resistance is very evident from many appearances in nature, as the support of vapours or clouds, the rising of smoke and fine particles of dust, and the flying of birds; in art, it is exemplified by the flying of a boy's paper kite, the rising of soap-bubbles, and its buoyant property by the floating of balloons.

The flight of birds is not accomplished altogether by the buoyant property in the air. These animals support themselves by striking their wings against the fluid through which they are passing; and this friction, along with the property of buoyancy in the atmosphere, sustains them at any height to which they are pleased to ascend. Birds do not generally fly above half a mile in height, and seldom above a few hundred yards. At considerable elevations the air is so specifically light as to be unsuitable for their easy support. Those which rise to the higher regions of the atmosphere, as for instance the eagle, are provided with large wings, which enable them to support themselves in the comparatively thin fluid in which they move.

The light heated air which escapes from a fire, ascends, and is buoyed up by the more dense air beneath. Hydrogen, or any other gas of a less specific gravity than air, in the same manner ascends and floats in the atmosphere at the height at which it finds air of its own specific gravity. On the same principle, if heated air or any light gas be enclosed in a large silk bag, it will ascend in the atmosphere till it reach a region of air which is incapable of supporting it. Thus, a soap-bubble enclosing warm air readily ascends to the ceiling of an apartment. If the bubble be made with cold water, it will sink instead of rising.

A balloon is a bag made of fine varnished silk, and of such a magnitude that the difference betwixt the weight of its contents and that of the displaced air is sufficient to support the weight of the silk and the other parts of the apparatus. Balloons were originally made to rise by being filled with heated air from a fire hung beneath them; but this dangerous and inconvenient practice was in course of time superseded by the use of hydrogen gas, one of the lightest airs which can be prepared. Hydrogen gas has latterly been succeeded by carbureted hydrogen, which, though not so light, is more easily obtained, being the gas with which towns are now generally lighted. Employing a moderately pure and light gas, the contents of a balloon may be estimated to weigh only an eighth of the weight of the atmosphere, bulk for bulk; and hence, after adding another eighth for weight of apparatus, it will ascend with a force of six-eighths; in other words, if the gas and apparatus weigh two pounds, the balloon will lift from the ground a weight of other six pounds. The force with which a balloon will ascend is therefore to be calculated by measuring its capacity in cubic feet, and comparing the result with an equal bulk of atmospheric air: the difference of weight is the buoyant force of the balloon.

Of aërostation, or the art of moving through the air in balloons, great expectations were originally entertained; but the experience of half a century has proved that it is of no practical value. Its only use is the exhibition of an interesting principle in pneumatics. A balloon constructed in the best known manner, and moving upwards with a powerful force, is subject to the following drawbacks:—as the balloon ascends, its contents expand in consequence of the increasing rarefaction of the atmosphere; if, therefore, it has been entirely filled when on the ground, a portion of the gas must be allowed to escape as it rises, otherwise it will burst. Discharges of ballast are also required in consequence of the absorption of moisture from clouds; and there being no means of recovering the lost ballast, the balloon, on the return of heat, rapidly rises in the air, its contents expanding in the ascent, and rendering further liberations of gas necessary to prevent explosion. These alternations continuing to operate more or less frequently, it is evident that they must soon put an end to the buoyant power, however great originally, and, along with the contending effects of winds, forcibly terminate the excursion through the air.

[WORKS ON HYDROSTATICS, HYDRAULICS, AND PNEUMATICS.

The writers we shall refer to, independently of those who treat on every branch of natural philosophy in conjunction, are as follows:

"Hydrostatical and Pneumatical Lectures, by Roger Cotes, A. M." This work was published after the death of the author, by Dr. Smith; it possesses great merit, and will, so long as science lasts, be esteemed very highly by its votaries. The early death of Mr. Cotes, at the age of thirty-three, was deplored by mathematicians as a public calamity. Sir Isaac Newton asserted that, had his life been spared, he would have proved one of the greatest men that ever lived. "If Mr. Cotes had lived," said this illustrious philosopher, "we should have known something."

"The Principles of Hydrostatics, for the use of the Students in the University of Cambridge, by the Rev. Dr. Vince," includes the fundamental principles of Pneumatics and Acoustics; and, independently of an account of the instruments illustrative of Hydrostatics, he has given full descriptions of the air-pump and condenser; the thermometer, hygrometer, and pyrometer. There is also a section devoted to the subjects of winds, vapours, and the formation of springs.

Ewbank's "*Mechanics and Hydraulics*" is most thorough and satisfactory on the history of Hydraulics, with the application of the science to the common arts of life. It is very richly embellished with engravings illustrating hydraulic machinery and implements both ancient and modern.

Adams's "Lectures on Natural Philosophy" contains a great number of experiments in pneumatics, with numerous engravings illustrating the apparatus employed in the experiments.

The apparatus employed in Pneumatics is manufactured in great perfection by Mason, of Philadelphia, and Claxton, of Boston.—*Am. Ed.*]

OPTICS—LIGHT—ACOUSTICS.

OPTICS—LIGHT.

The term *Optics* is derived from a Greek word which signifies *seeing*, and applies to that branch of natural philosophy which treats of the phenomena of *light* and *vision*. Of the precise character of light, there are various theories, but none which admits of actual demonstration or proof. By some it has been described as consisting of very minute particles, which are thrown off from what are called luminous bodies in all directions, and with immense velocity; while others consider it as the effect of an undulation or vibration produced by luminous bodies in the thin and elastic medium which is interposed between them and the seat of our vision; this vibration producing an effect upon our organs, which we recognise as light, in a manner analogous to the impression of sound on the ear, caused by vibrations of the atmosphere. This theory is called the *undulatory* theory of light; and the former theory, in which light is supposed to consist of *material* particles, is called the theory of *emission*. Whatever may be the cause or absolute nature of light, we know it is a remarkable property of luminous bodies, that it enables us to see the luminous objects themselves, as well as others, and that its absence produces darkness.

All visible bodies may be divided into two classes—*self-luminous* and *non-luminous*. Under the first head are comprised all those bodies which possess in themselves the property of exciting the sensation of light or vision, such as the heavenly luminaries, terrestrial flames of all kinds, phosphorescent bodies, and those bodies which shine by being heated or by friction. Under the second class we recognise such bodies as have not of themselves the power of throwing off particles or undulations of light, but which possess the property of reflecting the light which is cast upon them from self-luminous bodies. A non-luminous body may thus, by reflection, receive light from another non-luminous body, and communicate it to a third, and so on. All reflected light, however, is inferior in point of brilliancy to that which comes direct from a self-luminous body.

Anciently, it was believed that light was propagated from the sun, and other luminous bodies, instantaneously; but the observations of modern inquirers have shown that this was an erroneous hypothesis, and that light, like sound, requires a certain time to pass from one part of space to another, though the velocity of its motion is truly astonishing, as has been manifested in various ways. Astronomers have proved, by observing the eclipses of Jupiter's satellites, when that planet is nearest and when it is farthest from the earth, that light moves from the sun to the earth, a distance of 95,000,000 of miles, in seven and a half minutes, or about 200,000 miles during a single vibration of the pendulum. So prodigiously great is this velocity, that, as far as any common observation is concerned, light may be said to be perfectly instantaneous in its universal action.

Light proceeds in a straight direction from the luminous body which produces it, towards the part or situation against which it is permitted to act. In consequence of this directness, a shadow or darkened spot is observable behind any opaque object presented to the light. During night, we are in the earth's shadow, and this shadow reaches so far beyond us into space, that when the moon plunges into it in her course, she undergoes an eclipse. The direct shining of the sun, or any other luminous body, is in the form of *rays*, or thin ethereal lines, each acting independently of the other; no such separation of parts, however, is observable, in common circumstances, in consequence of the diffusive properties of our atmosphere. Seeing is simply the reception of the direct or reflected ray from an object by our eye. Until the rays of the sun reach the spot on which we are placed, we are neither conscious of light nor of the presence of the sun as an object. In the same manner, a candle being lighted and exposed in the open country in a dark night, all who are able to see it are within the influence of its rays; but beyond a given distance these rays are too weak to produce vision, and all who are in this remote situation cannot see the smallest appearance of the candle. It will therefore be understood, that the seeing of any luminous object is equivalent to being within the influence of rays of sufficient intensity proceeding from it. The number of rays which proceed from even a common candle is so vast as to be beyond our imagination to conceive; for if such a light is visible within a sphere of four miles, it follows, that if the whole of that space were surrounded with eyes, each eye would receive the impression of a ray of light.

In proportion as light advances from its seat of production, it diminishes in intensity. The ratio of diminution is agreeable to that which governs physical forces, that is, the intensity of the light will diminish as the square of the distance increases, or at the rate of 1, 4, 16, &c. But in proportion as we lose in intensity we gain in volume; the light is the weaker the farther it is from the candle, but it is filling a wider space.

Preliminary to any further exposition of the nature and action of light, we offer the following definitions of terms. Any parcel of rays, passing from a point, is called a *pencil* of rays. By an optical *medium* is meant any pellucid or transparent body, as, for example, air, water, or glass, which suffers light to pass through it. *Parallel rays* are such as move always at the same distance from each other. If rays continually recede from each other, they are said to *diverge*; if they continually approach each other, they are said to *converge*. The point at which converging rays meet is called the *focus*; the point towards which they tend, but which they are prevented from coming to by some obstacle, is called the *imaginary focus*. When rays, after passing through one medium, on entering another medium of different density, are bent out of their former course, and made to change their direction, they are said to be *refracted*; when they strike against a surface, and are sent back again from the surface, they are said to be *reflected*. A *lens* is a glass ground into such a form as to collect or disperse the rays of light which pass through it. These are of different shapes, and thence receive different names. The following figures individually represent sections of the variously shaped lenses and other glasses used in optics.

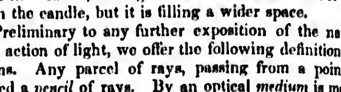


Fig. 1.

A is a triangular stalk of pure glass, of which we have here a cross sectional or end view, and which is called a *prism*. Each side of the prism is smooth. B is a section of a piece of plane glass, with sides parallel to each other. C is a sphere or ball of glass, and consequently is convex on all parts of its surface. D is a piece of glass convex or bulging on its two sides, and is called a *double convex lens.* It is this kind of lens which is used for magnifying objects, in spectacles, telescopes, and other instruments. E is a *plano-convex lens*, flat on one side ano convex on the other. F is a *double concave lens*, a glass hollowed on each side. G is a *plano-concave lens*, or planed on one side and concave on the other. H is a *meniscus*, or lens convex on one side and concave on the other, both surfaces meeting, and of which we have an example in watch-glasses. I is an example of the *concavo-convex* lens, in which the surfaces disagree, or do not meet when continued. In all these lenses, an imaginary line, represented by M G N, and passing through the centres of the surfaces, is called the *axis*. Thus, the line said to pass through the centre of any lens, in a direction perpendicular to its surface, is called its axis.

In treatises on optics, it is customary to divide the subject into two sections, under the heads Dioptrics and Catoptrics. The term *dioptrics* is compounded of two Greek words signifying to *see through*, and refers to the transmission of rays of light through transparent bodies, as well as the laws by which they are produced. *Catoptrics* is a term also from the Greek, and signifies to *see from* or *against*; it refers to the reflection of light from surfaces, and the formation of images by means of mirrors and other objects.

REFRACTION OF LIGHT.

Refraction, as already mentioned, is the bending of rays of light from the course they formerly pursued. If the rays, after passing through a medium, enter another of a different density, perpendicular to its surface, they are not refracted, but proceed through this medium in their original direction. For instance, if the sun's rays were to strike upon the surface of a river at right angles, or perpendicularly, to its surface, they would go straight to the bottom, and the line they observed in the air would be continued in the water. But if they enter obliquely to the surface of a medium either denser or more rare than what they moved in before, they are made to change their direction in passing through that medium; in other words, they are refracted.

The mode of the refraction depends on the comparative density or rarity of the respective media. If the medium which the rays enter be denser, they move through it in a direction nearer to the perpendicular drawn to its surface. On the contrary, when light passes out of a denser into a rarer medium, it moves in a direction farther from the perpendicular. This refraction is greater or less, that is, the rays are more or less bent, or turned aside from their course, as the second medium through which they pass is more or less dense than the first. To prove this in a satisfactory way, take an upright empty vessel into a darkened room, which admits but a single beam of light obliquely through a hole in a window-shutter. Let the empty vessel stand on the floor, a few feet in advance of the window which admits the light, and let it be so arranged that, as the beam of light descends towards the floor, it just passes over the top of the side of the vessel next the window, and strikes the bottom on the side farthest from the window. Let the spot where it falls be marked. Now, on filling the vessel with water, the ray, instead of striking the original spot, will fall considerably nearer the side towards the window. And if we add a quantity of salt to the vessel of water, so as to form a dense solution, the point where the ray strikes the bottom will move still nearer to the window. In like manner, if we draw off the salt water, and supply its place with alcohol, the beam of light will be still more highly refracted; and oil will refract yet more than alcohol

The property of refraction may also be observable in the following experiment. Let the annexed oblong figure represent a vessel half filled with water, and R the ray of light which may be expected to pass through

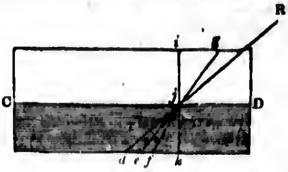


Fig. 2.

it to the bottom at *d*. The direction of the ray is perfectly straight until it enters the water at *j*, when, instead of proceeding in a straight line to *d*, it is bent from its course and compelled to strike the bottom of the vessel at *e*. If oil instead of water had been used, the ray would have been still more bent, and have reached the bottom at *f*. If the ray had been sent directly downwards, as from *i* to the surface of the water at *j*, it would not have been refracted, but have proceeded straight to the bottom at *k*.

The following simple experiment is well known:—Take an empty basin and place it on a table, then lay a shilling at the bottom of the basin, in such a position that the eye of the observer will not see it. Now, fill the basin with water, and the shilling, though lying unmoved, will come completely into sight. The explanation of this phenomenon is, that the ray of light producing vision in the eye is bent on emerging from the water, and has all the effect of conveying our sight round a corner.

The refractive power of water is also observable when we thrust a straight stick or instrument into it, on aiming at any object. We see that the stick seems to be bent, and fails in reaching the point which we desired it should. On this account, the aim by a person not directly over a fish must be made at a point apparently below it, otherwise the weapon will miss by flying too high. Persons who spear salmon in rivers require to calculate upon this refractive power in taking their aim.

With regard to the refractive power of transparent substances or media, the general rule, with certain limitations, is, that it is in proportion to the densities of the bodies. It increases, for instance, from the most perfect vacuum which can be formed, through air, fresh water, salt water, glass, and so on. But those substances which contain the most inflammable matter, have the greatest refractive power. It was from the great refractive powers of the diamond and water, that Newton, with admirable sagacity, predicted that they contained inflammable principles. This fact future discoveries in chemistry verified. Tables of the refractive powers of substances most interesting in optics will be found in Brewster's Optics. From these it would appear that substances which contain fluoric acid have the least refractive power, as inflammable ones have the greatest. With regard to the cause of refraction, on the theory of emission, the refracting medium would attract the particles of light, and increase their velocity during their transmission, and would alter the direction of their motion, thus causing refraction but the intensity of the attractive force would require to be different for light of different colours; and on the undulatory theory, the ether within the refracting medium would be condensed by the attraction of its particles on the ether, and the velocity of transmission of the wave of light through this condensed ether would be less than in free space, and, from this cause, the direction of the motion would be altered, or refraction would take place· and from the different lengths of the waves of different colours, the velocity of their transmission would be dif ferent, thus causing different degrees of refrangibility according to the difference of colour.

The refraction of rays of light is observable in the case of common window-glass. The two sides of a pane not being perfectly parallel to each other, bodies seen through it appear as if distorted; and as the obliquities in the glass are very various, the distortions are equally grotesque and numerous. Some windows are purposely ground on the surface, to produce universal and minute refraction; and thus so great a confusion is introduced among the rays, that objects are not distinguishable through the glass. When the obliquities on the surface of one side of a piece of glass stand distinct from each other, so as to admit of refraction in a clear and distinguishable manner, then each obliquity affords a separate view of an object on the opposite side, and thus an object seems to be multiplied as many times as there are obliquities.

The refraction of light is observable on a great scale in relation to our atmosphere. The rays of the sun, on reaching the confines of the atmospheric fluid which envelops the earth, enter a medium of greater density than that which they have previously been pursuing, and consequently are refracted or bent. One obvious effect of this is, that we never see the sun in the actual position which he occupies. He is always, less or more, in relation to our eyes, what the shilling is said to be in the above experiment with the basin of water. This is peculiarly the case in the morning, when his earliest rays reach our eyes; entering a denser medium, these rays bend round to meet our vision, and we actually see the body of the sun a few minutes before he has risen above the horizon—like the shilling in the basin, we see him round a corner. In proportion as the sun approaches the zenith, the refraction diminishes; and as he recedes towards setting, it increases. So considerable is it in the hazy atmosphere of the evening, that we retain a sight of the sun's disk after it has sunk. The same phenomena occur in relation to the other heavenly luminaries.

From these explanations it will appear that the directness of our vision is at all times liable to be disturbed by atmospheric conditions. So long as the atmosphere betwixt our person and the object we are looking at is of the same density, we may be said to see in a straight line to the object. But if by any cause a portion of that atmosphere is rendered less or more dense, the line of vision is at once refracted or bent from its course. A thorough comprehension of this simple truth in science has banished a mass of superstition. It has been found that, by means of powerful refraction, objects at a great distance, and round the back of a hill, or considerably beneath the horizon, are brought into sight. In some countries, this phenomenon is called the *mirage*. The following is one of the most interesting and best authenticated cases of mirage. In a voyage performed by Captain Scoresby in 1822, he was able to recognise his father's ship, when below the horizon, from the inverted image of it which appeared in the air. "It was," says he, "so well defined, that I could distinguish by a telescope every sail, the general rig of the ship, and its particular character; insomuch that I confidently pronounced it to be my father's ship the *Fame*, which it afterwards proved to be; though, on comparing notes with my father, I found that our relative position at the time gave our distance from one another very nearly thirty miles, being about seventeen miles beyond the horizon, and some leagues beyond the limit of direct vision. I was so struck by the peculiarity of the circumstance, that I mentioned it to the officer of the watch, stating my full conviction that the *Fame* was then cruising in the neighbouring inlet."

A curious phenomenon of this kind was seen by Dr. Vince, on the 6th of August, 1806, at 7 P.M. To an observer at Ramsgate, the tops of the four turrets of Dover Castle are usually seen over a hill between Ramsgate and Dover. Dr. Vince, however, when at Ramsgate, saw the whole of Dover Castle, as if it had been brought over and placed on the Ramsgate side of the hill. The image of the castle was so strong and well defined, that the hill itself did not appear through the image.

In the sandy plains of Egypt, the mirage is seen to great advantage. These plains are often interrupted by small eminences, upon which the inhabitants have built their villages, in order to escape the inundations of the Nile. In the morning and evening, objects are seen in their natural form and position; but when the surface of the sandy ground is heated by the sun, the land seems terminated at a particular distance by a general inundation: the villages which are beyond it appear like so many islands in a great lake, and between each village an inverted image of it is seen.

That the phenomena of the mirage are produced by variations in the refractive power of the atmosphere, can be proved by experiment. If the variation of the refractive power of the air takes place in a horizontal line perpendicular to the line of vision—that is, from right to left—then we have the lateral mirage: that is, an image of a ship may be seen on the right or left hand of the real ship, or on both, if the variation of refractive power is the same on each side of the line of vision. If there should happen at the same time both a vertical and a lateral variation of refractive power in the air, and if the variation should be such as to expand or elongate the object in both directions, then the object would be magnified as if observed through a telescope, and might be seen and recognised at a distance at which it would not otherwise have been visible. If the refractive power, on the contrary, varied so as to contract the object in both directions, the image of it would be diminished as if seen through a concave lens.

In order to represent artificially the effects of the mirage, Dr. Wollaston suggested the viewing of an object through a stratum of spirit of wine lying above water in a crystal jar, or a stratum of water lying above one of syrup. These substances, by their gradual incorporation, produce a refractive power diminishing from the spirit of wine to the water, or from the syrup to the water; so that, by looking through the mixed or intermediate stratum at a word or object held behind the bottle which contains the fluids, an inverted image will be seen. The same effect, it has been shown, may be produced by looking along the side of a red-hot poker at a word or object ten or twelve feet distant. At a distance less than three-eighths of an inch from the line of the poker, an inverted image is seen, and within and without that an erect image.

The method employed by Sir David Brewster to illustrate these phenomena, consists in holding a heated iron above a mass of water bounded by parallel plates of glass; as the heat descends slowly through the fluid, we have a regular variation of density, which gradually diminishes from the bottom to the surface. If we now withdraw the heated iron, and put a cold body in its place, or even allow the air to act alone, the superficial stratum of water will give out its heat, so as to produce a decrease of density from the surface to a certain depth below it. Through the medium thus constituted, the phenomena of the mirage may be seen in the finest manner.

Double Refraction of Light.—In the preceding part of this section, we have considered a single ray of light, reflected or transmitted through the substance of a transparent body, as leaving it in the same way in which it came into contact with it, namely, in a single pencil or ray. But there are a great many bodies which have the power of breaking the pencil of light incident upon their surfaces into two separate parts or pencils, more or less inclined to one another, according to the nature and state of the body, and according to the direction of the inciden pencil. This is called double refraction, and the bodies which produce it are called doubly refracting bodies or crystals. They are very numerous, and include all salts and crystallized minerals not having the primitive forms of the cube, the regular octohedron, and the rhomboidal dodecahedron. Of all known bodies, the Iceland spar, or rhomboidal carbonate of lime, shows the fact with the greatest certainty; and as it is a mineral easily procured, it has been generally used in experiments upon this subject. Its crystals are of a rhomboidal form, having six acute solid angles, and two obtuse. Double refraction of light is employed to advantage in some kinds of light-houses; and those who wish to investigate its nature and properties may be referred to advanced treatises on the subject.

With respect to the *polarization of light*—which is the separation of a ray of light into two rays, having different properties from each other, among which properties is that of producing colour in a variety of ways, although the original ray may be common or white light—we must also refer to works of higher scope than the present.

COLOUR BY REFRACTION.

One of the most remarkable phenomena attending refraction is, that the rays of light which seem to us to be white, may be separated into rays of various colours. It will be obvious that light has the effect of representing colours, where no colour substantially exists, by noticing the glancing and varied hues on irregular surfaces of glass, ice, or other crystallized substances.

The proper method of analyzing the rays of light, and discovering into what colours they may be resolved, is to procure a prism, and perform the following experiment in a darkened chamber:—In the window-shutter E of a

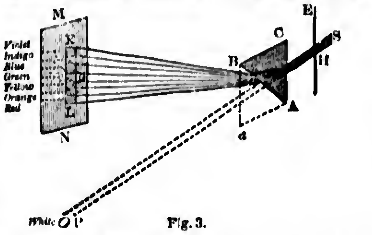


Fig. 3.

darkened room, make a small hole H, through which admit a beam of the sun's light S, which, when nothing is interposed, will proceed in a straight line to P, and form a luminous white spot. If we now interpose a prism B A C, whose refracting angle is B *a* C, so that the beam of light may fall on its surface C A, and emerge at the same angle from its second surface B A in the direction *g* G, and if we receive the refracted beam on the opposite wall, or on a white screen M N, "we should expect," says Sir David Brewster, "from the principles already laid down, that the white beam which previously fell upon P would suffer only a change in its direction, and fall somewhere upon M N, forming there a round white spot exactly similar to that at P. But this is not the case. Instead of a white spot, there will be formed upon the screen M N an oblong image K L of the sun, containing seven colours, viz.: red, orange, yellow, green, blue, indigo, and violet, the whole beam of light diverging from its emergence out of the prism at *g*, and being bounded by the lines *g* K, *g* L. This lengthened image of the sun is called the solar spectrum, or the prismatic spectrum. If the aperture H is small, and the distance *g* G considerable, the colours of the spectrum will be very bright. The lowest portion of it at L is a brilliant red. This red shades off by imperceptible gradations into orange, the orange into yellow, the yellow into green, the green into blue, the blue into a pure indigo, and the indigo into a violet. No lines are seen across the spectrum thus produced; and it is extremely difficult for the sharpest eye to point out the boundary of the different colours. Sir Isaac Newton, however, by many trials, found the lengths of the colours to be as follow, in the kind of glass of which his prism was made:—Red, 45; orange, 27; yellow, 40; green, 60; blue, 60; indigo, 48; violet, 80—Total length, 360."

These colours are not equally brilliant. At the lower end L of the spectrum, the red is comparatively faint, but grows brighter as it approaches the orange. The light increases gradually to the middle of the yellow, where it is brightest; and from this it gradually declines to the upper or violet end K of the spectrum, where it is extremely faint.

From the phenomena which we have now described, Sir Isaac Newton concluded that the beam of white light is compounded of light of seven different colours, and that for each of these different kinds of light, the glass of which his prism was made had different indices, that is, measures of refraction; the index of refraction for the red light being the least, and that of the violet the greatest.

By means of a second prism placed behind a hole in the screen M N, opposite the centre of each coloured space, Sir Isaac Newton refracted the light a second time. In this case it was not drawn out into an oblong image as before, and was not refracted into any other colour than that which formerly belonged to each particular ray. Hence this great philosopher concluded that the light of each particular colour possessed the same index of refraction; and he termed such light homogeneous, that is, of the same kind, or simple; white light being regarded as heterogeneous, that is, of different kinds, or compound.

By various experiments, Sir Isaac proved that all the colours, when again combined, formed or recomposed white light. Indeed, the doctrine may be illustrated by mixing together in proper proportions seven colours as like those of the spectrum as can possibly be got. By their union a grayish white is formed, for powders of the exact tint as those of the spectrum cannot be obtained. It may also be proved in this manner:—Let a circle of paper be divided into sections of the same size, and coloured like the spaces in the spectrum, and placed upon a humming-top, which is made to revolve rapidly; the effect of all the colours when combined is to produce a grayish white.

"All transparent substances, in bending light," observes Dr. Arnott, "produce more or less of the separation of colour; but it is an important fact, that the quality of merely bending a beam, or of *refraction*, and that of dividing it into coloured beams, or of *dispersion*, are distinct qualities, and not having the same proportion to each other in different substances. Newton, from not discovering this, concluded that a perfect telescope of refraction could never be made; he supposed that the bent light would always become coloured, and so render the object indistinct. We now know, however, that, by combining two or more media, we may obtain bending of light without dispersion—thus, by opposing a glass which bends five degrees and disperses one degree, to another glass which bends three degrees and disperses one, the opposing dispersions will just counterbalance or neutralize each other, while the two degrees of excess of bending will remain to be applied to use."

It having been found, by the experiments of Newton and others, that none of the seven colours of the solar spectrum could be broken by the prism into new colours, the theory was in some measure established that there were *seven* primitive colours. In time, however, practical men discovered that there were only *three* simple or homogeneous colours, and that all others resulted from them. These three primitive colours were *red*, *blue*, and *yellow*. That this was the true doctrine of colours, has been completely set at rest by the experiments of Mr. D. R. Hay (Edinburgh), author of a treatise on the Laws of Harmonious Colouring. We extract the following account of Mr. Hay's experiments from the work in question, and the principle of which seems afterwards to have been adopted by Sir D. Brewster:—

"Although this theory (that of there being only three primitive colours) was not set up in opposition to that of the natural philosophers, but seemed only to be established in a practical point of view, neither was it supported by any scientific experiments; yet it appeared to me more consistent with the general simplicity of nature, and I could not believe that she required seven homogeneous parts to produce what art could do by three. For instance, an artist can make all the colours, and indeed a correct representation of the prismatic spectrum (so far as the purity of the materials will allow), with three colours only; while, according to the theory of Sir Isaac Newton, seven simple or homogeneous colours were employed to produce the real one.

"The following discovery, made by Buffon, and illustrated by succeeding philosophers, helped to strengthen me in the conviction, that the scientific theory might, like that of the practical artist, be reducible to three simple or homogeneous parts. If we look steadily for a considerable time upon a spot of any given colour, placed on a white or black ground, it will appear surrounded by a border of another colour. And this colour will uniformly be found to be that which makes up the triad; for if the spot be red, the border will be green, which is composed of blue and yellow; if blue, the border will be orange, composed of yellow and red; and if yellow, the border will be purple—making in all cases a tri-unity of the three colours called by artists homogeneous.

"With a view to throw such light upon the subject as my limited opportunities would permit, I went over the experiments by which Sir Isaac Newton established his theory, and the same results occurred: I could not separate any one colour of the solar spectrum into two. The imperceptible manner in which the colours were blended together upon the spectrum, however, and the circumstance of the colours which practical people call compound, being always placed at the adjunct of the two of which they say it is composed, with my previous conviction, induced me to continue my experiments: and although I could not, by analysis, prove that there were only three colours, I succeeded in proving it to my own satisfaction, synthetically, in the following manner:—

"After having tried every colour in succession, and finding that none of them could be separated into two, I next made a hole in the first screen in the centre of the blue of the spectrum, and another in that of the red. I had thereby a spot of each of these colours upon a second screen. I then, by means of another prism, directed the blue spot to the same part of the second screen on which the red appeared, where they united and produced a violet as pure and intense as that upon the spectrum. I did the same with the blue and yellow, and produced the prismatic green; as also with the red and yellow, and orange was the result. I tried, in the same manner, to mix a simple with what I thought a compound colour, but they did not unite; for no sooner was the red spot thrown upon the green than it disappeared.

"I tried the same experiment with two spectra, the one behind, and of course a little above the other, and passed a spot of each colour successively over the spectrum which was farthest from the window, and the same result occurred. It therefore appeared to me that these three colours had an affinity to one another that did not exist in the others, and that they could not be the same in every respect, except colour and refrangibility, as had hitherto been taught.

"These opinions, the result of my experiments, I published in 1828, as being a necessary part of a treatise of this nature; and I did so with great diffidence, well knowing that I was soaring far above my own element in making an attempt to throw light upon such a subject. I had, however, the gratification to learn that these facts were afterwards proved in a communication read to the Royal Society of Edinburgh by Sir David Brewster, on the 21st of March, 1831, in which he also showed that white light consists of the three primary colours, red, yellow, and blue; and that the other colours shown by the prism are composed of these.

"The three homogeneous colours, yellow, red, and blue, have been proved by Field, in the most satisfactory manner, to be in numerical proportional power as follows—yellow three, red five, and blue eight.

"When these three colours are reflected from any opaque body in these proportions, white is produced. They are then in an active state, but each is neutralized by the relative effect that the others have upon it. When they are absorbed in the same proportions, they are in a passive state, and black is the result. When transmitted through any transparent body, the effect is the same; but in the first case they are material or inherent, and in the second impalpable or transient. Colour, therefore, depends entirely on the reflective or refractive power of bodies, as the transmission or reflection of sound does upon their vibratory powers."

To persons practically engaged in colours, we have much pleasure in recommending Mr. Hay's work, as containing a variety of useful information.

THE RAINBOW.

Every one knows that the rainbow is that brilliant and many-coloured arch which is occasionally seen spanning the sky opposite to the sun. In France and elsewhere, it is called the arc of the sky; and whilst to poets and other admirers of nature it is an object almost worshipped for its beauty, to the philosopher it is no less interesting and attractive. Rainbows are only visible when rain is falling between the spectator and that part of the sky which is opposite to the sun which is in its centre, as if at the end of a straight line drawn from the sun through the eye of the spectator towards the opposite horizon; and being always under the horizon, the bow is less than a semicircle. It consists of two bows or arches, the one inner or primary, the other outer or secondary; and within the primary rainbow, and in contact with it, and without the secondary one, there have been seen supernumerary bows.

The primary or inner rainbow, which is commonly seen alone, is part of a circle, whose radius is 41°. It consists of seven differently-coloured bows, namely, violet, which is the innermost, indigo, blue, green, yellow, orange, and red, which is the outermost. These colours have the same proportional breadth as the spaces in the prismatic spectrum. This bow is therefore only an infinite number of prismatic spectra, arranged in the circumference of a circle; and it would be easy, by a circular arrangement of prisms, or by covering up all the central part of a large lens, to produce a small arch of exactly the same colours. All that we require, therefore, to form a rainbow, is a great number of transparent bodies capable of forming a great number of prismatic spectra from the light of the sun.

Sir David Brewster thus explains the cause of the arc of the sky:—As the rainbow is never seen unless when rain is actually falling between the spectator and the sky opposite to the sun, we are led to believe that the transparent bodies required are drops of rain, which we know to be small spheres. If we look into a globe of glass or water held above the head, and opposite to the sun, we shall actually see a prismatic spectrum reflected from the farther side of the globe. In this spectrum, the violet rays will be innermost, and the spectrum vertical. If we hold the globe horizontal, on a level with the eye, so as to see the sun's light reflected in a horizontal plane, we shall see a horizontal spectrum, with the violet rays innermost. In like manner, if we hold a globe in a position intermediate between these two, so as to see the sun's light reflected in a plane inclined 45° to the horizon, we shall perceive a spectrum inclined 45° to the horizon, with the violet innermost. Now, since in a shower of rain there are drops in all positions relative to the eye, the eye will receive spectra inclined at all angles to the horizon, so that when combined, they will form the large circular spectrum which constitutes the rainbow.

To explain this more clearly, let A B, fig. 4, be drops of rain exposed to the sun's rays, incident upon them in the direction T A, T B, out of the whole beam of light which falls upon the drop; those rays which pass through or near the axis of the drop will be refracted to a focus behind it; but those which fall on the upper side of the drop will be refracted, the red rays least, and

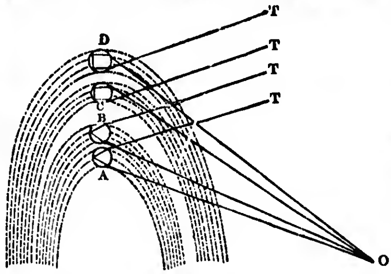


Fig. 4.

the violet most, and will fall upon the back of the drop with such sufficient obliquity that many of them will be reflected, as shown in the figure. These rays will be again refracted, and will meet the eye at O, which will perceive a spectrum or prismatic image of the sun, with the red space uppermost, and the violet undermost. If the sun, the eye, and the drops A B, are all in the same vertical plane, the spectrum produced by A B will form the colours at the very summit of the bow, as in the figure. Let us now suppose a drop to be near the horizon, so that the eye, the drop, and the sun are in a plane inclined to the horizon, a ray of the sun's light will be reflected in the same manner as at A B, with this difference only, that the plane of reflection will be inclined to the horizon, and will form part of the bow distant from the summit. Hence it is manifest that the drops of rain immediately above the line joining the eye, and the upper part of the rainbow, and in the plane passing through the eye and the sun, will form the upper part of the bow; and the drops to the right and left hand of the observer, and without the line joining the eye and the lowest part of the bow, will form the lowest part of the bow on each hand. Not a single drop, therefore, between the eye and the space within the bow, is concerned in its production; so that, if a shower were to fall regularly from a cloud, the rainbow would appear before a single drop of rain had reached the ground.

If we compute the inclination of the red ray and the violet ray to the incident rays T A, T B, we shall find it to be 42° 2′ for the red, and 40° 17′ for the violet, so that the breadth of the rainbow will be the difference of those numbers, or 1° 45′, or nearly three times and a half the sun's diameter. These results coincide so accurately with observation, as to leave no doubt that the primary rainbow is produced by two refractions and one intermediate reflection of the rays that fall on the upper sides of the drops of rain.

It is obvious that some of the rays will suffer a second reflection at the points where they are represented as quitting the drop; but these reflected rays will go up into the sky, and cannot possibly reach the eye at O. But though this is the case with rays that enter the upper side of the drop, as at A B, or the side farthest from the eye, yet those which enter it on the under side, or the side nearest the eye, may after two reflections reach the eye, as shown in the drops D C, where the rays T T enter the drops below. The red and violet rays will be refracted in different directions, and, after being twice reflected, will be finally refracted to the eye at O; the violet forming the upper part, and the red the under part of the spectrum. If we now compute the inclination of these rays to the incident rays T T, we shall find them to be 50° 58′ for the red ray, and 54° 10′ for the violet ray; the difference of which, or 3° 12′, will be the breadth of the bow, and the distance between the bows will be 8° 15′. Hence it is clear that a secondary bow will be formed without the primary bow, and with its colours reversed, in consequence of their being produced by two reflections and two refractions. The breadth of the secondary bow is nearly twice as great as that of the primary one, and its colours must be much fainter, because it consists of light that has suffered two reflections in place of one.

Many peculiar kinds of rainbows have been observed, such as lunar ones, in which, however, the colours are faint and barely perceptible. Supernumerary rainbows are sometimes seen. "On the 5th of July, 1828," says Sir D. Brewster, "I observed three supernumerary bows within the primary bow, each consisting of green and red arches, and in contact with the violet arch of the primary bow. On the outside of the outer or secondary bow, I saw distinctly a red arch, and beyond it a very faint green one, consisting of a supernumerary bow, analogous to those within the primary rainbow."

Red rainbows, distorted rainbows, and inverted rainbows on the grass have been observed. The latter are formed by the drops of rain suspended on the spiders' webs in the fields. It is only necessary to mention that the iris, so frequently seen overarching the cataract, is produced by the refraction of light in passing through the misty vapour generated by the fall of the column of water.

REFLECTION OF LIGHT.

Light, as has been mentioned, is diffused around us by the refractive power of the atmosphere, and therefore objects are quite visible though the rays of the sun do not strike directly upon them; in plainer terms, the atmosphere may be compared to the thick piece of glass called a *bull's eye* fixed in the deck of a ship, by which rays of light are collected and dispersed into all corners of the apartment beneath. The atmosphere being thus a vehicle of light, it may be supposed that, if we were to ascend to a great height above the level of the earth, or beyond the sphere of the atmosphere, we should be almost in darkness, although we were in reality nearer the sun. There is reason to believe that such would be the case; for travellers who have ascended to the summit of Mont-Blanc, or about 15,000 feet above the level of the sea, mention, that at that height the sky appears to be of an exceedingly dark blue colour, or almost black, and the light so faint that the stars are visible. We may understand from this that the rays of the sun travel through immense regions of darkness before they reach our atmosphere.

and are diffused into that universal soft light which we observe around us.

But, besides being diffused by a pure atmospheric medium, light is greatly increased in brilliancy by *reflection*. If all the objects on the surface of our planet were to be black, which is a negation of all colour, the sun's light would be absorbed, or at least return no part of the rays which fell upon them; and we should, even while the sun shone, possess much less light than we now enjoy. Nature has avoided this calamity, and, by producing all varieties of colours in objects, the sun's rays which fall upon them are less or more reflected, or sent back into the general mass of light. We now, then, understand, that every object we see reflects rays of light, and that these rays travel from the object to our eye, as soon as we bend our vision upon it: inasmuch, however, as a thousand or more individuals may see the same object at the same instant of time, it is evident that the rays proceed at all points, and fall upon eyes at every variety of angle.

If the object be clear or polished in its surface, it will possess the power of representing the image of any object within reach of its rays. Thus, the surface of a smooth lake will represent the image of the sky above, or the neighbouring hills, or of any object floating on its surface. This natural property in clear surfaces has suggested the formation of mirrors or looking-glasses. A mirror, or *speculum*, as it is scientifically called, is any instrument of a regular form, employed for the purpose of reflecting light or forming images of objects. Mirrors usually consist of metal or glass, having a highly polished surface. Those which are constructed of glass are coated upon the back with quicksilver, or rather with tin-foil mixed with a little mercury, for the purpose of reflecting more light; were this not the case, so little light would be thrown back, on account of glass transmitting it to a considerable extent, that a very indistinct image would be formed. The word speculum is generally confined to metallic mirrors, and they are either plane, concave, or convex. The plane ones are perfectly flat like a looking-glass; and a common watch-glass conveys a very good idea of the other two species of mirrors. Coat the hollow surface with mercury, and place it before a candle, it forms a convex mirror; coat it upon the other side, and employ it as before, it becomes a concave mirror.

If a plane mirror AB be placed exactly in a horizontal position, a ray of light c darting downwards in an exactly perpendicular direction, and striking it at *d*, will be thrown back in the exact path which it traversed in its descent, without any deviation. If, however, it descends in an oblique manner, as is shown at *e*, a point midway between the perpendicular *c* and the horizontal AB, it will not return, as in the former instance, to the place whence it came, but will be reflected from the mirror at an angle exactly equal to that at which it descended upon *d*. The ray *e d* is called the *incident ray*, and the ray *d b* is termed the reflected ray. In the figure *e d c* is called the *angle of incidence*, and *b d c the angle of reflection:* and they are both, as we have observed, exactly equal to each other. This being the fact, we have afforded us a method of universal application, by which, when once the angle of incidence, or that at which the ray falls upon a body, is found, that of reflection is easily obtained. This holds true whatever shape the mirror may be of, plane, concave, or convex, and whatever number of rays may fall upon it.

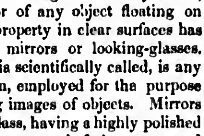


Fig. 5.

Let us apply the principle here mentioned to the simple phenomenon of seeing ourselves in a plane looking-glass. When we stand directly in front of a mirror, we see our image represented in it; and as we move, so does the image appear to move also, but with a peculiarity in its motion: if, for example, we walk towards the mirror, the image is seen to approach in a similar manner, but the approach is with double the velocity, because the two motions are equal and contrary. Suppose, however, while we stand at the glass, another person walks up behind us, his image will appear to us to move at the same rate as he walks, though to him the velocity will seem double, because, with regard to us, there will be but one motion, and with regard to him there will be two equal and contrary motions.

In this case of standing directly in front of the mirror, the image is necessarily before us, for the rays proceeding from our eye to the mirror are sent back from the surface without any angle of incidence. The case is otherwise when we stand so far at a side that we cannot see ourselves in the glass, though we can see the image of another person equally far off on the opposite side. Two persons so situated will see each other though they cannot see themselves, because the rays from the first person striking on the glass form an angle of reflection, and dart off in the direction of the second person, while the rays from the second person are similarly reflected towards the first. Such is a practical exemplification of the angle of reflection in mirrors.

The principle of reflection may be more minutely explained as follows:—We suppose RR to be the surface of a plane mirror, the arrow MN any object placed in front of it, and E the eye of an observer placed at *i k*. Of the rays which shoot in a rectilinear direction from the points MN of the object, and are reflected from the mirror, those which enter the eye are few in number, and must be reflected from portions DF and GH of the mirror, so situated with reference to the eye and the object, that the angles of incidence of the rays which fall on these portions must be equal to the angles of the reflection of those which enter the eye between *i* and *k*. For instance, the ray MD is reflected in the direction D *i*, and the ray MF in the direction F *k*. In the same manner, the rays NG and NH will be reflected severally in the directions G *i* and H *k*. If the rays *i* D and *k* F be continued backwards, they will meet at a point *m*, whence they will appear to have come to the eye. For the same reason, the rays G *i* and H *k*, if continued in the same manner, will seem to meet at the point *n* as their focus, and *m n* will be the virtual image of the object MN. It is called *virtual*, because it is not formed by the actual union of rays in a focus, and cannot be received upon paper. The virtual image *m n* is as far behind the mirror as the object MN is before it; consequently, if we join *m n*, it will be of the same dimensions as MN, and have the same position behind the mirror as the object has before it. If we join the points M *m* and N *n*, the lines M *m* and N *n* will be perpendicular to the mirror RR, and consequently parallel. In every position of the eye, the image is seen in the same spot; its absolute size is always the same, and its apparent size is also the same when seen at equal distances from the eye. If the object MN is an individual surveying himself in the mirror, he will see his perfect image as if at *m n*.

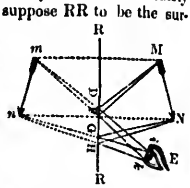


Fig. 6.

The manner in which rays are reflected from a concave mirror, next deserves our attention. It will have been frequently observed by the reader, that when he looked at himself in the hollow of a polished metal spoon, his face and bust appeared to be inverted, or upside down. We explain this by referring to the accom panying diagram, fig 7. MN is an object placed at some distance from a concave mirror AB, whose centre is C,

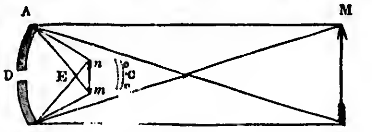


Fig. 7.

and whose principal focus is E. The rays from M fall diverging upon the mirror, and are reflected to a focus at *m* (a little without the principal focus), where they form an image of the extremity M. In the same way, a representation of the extremity N will be painted at *n*, so that a complete but inverted image of NM will thus be formed; and it is evident that it will be very bright, though small, because a great number of rays are concentrated, and concur in forming each point of the image. The size of the image thus formed corresponds to the distance of the object from the mirror. If the latter be large, and the former very bright, a series of beautiful experiments may be made by varying the distance of the object, and observing the variations in the size and place of the image. As the object recedes from the mirror, the picture approaches E, and gradually decreases in size.

If we consider *m n* as a small object, a magnified representation of it will be formed at MN, which, when viewed by a convex lens, such as will be afterwards described, constitutes a *reflecting microscope*. If we place a small concave mirror *o p* behind it, so as to enlarge the image, and reflect the rays through an opening D in the large mirror AB, then this second image may be magnified still more by means of a lens, in which case it constitutes a Gregorian reflecting telescope, so called from the inventor James Gregory. If instead of a concave we employ a convex mirror *o p*, and place it between E and *n m*, so as to reflect the rays which would otherwise have met at *n m*, then an enlarged image would in this case also be painted at D, where it can be magnified as in the former instance.

An image formed by a concave mirror is always highly magnified when the object is near the focus, but as it passes that point and approaches the mirror, the image gradually decreases in size, and becomes equal to the object when the latter touches the mirror. Indeed, when the object is placed between the principal focus and the mirror, the image is a virtual one apparently formed behind the mirror, or would be so formed behind it if the substance of the mirror permitted. Concave mirrors, from their property of converging rays into a focus, may be used as burning-glasses; practically, mirrors of this shape are used to gather the rays from lamps, and reflect them, with increased brilliancy, into the darkness. The lamps of coaches, light-houses, &c., are fitted up with these reflectors.

With respect to convex mirrors, they always form images of a diminished size, because the rays which form them become convergent in their passage to the eye of the spectator; in other words, the rays from the object proceed to a virtual or imaginary focus behind the mirror, and thence the image, in a miniature form, seems to be reflected to the eye. In this, as in all cases of reflection from concave mirrors, the size of the image represented is exactly what it might be expected to be if we could see through the glass, and observe the dimensions at the virtual focus.

It is perhaps not generally known, that images may be formed upon a piece of paper, by placing a small hole between the object and the paper, and excluding all extraneous light. This will be best understood by the following diagram:—

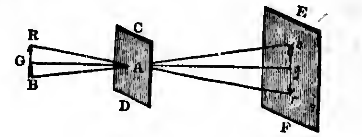


Fig. 8.

Let CD be a window-shutter having a small aperture A, and EF a piece of paper placed in a dark chamber. Then, if an illuminated object, RGB, is placed on the outside of the shutter, we shall observe an inverted image of this object painted on the paper at *r g b*. In order to understand how this takes place, let us suppose the object RGB to have three distinct colours—*red* at R, *green* at G, and *blue* at B; then it is plain that the *red* light from R will pass in straight lines through the aperture A, and fall upon the paper EF at *r*. In like manner, the *green* from G, and the *blue* light from B, will severally fall upon the paper at *g* and *b*, and an inverted image *r g b* of the object RGB will be painted upon it. Every coloured point in the object RGB having a coloured point corresponding to it, and opposite to it, on the paper EF, the image *b g r* will be an accurate picture of the object RGB, provided the aperture A is very small. If it be increased in size, indistinctness in the image will ensue; for, with a large aperture, two adjacent points of the object will throw their light on the same point of the paper, and thus create confusion in the picture. It is perfectly clear, that if the paper EF be moved to a farther distance from the hole A, the size of the image will be increased; and if it be brought nearer to it, it will be diminished.

LENSES.

Lenses, as already mentioned, are of different forms, and consequently possess different refractive powers. A lens may be composed of any transparent substance, as glass, diamond, a globule of water, &c.; in the arts, a lens is made of glass, as pure and colourless as possible. The design in forming lenses is to procure a medium through which the rays of light from any object may pass, and converge to a corresponding point beyond. The manner in which the rays proceed through the glass, and then centre in a focal point, will depend on the form of the lens, its capacity for refraction, and the distance of the object.

If we take a piece of glass, flat on one side and cut into different faces on the other, and then look through it from the flat side at any object—for instance, a pea, we shall see as many peas as there are faces receiving the rays from the single pea. We may exemplify this

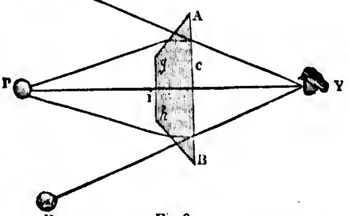


Fig. 9.

principle of multiplication by the preceding figure, in which AB is a lens flat on one side, and cut into three faces on the other, $g\,h$. Y is the eye of the spectator, and P the pea to be looked at. The eye receives a pencil of rays direct through the lens at *i*, and sees the object without refraction. A pencil also proceeds from P to the face *g* A, and another pencil proceeds from *c* to the face *h* B, and in both cases the rays are bent and refracted to the eye. This eye, however, does not recognise the path of either of these oblique rays, but perceives the image of a pea at D and at E; and thus three peas seem to be seen in place of only one.

In smoothly ground lenses, in which there are no distinct faces to multiply the images of an object, the rays bend, as we have said, so as to meet in a corresponding point beyond them. A lens may consist of a perfect globe of glass, or globe filled with pure water, in which case the refractive power will be considerable; a double convex lens, which is the more common kind, may be viewed as a portion cut out of the side of a sphere, as seen in the annexed figure. Here, as in all such cases of convexity, the focus of the parallel rays passing through the lens is at *f*, which is the centre of the sphere of which the farther or anterior side is a portion, or a point at half the diameter of the sphere from it. (Half the diameter is technically called the *radius.*) Should we take a plano-convex lens, the focal point would be considerably different. In fig. 11 we have an example of this kind of lens, which evidently possesses only half the refractive power of the double convex glass. Here the parallel rays, falling on the convex side of the lens, are seen to converge at the distance of the whole diameter of the sphere. Thus, the focal point at which the rays of light fall, is always regulated by the degree of curvature of the lens. We shall illustrate this by various diagrams, to which we ask the reader's careful attention, for the subject is somewhat difficult, and cannot be comprehended by a superficial glance.

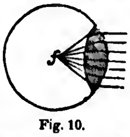


Fig. 10.

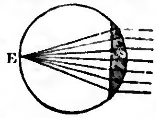


Fig. 11.

We take a double convex lens, represented by A B C, the axis of which is the line G′ C D′. The ray D′ G′,

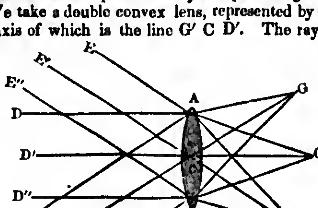


Fig. 12.

being straight through the centre, suffers no refraction; but the rays D A and D″ B are refracted, so as to meet at the focal point G′. We now observe that the parallel rays E A, E′ C, and E″ B, and also F A, F′ C, and F″ B, falling obliquely on the lens, will in a similar manner be refracted, and have their foci at G and G″, at the same distance from the lens. Those lines which pass through the centre, as E′ C G″ and F′ C G, do not alter their direction, not being refracted. Thus, in whatever way parallel rays pass through a lens, we have a focal point beyond it, be it straight forward or in an oblique direction.

The distance at which the rays meet beyond the lens is exemplified in the next diagram (fig. 13), given by Dr Arnott in his treatise on Physics, and whose definition of the focal point we beg leave to offer:—"Rays falling from *a* on a comparatively flat or weak lens at L, might meet only at *d*, or even farther off; while, with a stronger or more convex lens, they might meet at *c* or at *b*. A lens weaker still might only destroy the divergence of the rays, without being able to give them any convergence, or to bend them enough to bring them to a point at all, and then they would proceed all parallel to each other, as seen at *e* and *f*; and if the lens were yet weaker, it might only destroy a part of the divergence, causing the rays from *a* to go to *g* and *h*, after passing through, instead of to, *i* and *k*, in their original direction.

"In an analagous manner, light coming to the lens in the contrary direction from *b c d*, &c., might, according to the strength of the lens, be all made to come to a focus at *a* or at *l*, or in some more distant point; or the rays might become parallel, as *m* and *n*, and therefore never come to a focus, or they might remain divergent.

"It may be observed in the annexed figure, that the farther an object is from the lens, the less divergent are the rays darting from it towards the lens, or the more nearly do they approach to being parallel. If the distance of the radiant point be very great, they really are so nearly parallel that a very nice test is required to detect the non-accordance. Rays, for instance, coming to the earth from the sun, do not diverge the millionth of an inch in a thousand miles. Hence, when we wish to make experiments with parallel rays, we take those of the sun.

"Any two points so situated on the opposite sides of a lens, as that when either becomes the radiant point of light, the other is the focus of such light, are called *conjugate foci*. An object and its image formed by a lens, must always be in *conjugate foci;* and when the one is nearer the lens, the other will be in a certain proportion more distant.

"What is called the *principal* focus of a lens, and by the distance of which from the glass we compare or classify lenses among themselves, is the point at which the sun's rays, that is parallel rays, are made to meet; and thus, by holding the glass in the sun, and noting at what distance behind it the little luminous spot or image of the sun is formed, we can at once ascertain the focus of a glass, as at *a* for the rays *e* and *f*."

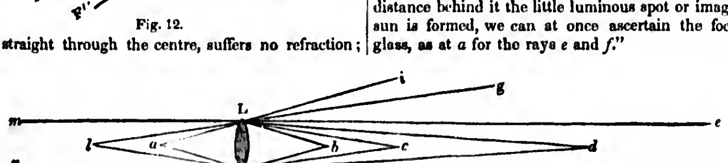


Fig. 13.

From the preceding explanations, it will be understood that when an object is placed at any distance from a lens, an image of it will be formed in the corresponding conjugate focus; but to see this image distinctly, the eye must generally be placed at least six inches behind it, that is, farther from the lens. When, however, the object is placed in the principal focus, the rays are refracted parallel, and the image in this case is distinct when seen at any distance. But the most remarkable quality of a double convex lens remains to be noticed; we allude to its magnifying power. This quality is entirely a result of the refractive powers of the glass: embraced within the sphere of the rays from the lens, the object is apparently expanded in size, and seen brought nearer to the eye. This may be elucidated, for small objects seem near, by a reference to the diagram, fig. 14.

Let E be the eye, and *m n* the diameter of its pupil, R W a small object placed at the least distance of distinct vision (about six inches from the eye for small objects); and let R W be its apparent size when seen by the unaided eye. If a convex lens A B is now interposed between the eye and the object, so that the object R W

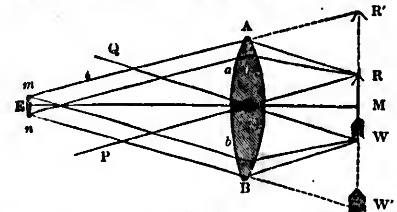


Fig. 14.

shall be in the principal focus of the lens, an enlarged image R′ W′ of the arrow will then be seen, its extremities R′ W′ lying in the directions E A, E B. The directions of these rays are determined thus:—From R and W draw the central rays R C P, W C Q, through the centre C of the lens; then the rays of the conical pencil, proceeding from the point R to every point of the nearer surface of the lens, are refracted in such a manner by the lens, that they all emerge in directions parallel to the central ray R C P; but of the whole refracted pencil only a small portion enters the eye, namely the pencil A *m n a*, limited by the size of the pupil *m n*; and the head A of the arrow, whence this pencil proceeds, appears to lie in the direction of the pencil E A R′ at R′. It is shown exactly in the same manner, that the point W will appear in the direction E B W′ at W′. The enlarged image of the small arrow R W is therefore R′ W′. The proportion in which the image is enlarged will be easily ascertained thus:—The triangles E R′ W′, C R W, are similar, and therefore the ratio of R′ W′ to R W, is that of E R′ to C R, or of E M to C M; that is, as the least distance E M of distinct vision, to the focal length C M of the lens. If, therefore, the least distance of distinct vision be divided by the focal length of the lens, the quotient will be its magnifying power. If E M be reckoned 6 inches for small objects, and if the focal length C M be 2 inches; then, since 6, divided by 2, gives 3 for a quotient, the magnifying power is 3 times. If C M were one quarter of an inch, then 6, divided by ¼, gives 24 for a quotient, and the magnifying power would in this case be 24 times.

A more simple explanation may be attempted as follows:—Turn to fig. 9, representing the lens with three faces on one side and flat on the other. There it is observed that the vision travels in the direction of the ray from the object, as it passes through the glass, and therefore sees an appearance of three objects. Now, in the above case of a magnifying lens, the vision in the same manner travels from the eye at E in the direction of the angle of refraction; it goes on to R′ and W′, and thus the actual object being drawn out, as it were, to meet these points of vision, or seemingly expanded by the bent rays, we of necessity see an apparently larger object. If the glass were cut in faces, instead of being smooth, the object would not appear drawn out, but would be multiplied in as many points as there are faces.

The inversion of the image by a lens may be illustrated by the diagram, fig. 15. A B C is an arrow, with the point uppermost, placed beyond the focus at F, of a double convex glass *d e f*. In virtue of the refractive power of the lens, the rays which proceed from A meet at Z, and form an image of the arrow-point inverted; while the rays from C meet at X, and form a similarly inverted image of the feather part of the arrow. The rays proceeding from B unite at *b*. Here, only rays from A, B, and C, are represented for the sake of clearness, but in point of fact rays from all parts of the object proceed through the lens, and hence an entire image is formed in an inverted position. Should the object A B C

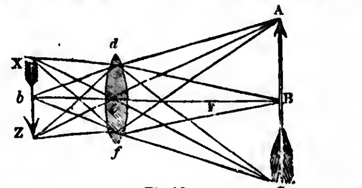


Fig. 15.

be brought nearer the lens, the image will be removed to a greater distance, because then the rays are rendered more divergent, and cannot so soon be collected into corresponding points beyond. To procure a distinct image, the object must be removed farther than the focal point F from the glass. In this exemplification, the object seems to be diminished; but if we make the small arrow the object, the larger one will be the image of it magnified.

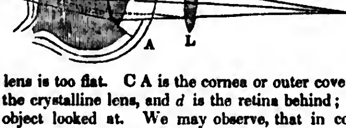
In order to explain the power of lenses in magnifying distant objects, and bringing them near us, let us suppose an object placed at one hundred feet distance from the eye of a spectator. Let us place a convex glass of twenty-five feet focal distance half way between the object and the eye; then, as has been previously observed, an inverted image of the object, and of the same size, will be formed fifty feet behind the lens. If this picture is looked at six or eight inches behind it, it will be very distinctly seen, and nearly as well as if the object itself had been brought to within six or eight inches of the eye of the spectator. If, however, instead of a lens of twenty-five feet focal length, a lens of a shorter focus is made use of, and so situated with respect to the eye and the object that its conjugate foci are at the distance of twenty and eighty feet from the lens—that is, the object is twenty feet before the lens, and its image eighty feet behind it—then the size of the image will be four times that of the object. If the eye, therefore, looks at this magnified image six inches behind it, it will be seen with great distinctness. In this case the image is magnified four times directly by the lens, and 200 times by being brought 200 times nearer the eye; so that its apparent magnitude is 800 times larger than before. At distances less than the preceding, the rule for finding the magnifying power of a lens, when the eye views the image which it forms at six inches' distance, is, according to Sir David Brewster, as follows:—"From the distance between the image and object in feet, subtract the focal distance of the lens in feet, and divide the remainder by the same focal distance. By this quotient divide twice the distance of the object in feet, and the new quotient will be the magnifying power, or the number of times that the apparent magnitude of the object is increased. When the focal length of the lens is quite inconsiderable, compared with the distance of the object, as it is in most cases, the rule becomes this: Divide the focal length of the lens by the distance at which the eye looks at the image; or, as the eye will generally look at it at the distance of six inches, in order to see it most distinctly, divide the focal length by six inches, or, what is the same thing, double the focal length in feet, and the result will be the magnifying power."

THE EYE—VISION.

Having, in our Account of the Human Body, described the anatomical construction of the eye, we shall here confine ourselves to the actual process of vision. As mentioned in the article referred to, the eye, in front, consists of the *iris* or variously coloured ring, which has the property of contracting or expanding to regulate the admission of light through the little dark spot in the centre called the *pupil*. Immediately behind the iris and pupil, there is a transparent substance, resembling in shape a double convex glass, which is thence called the *crystalline lens*. The use of this lens is to collect and refract the rays of light, so that they may converge to a point beyond; in other words, cause them to fall on the back part of the eye, called the *retina*. Such are the main instruments of vision; and the sense of seeing is produced by certain nerves which convey intelligence of the image on the retina to the brain. If these nerves be injured, the image will still be pictured on the retina, but the mind will possess no power of recognising their presence.

It will be understood from these explanations, that the main instrument of vision is the crystalline lens, which collects the rays and brings them to a focus on the retina. If the lens be perfectly transparent, and of the proper convexity, the light is enabled to act with due effect on the retina, and the representation of the object looked at will be correctly pictured to the mind. But if the transparent coating of the eye be dull, or the lens be either too flat or too convex, every object will appear dim.

Two kinds of defective vision are more common than any other, and they are known by the name of *long-sightedness* and *short-sightedness*. Long-sightedness, or the power of seeing objects best at a considerable distance, is caused by too great a flatness in the crystalline lens and outer coating of the eye; and the deficiency of vision in old persons is usually from a similar cause. To remedy this defect, as far as possible, artificial lenses of glass are employed. These lenses are called *spectacles*, and may be supposed to act in the manner we have now to describe. Fig. 16 represents an eye in which the crystal-



line lens is too flat. C A is the cornea or outer covering, *b* is the crystalline lens, and *d* is the retina behind; B is the object looked at. We may observe, that in consequence of the flatness of the lens *b*, the rays proceeding from the object are not sufficiently refracted, but proceed to a focus as far back as R; in other words, the focus would be at R, if the retina would permit; but as the retina is in the way, the rays, from not being focalized upon it, cause imperfection in the vision. To remedy this, we interpose an artificial convex lens, or glass of a pair of spectacles, L L, and by its aid the rays, represented by dotted lines in the figure, are brought to a focus on the retina at *d*. Thus, by selecting spectacles of a proper focalizing power in relation to the eyes, one kind of imperfect vision is very happily remedied.

Short-sightedness arises from a cause the reverse of that just alluded to, being produced by too great a degree

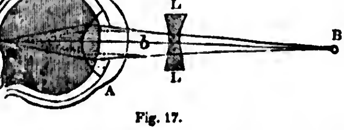


Fig. 17.

of convexity in the crystalline lens and cornea. In this case, the rays come to a focus too soon within the eye, and do not reach the retina, unless the object is brought quite close to the organs of vision. We offer a representation of this condition in Fig. 17. In consequence of the projecting globularity of the cornea C A, and the too great refracting power of the crystalline lens, the rays from the object B fall short of the retina at R. To remedy this, we interpose a double concave lens, L L, by which the rays are rendered more divergent before they reach the eye, and are brought to a focus, where they should be, on the retina.

We have said above, that in short-sighted persons the rays do not reach the retina unless the object is held close to the eyes. The effect produced by this is similar to that of employing concave spectacles; because the nearer we hold an object to our sight, the angle of the rays from it is the wider; the rays are more expanded before they enter the eye—that is, more divergent. This may be illustrated by Fig. 18. The extreme rays from a

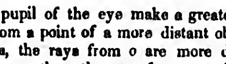


Fig. 18.

point to the pupil of the eye make a greater angle at o than those from a point of a more distant object *a* make at *a*; that is, the rays from o are more divergent on entering the eye than the rays from *a*, and thus nearness of an object is equivalent to seeing it at a greater distance through a concave lens. So when the object a is farther distant than o, the rays from *a* have a less divergence, which is equivalent to viewing it at a nearer distance with a convex lens. These remarks, however, refer merely to the distinctness of the vision, and not to the apparent size of the object.

The apparent magnitude of the same object when

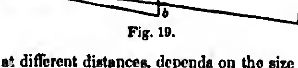


Fig. 19.

viewed at different distances, depends on the size of what is called the *visual angle*—that is, the angle formed at the eye by the rays from the extremities of the object. We may exemplify this by Fig. 19. An eye is looking at an object *a b*, and another object *c d*, at double the distance. It is evident that the rays from *a b* are more expanded, or cause a larger angle in the eye, than the rays from *c d*. Various familiar phenomena are explained from the law of the visual angle under which an object is seen; the apparent size being less always in proportion as the distance of an object is greater. Hence the principles of perspective in drawing, by which objects are made to appear at a great distance in the background of a picture, although in reality they are as far forward as the objects in front.—(See DRAWING AND PERSPECTIVE.)

Another important circumstance connected with vision requires to be noticed. In consequence of the refractive power of the crystalline lens, the rays from an object fall upon the retina in such a manner that the image is there pictured upside down; and this inversion of the real appearance of things requires to be corrected by an act of the mind under the influence of experience. We beg leave to offer Dr. Arnott's explanations on this somewhat puzzling point:—"Because the images formed on the retina are always inverted as respect the true position of the objects producing them—just as happens in a simple camera-obscura—persons have wondered that things should appear upright, or in their true situations. The explanation is not difficult. It is known that a man with wry neck judges as correctly of the position of the objects around him as any other person, never deeming them to be inclined or crooked, because their images are inclined in relation to the natural perpendicular of his retina; and that a bedridden person, obliged to keep his head upon his pillow, soon acquires the faculty of the person with wry neck; and that boys who at play bend themselves down to look backwards through their legs, although a little puzzled at first, because the usual position of the images on the retina is reversed, soon see as well in that way as in any other. It appears, therefore, that while the mind studies the form, colour, &c., of external objects in their images projected on the retina, it judges of their position, not by the accidental position of the images on the retina, but by the direction in which the light comes from the object towards the eye, no more deeming an object to be placed low because its image is low in the eye, than a man in a room into which a sunbeam enters by a hole in the window-shutter, deems the sun low because its image is on the floor. A candle carried past a key-hole, throws its light on the opposite wall, so as to cause the luminous spot there to move in a direction the opposite of that in which the candle is carried; but a child is very young indeed who has not learned to judge at once of the true motion of the candle by the contrary apparent motion of the image. A boatman, who, being accustomed to his oar, can direct its point against any object with great certainty, has long ceased to reflect that to move the point of his oar in some one direction, his hand must move in the contrary direction. Now, the seeing things upright, by images which are inverted, is a phenomenon akin to those which we have here reviewed."

The same able writer on physics proceeds to a definition of another peculiarity in visual arrangements, namely, why, from having two eyes, the object does not appear to us to be double:—"In answer to this, we shall only state the simple facts of the case. As in two chess-boards there are corresponding squares, so in the two eyes there must be corresponding points, and when on these points a similar impression is made at the same time, the sensation or vision is single; but if the impression be made on points which do not correspond, owing to some disturbance of the natural position of the eyes, the vision becomes double. Healthy eyes are so wonderfully associated, that, from earliest infancy, they constantly move in perfect unison. By slightly pressing a finger on the ball of either eye, so as to prevent it following the motion of the other, there is immediately produced the double vision: and tumours about the eye often have the same effect. Persons who squint have always double vision, but they acquire the power of attending to the sensation in one eye at a time. Animals which have the eyes placed on opposite sides of the head, so that the two can never be directed to the same point, must have in a more remarkable degree the faculty of thus attending to one eye at a time.

"The corresponding points in the two eyes are equidistant and in similar directions from the centres of the retinæ, which centres are called the points of distinct vision, and at them the imaginary lines named the axis of the eyes terminate; but it is worthy of remark that these points, in being both to the right or both to the left of the centres, must be one of them on the inside of the centre, as regards the nose, and the other on the outside—that is to say, a point of the left eye between the centre and nose has its corresponding point in the right eye between the centre and the cheek—and from this fact arise consequences meriting attention. When the two eyes are directed to any object, their axis meet at it, and the centres of the two retinæ are opposite to it, and all the other points of the eyes have perfect mutual correspondence as regards that object, giving the sensation of single vision; but the images formed at the same time, of an object nearer to or farther from the eye than the first supposed, cannot fall on *corresponding* points, for an object nearer than where the axes meet would have both its images on the outsides of the centres, and an object more distant would have both its images on the insides of the centres, and in either case the vision would be double. Thus, if a person hold up one thumb before his nose, and the other in the same direction, but farther off, by then looking at the nearest, the more distant will appear double, and by looking at the more distant, the nearest will appear double. The reason for applying the term 'point of distinct vision', to the centre of the retina, is felt at once by looking at a printed page, and observing that only the one letter to which the axis of the eye is directed, is distinctly seen; and, consequently, that although the whole page be depicted on the retina at once, the eye, in reading, has to direct its centre successively to every part."

The retina of the eye possesses such exquisite sensibility, that it retains the impression of the image of any bright object presented to it, for the space of the sixth of a second after the object has been withdrawn, or after the eye has been shut. Thus, the burning end of a rapidly whirled stick will appear to form hoops of fire; and a fiery meteor or sky-rocket shooting rapidly through the air, will appear as a long line of light. The mind is in these and similar instances deceived, as the eye in reality sees only a point of fire at precisely the same time. The retina, for the same reason, retains for a time an impression of any vivid colour. When we look at the sun, the retina is so strongly affected as to be incapable for a time of seeing other objects distinctly. The most remarkable circumstance connected with these phenomena is, that when the eye is shut after such impressions, a spot of colour, *different* from the colour looked at, is apparently seen. A spot of this nature is in optics called a *spectrum;* and works of an extended character on the science embrace lengthened definitions of the various spectra with which the eye will be affected. We need here only refer to the experience of our readers on this interesting point, and mention generally, that no satisfactory explanation has ever been given of the reason why the colours in the spectra differ from those which were actually seen.

OPTICAL INSTRUMENTS.

Telescopes.—Telescopes, sometimes called spying-glasses, are instruments in the form of tubes, fitted up with lenses of different kinds and powers, and used for examining distant objects. The word telescope is from the Greek, and signifies *afar off*, and *to see*. A telescope of a simple construction, consists of a convex lens placed at one end of a tube, which is termed the *object-glass;* and by it the light reflected by the objects in front is collected and formed into images near the other end of the tube, where they are inspected by another lens, of shorter focal length, called the *eye-glass*. This lens is fixed in a smaller tube, which slides backwards and forwards, so as to admit of the focal distance being adjusted to different eyes, &c. In telescopes with only two lenses, such as those used for astronomical purposes, with a convex eye-glass, the image is inverted—a circumstance of no importance in viewing the heavenly bodies. In Fig. 20 we have a representation of the manner in which a simple telescope with two glasses acts.

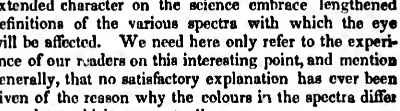


Fig. 20.

A E B is a double convex lens, forming the object-glass, and C D is a double concave lens forming the eye-glass. It may be observed, that from the object at M, a pencil of rays go on diverging till they reach the convex lens A E B, where they are so refracted that they would converge and meet in the point *m*, did not the lens C D refract them parallel. The pencil of rays from N, in the same manner, are converged to a point *n*. As the rays are rendered parallel on merging from the glass C D, they convey a clear image to the eye at E. The telescope made by Galileo was of this simple construction.

The magnifying power of such a telescope being limited, it became necessary to contrive an instrument in which the deficiency would be remedied. This has been accomplished by the construction of a telescope with a convex eye-glass, called the *astronomical* telescope. But this telescope inverts the image—a deficiency which is removed by constructing the instrument with four double convex lenses, as represented in Fig. 21. The rays from the object M N, are refracted

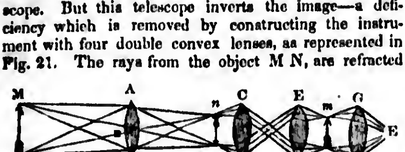


Fig. 21.

by the glass A E B, and we have an inverted image *n*. The rays now pass through C D and E F, by which transit they bring the image upright at *m*, and by the glass G H they are made to enter the eye at E. This, and other instruments in which refracting lenses are employed, are called *refracting telescopes*, and they magnify or bring near in proportion as the focal distance of the object-glass is greater than the focal distance of the eye-glass.

Refracting telescopes require to be of considerable length where much power is required, and on that account reflecting telescopes are for many purposes preferred. The reflecting telescope was invented by Sir Isaac Newton, but has been much improved since his time. A view of the improved instrument is given in Fig. 22. The peculiarity of this instrument is, that the image of the object is reflected from a concave mirror within the tube, and this image is again reflected from a small mirror to the eye. Referring to the figure, T is

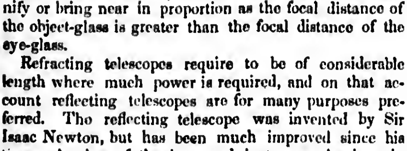


Fig. 22.

the tube, and A B the object to be represented. At the end opposite from the object, there is a small tube *t t*. At the main end of the wide tube, there is a concave mirror D F, with a hole in the middle at P. The principal focus of this mirror is at I K; here the image *m* is inverted, and the rays, crossing each other at *n*, go on to the small reflector L. From this they are reflected in parallel lines through the hole P. At P they enter the plano-convex lens R, which causes them to converge at *a b*; but here the image requires to be magnified, which is done by means of the plano-convex lens S; in other words, the object is seen under the angle *c f d*. In order to accommodate focal distances, the small mirror L can be removed to a greater distance or brought nearer, by the rods and screws communicating from X.

Microscope is a term compounded of two Greek words, signifying *to see what is small*, and denotes that instrument employed to examine minute objects. Those microscopes of greatest power, and termed compound, approach to the telescope in their form. The difference lies in this, that whilst in the telescope the object-glass forms the image of a distant object just as much smaller than itself as the distance of the image from the glass is less, in the microscope, conversely, a small object, placed near the focus of the object-glass, produces a more distant image, as much larger than itself as the image is more distant. In both cases an appropriate eye-glass is employed. The object-glass of a microscope is in general very small, that of a telescope large. An object-glass of a microscope having one-eighth of an inch of focal distance, and so placed as that the image of the object is formed at six inches, the image will be of a diameter forty-eight times as great as the object; and when viewed through an eye-glass of half an inch focus, it will appear magnified twelve times more, or will appear 30,000 times larger than the object. A single or one-lens microscope, magnifies chiefly by allowing the eye to see the object nearer than it could do without the glass.

A *Camera-Obscura* or *Dark Chamber* is formed by placing a convex lens in an aperture made in the window-shutter of a darkened room. A glass of proper size and focal distance is chosen, and a screen or the wall of the chamber is properly prepared to receive the light, and by this means there is painted on it an accurate picture of all the objects seen from the window, every thing bearing an exact resemblance to the reality. Nothing can surpass the beautiful effects produced by this delightful instrument.

The *Camera Lucida* is an instrument now frequently used in drawing landscapes, delineating objects of natural history, and copying and reducing drawings. The best form of the instrument consists of a piece of thick parallel glass, at one end of which there is a metallic mirror having a highly polished face. The rays from the object are made first to pass through the glass, when they are reflected back upon one of its sides by the mirror, and from the glass they are again reflected to the eye.

The Magic Lantern.—When a small object is placed close to a lens, and the image reflected upon the wall of a dark chamber, at say, one hundred times farther from the lens than the object is, there will be a greatly magnified representation of the object. It will only be seen, however, under ordinary illumination; and it is therefore necessary to have a very strong light, concentrated by a suitable mirror or glass, and directed upon the object. When artificial light is employed, as of a lamp, the instrument then becomes a magic lantern. It consists of an argand burner placed in a dark lantern, on one side of which is a concave mirror, the vertex being opposite the centre of the flame, which is placed in its focus.

A representation of a magic lantern is offered in fig 23. The lantern is made of tin japanned; and to

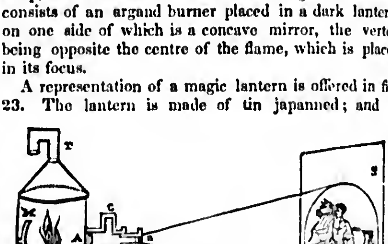


Fig. 23.

carry off the smoke from the flame, it is provided with a tube T at the top. L is the light, and M N a concave mirror to give strength to the light, and send the rays through the tube A B in front. At A in this tube is a hemispherical illuminating lens, and there is a convex lens at B. In the middle of the tube there is a wide part, C D, open at the sides, for the reception of *slides*. These slides are slips of glass on which pictures are

...ainted, and the principle of the apparatus consists in forming a representation of the picture, in a magnified size, on a distant white wall or screen S. The slide being placed in one of the conjugate foci of the lens B, the image is consequently enlarged. By bringing the ... nearer the screen, we diminish the representation, because we cause the rays to strike the screen at a point where they are less divergent. It is an improvement in exhibiting the representations from the magic lantern, to cause the images to fall on a piece of distended and wetted muslin, behind which the spectators are placed. Lately, the mode of representing scenes has been further improved by using two lanterns, placed at equal distances; in this case, while the view in one is being withdrawn, the view in another is coming on, and the eye is charmed with seeing, for example, a scene in winter dissolve and assume the appearance of a similar scene in summer. Such is the principle of the *dissolving views*, exhibited at the Polytechnic Institution in London, in 1841.

ACOUSTICS.

The term Acoustics is derived from two Greek words, which signify *I hear* and *an art*, and is applied to that branch of natural philosophy which treats of the nature of *sound*, and the laws of its production and propagation.

Atmospheric vibration is allowed to be the cause of sound. For instance, a bell is struck by its clapper, the body of the bell consequently vibrates, as we may sensibly assure ourselves by applying our nail lightly to the edge: in its agitation, it beats or makes impulses on the air, which, yielding under the stroke or pressure, is compressed or condensed to a certain distance around. The compressed air instantly expands, and in doing so, repeats the pressure on the air next in contact with it; and thus each one of the original strokes of the vibrating metal sends out a series of *shells* of compressed air, somewhat like the waves dispersed over a lake from the dropping of a stone into its placid bosom, and like them always lessening in bulk and force. These *shells* are from two inches to thirty feet in thickness. The air, thus agitated, finally reaches the ear, where it gives a similar impulse to a very fine nervous membrane, and the mind then receives the idea or impression which we call a *sound*.

With regard to the velocity with which the impulse of sound advances, it appears, from the most accurate experiments on the discharge of pieces of ordnance, and marking the interval between the flash and the report, at a distance carefully measured, that, when the atmosphere is at the temperature indicated by 62° of Fahrenheit's thermometer, sound travels at the rate of 1125 feet per second, which is nearly equal to the velocity of a cannon-ball the moment it issues from the piece.* The ball is very speedily retarded by the resistance of the air, but sound advances with undiminished velocity, though unequal intensity. It will travel a mile in little more than four seconds and a half, or twelve and three-fourth miles per minute. On this depends an easy method of determining in many cases our distance from objects, and which may often prove useful, particularly in thunder-storms. We have only to observe in seconds the interval between the flash and the report, and allow four seconds and a half to every mile, or 1125 feet to every second. It is remarkable, also, that all kinds of sounds, strong or weak, acute or grave, advance with the same velocity; and this arises from the circumstance, that all the oscillatory movements in the air, however minute or however extended, are performed each in the very same interval of time. For every degree of Fahrenheit above 62°, the velocity of sound is increased one foot and about a seventh (strictly 1 14-100th foot), and for every degree below 62°, it is lessened in the same measure; so that, when the temperature is at the freezing point, the rate is only 1090 feet per second.

That water is a vehicle of sound as well as the air, is proved by various circumstances, particularly by the fact, that a bell rung under water can be heard above and if the head of the auditor be also under water, it will be still more distinctly heard. The sound which the sonorous body produces, however, is graver than that which it gives forth in the air. That the atmosphere is necessary for the transmission of sound is evident from the fact, that a bell rung in the exhausted receiver of an air pump can scarcely be heard. Smooth bodies form favourable channels of sound, as, for example, the surface of ice, snow, water, or the hard ground. Savages, it is well known, are in the habit of putting their ear to the ground in order to discover the approach of enemies or beasts of prey. Tubes convey sounds with great accuracy and to great distances, and this property has been applied to various useful purposes. The most valuable of these purposes is that of examining the chests of persons supposed to possess pulmonary affections. This is done by means of the *stethoscope*, an instrument invented by Dr. Laennec of Paris, and which resembles a small trumpet. The wide end of the instrument is applied to the body, and the other is held to the ear of the physician, who then has a very clear perception of the sounds caused by the action of the lungs, and can judge whether they be healthy or the reverse. A person of skill can exactly describe the condition of the lungs from the nature of the sounds which thus reach his ear.

In a public exhibition in London, there has long been shown an apparatus consisting of a four-footed stand and several trumpet-mouthed tubes, from any one of which a spectator will receive a ready answer to a question. The answer is said to come from "the invisible girl," and the true explanation of the puzzle is, that a secret tube in the legs of the apparatus communicates the sounds to a girl placed in a neighbouring apartment.

In consequence of sound requiring a certain length of time to travel, it is impossible for two sounds at any distance from each other, to be heard at the same moment by persons who are not at equal distances from both. "If two persons, A and B," says an American writer, "are standing at the distance of one mile from each other, and each fires a gun at the same moment, A will not hear B's gun until several seconds after he hears his own, because the sound will require that time to pass through the distance between them. And the same will be the case with B. One might at first suppose that if A should wait and fire at the moment he hears the report from B, the two sounds would then be heard together. A would hear them together, but the time that must elapse after B had fired, before the sound from A would come to *him*, would be greater than if they fired at the same moment. For he must wait till the sound of his own gun had gone to A, and then until the sound of A's discharge should return to him. It is thus evidently impossible for two persons, standing at a distance from each other, to produce a sound which shall be heard by both at the same time.

It is on account of this principle, that in long ranks of soldiers, where two bands of music are placed at a considerable interval from each other, it is impossible for the two bands to keep time with each other. They may indeed play together, but each soldier will hear the nearest sounds quickest, and thus they will seem to be

* The velocity here assigned to sound, is that given by Sir John Herschel, as the mean of the best experiments.

out of time. It is often noticed too, that if from an eminence we look upon a long column which is marching to a band of music in front, the various ranks do not step exactly together. Those in the rear are in each step a little later than those before them. This produces a sort of undulation in the whole column, which is difficult to describe, but which all who have noticed it will understand. Each rank steps, not when the sound is *made*, but when, in its progress down the column at the rate of 1125 feet per second, it reaches their ears. Those who are near the music hear it as soon as it is produced, while the others must wait till sufficient time shall have elapsed for it to have passed through the air to them.

"Should a commander stand at the distance of a fifth of a mile from his army, and command them to fire, they might all obey at the moment when the word of command reaches them; but the officer will hear the report of the guns from those at the side nearest him first, then those a little farther off, and so on to the most remote. Thus, though all might obey with equal alacrity, the sounds will not and cannot appear simultaneous, for the reports of the distant guns must be delayed long enough for the command to pass from the officer to the men, and then for the sound to return. All attempts, therefore, to make their firing appear exactly simultaneous from a long line must be in vain."

An *echo*, or duplication of sound, is one of the most interesting phenomena in acoustics. The cause of it is precisely analogous to the reaction of a wave of water. When a wave of water strikes the precipitous bank of a river, it is thrown back in a diagonal direction to the side whence it came, and there again strikes on the bank. In the same manner, the pulses or waves of sound are reflected or thrown back from flat surfaces which interrupt them, and, thus returning, produce what we call an echo. It is evident that the smoother the surface which reflects the sound, the more perfect will be the reverberation. An irregular surface, by throwing back the wave of sound at irregular intervals, will so confound and distract it, that no distinct or audible echo will be reflected. On the contrary, a regular concave surface will reflect sound in such a manner, that at a certain point the reflections from each part of the concave surface will be concentrated into a focus capable of producing a very powerful effect. The velocity with which an echo returns to the spot where the sound originates, depends, of course, upon the distance of the reflecting surface; and since sound travels at the rate of 1125 feet in a second, a rock situated at half that distance will return an echo in exactly one second. The number of syllables which we pronounce in a second will in such a case be repeated distinctly, while the end of a long sentence would blend with the commencement of the echo.

An echo may be double, triple, or even quadruple, according to the nature and number of the projecting surfaces from and to which the sound is allowed to play. Distinctly marked echoes of this combined and planned order may sometimes be heard in the vaults of cathedrals, in which case the waves of sound are driven from side to side of a deeply groined arch, and reverberate in protracted peals. One of the most interesting echoes of this kind in nature, is that which occurs on the banks of the Rhine at Lurley. If the weather be favourable, the report of a musket, fired on one side, is repeated from crag to crag, on opposite sides of the river alternately, as represented in fig. 24. P is considered as the primary point of radiation for the sound, and crossing the river it strikes at 1, then is sent off to 2, and so on to 3 and subsequent points, stopping or faintly dying away opposite E.

There are some remarkable echoes in ecclesiastical structures arising from peculiarities in the construction.

Fig. 24.

In erecting the baptistry of the church of Pisa, the architect, Giovanni Pisano, disposed the concavity of the cupola in such a manner, that any noise from below is followed with a very loud and long double echo. Two persons whispering, and standing opposite to each other, with their faces near the wall, can converse together without being overheard by the company between. This arises from the elliptical form of the cupola, each person being placed in the focus of the ellipse. In the cathedral church of Gloucester, there is, or was lately, a whispering gallery above the eastern extremity of the choir, which extends from one end of the church to the other. If two persons, placed at considerably distant points, speak to one another in the lowest voice, it is distinctly heard. A similar effect is produced in the vestibule of the Observatory of Paris, and in the cupola of St. Paul's, in London. A tourist has mentioned, that in Italy, on the way to Naples, and two days' journey from Rome, he saw in an inn a square vault, where a whisper could easily be heard at the opposite corner, but not at all on the side corner that was near to you. This property was common to each corner of the room. He saw another on the way from Paris to Lyons, in the porch of a common inn, which had a round vault. When any person held his mouth to the side of the wall, several persons could hear his whisper on the opposite side.

The whispering gallery in St. Paul's, London, is a great curiosity. It is 140 yards in circumference, and is just below the dome, which is 430 feet in circumference. A stone seat runs round the gallery along the front of the wall. On the side directly opposite the door by which visitors enter, several yards of the seat are covered with matting, on which the visitor being seated, the man who shows the gallery whispers with the mouth near the wall, at the distance of 140 feet from the visitor, who hears his words in a loud voice, seemingly at his ear. The mere shutting of the door produces a sound like a peal of thunder rolling among the mountains. The effect is not so perfect if the visitor sits down half way between the door and matted seat, and much less if he stands near the man who speaks, but on the other side of the door.

It is of great importance that buildings designed for large auditories should be constructed in such a manner that the voice of the speaker will neither echo from the walls nor be lost to the hearers. The best known form of apartment for the proper distribution of sound, is that in which the length is from a third to a half more than the breadth, the height somewhat greater than the breadth, and having a roof bevelled off all round the sides. This species of ceiling, called technically a coved or *coach roof*, from its being lower at the sides than centre, is in all cases best suited for conveying sounds clearly to the ears of auditors.

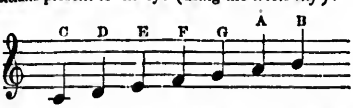
MUSICAL SOUNDS.

There is a peculiar character in sounds, depending on the character of the sounding body. A blow with a hammer, or the report of a pistol, produces only a noise. But if a body be of such a thinness and tightness as to produce a succession of impulses of a sufficient degree of quickness, a *tone* is the result, namely, a sound composed of a great number of noises, all so close upon each other, that they bring but one result to the ear. Wires and strings of metal and catgut, slips of metal, fine membranes, and columns of the air itself enclosed in tubes, are the most familiar means of producing sounds of this kind. Such sounds are said to be musical.

The study of musical sounds, as a branch of natural philosophy, is calculated, perhaps, to give as much pleasure to a man of science as music itself can convey to those who are gifted with what are called good ears. The natural character of these sounds, and their relations to each other, are very remarkable; while the relation of the whole to the human mind must be regarded as one of the most interesting proofs of creative design which the entire circle of nature presents.

The principal sounds of music may be said to be only seven in number. There are other five, which may be produced by the voice with some little difficulty; but the voice, in an untutored condition, gives forth only seven. The notes are of different degrees of shrillness, one rising above another in succession. A person who knows nothing of music beyond having heard another sing or play, and having seen the key-board of a piano-forte, will be ready to say that there are more notes than seven; but there are only seven that are, strictly speaking, various. The voice or an instrument may run up into other notes; but all of these are repetitions of the first seven, and identical respectively with them, in all respects except shrillness. In ordinary piano-fortes, there are at least six repetitions of the seven notes, so that the uppermost keys are more peepy than the voice of a child, while the lowest rumble like a drum.

The seven notes are named Do, Re, Mi, Fa, Sol, La, Si, or by the first seven letters of the alphabet in a peculiar arrangement, namely, C, D, E, F, G, A, B. They are thus represented in the well-known language which musicians present to the eye (using the *treble clef*):



Let an ordinary piece of catgut or violin-string be extended between two points on a board, and screwed up. It may be made, according to its length and degree of tension, to vibrate, when struck, exactly two hundred and forty times in a second. The note which it thus produces is C, or Do; and a man, on trial, will find that this is the note with which he is most apt to begin a song, when he attempts to sing. The note in his voice will be perfectly in unison with the note produced by the string; that is to say, they will melt into and agree with each other, and the effect will be pleasant. This is because the membrane at the top of the singer's windpipe (the instrument of his voice) vibrates exactly the same number of times in a second, producing that note, as the string does. The equality in the number of vibrations is what makes the notes the same, and the effect harmonious and agreeable.

We shall suppose the string to be forty-five inches long that produces the note C of 240 vibrations in a second. Being extended between two pegs near the surface of a board, the experimenter may place his finger upon it right in the centre, and twang or strike either half, when he will find a much shriller note produced, being, in reality, the first C, or Do, of a new series of the seven notes. In this case, the vibrations are exactly double, namely, 480 in a second, these being always the more rapid the shorter the string or the greater its tightness. The second or upper C is called the *octave* of the first, being the eighth note above it.

We shall now suppose that the string is shortened only so far as to leave thirty inches, or two-thirds of its length, free for twanging. This shorter string will sound the note G, or Sol. In this case, as the length of string is two-thirds, so are the vibrations three-halves, or one and a half times those in the former instance, namely, 360. All the other notes are produced by different proportions of string and numbers of vibrations, as shown in the adjoining scale:—

- C or Do (oct.), 22½ in. 480 vib.
- B or Si, 24 in. 450 vibrations.
- A or La, 27 in. 400 vibrations.
- G or Sol, 30 in. 360 vibrations.
- F or Fa, 33¾ in. 320 vibrations.
- E or Mi, 36 in. 300 vibrations.
- D or Re, 40 in. 270 vibrations.
- C or Do, 45 in. 240 vibrations.

What is remarkable here is the curious mathematical proportions on which the various notes depend. Taking the first C as one, and its octave as one-half, we have various lengths of string for the intermediate notes, in the following proportions: namely—for D eight-ninths, for E four-fifths, for F three-fourths, for G two-thirds, for A three-fifths, and for B eight-fifteenths; all of which proportions are exactly reversed with regard to the numbers of vibrations, these being in succession nine-eighths, four-fifths, &c. The proportions, as clearly appears to the eye from the above scale, are not regular: the string is first shortened five inches, then four, then two and a quarter, next three and three-quarters, and so on. Nevertheless, these are the musical notes which the voice naturally gives forth, and which the mind recognises as beautiful. The string twanged at lengths of what would appear more regular proportion, would give forth musical sounds, but not the seven notes of music—not those peculiar sounds which all nations recognise as such, and which nature has manifestly appointed to serve in that character.

Irregular as the proportions appear, there are some of the seven notes which are more proportioned to each other than the rest. They are said to be more *in harmony* with each other; and the effect, when they are struck together, is pleasing. It is to be observed in the first place, that a note always harmonizes well with its *octave*, or the eighth or repeating note above it. This is supposed to be because the vibrations of the one note in that case are exactly two for one of the other. The first Do also harmonizes well with Sol (G), which is called its *fifth*, being the fifth note above it; and this is, on the same supposition, because the vibrations are in that case as three to two, which is also a symmetrical proportion. Harmony is also produced when some other notes are sounded at the same moment with those which are third above them (their *thirds*); and this may be accounted for in a similar way. Thirds, fifths, and octaves, are therefore pleasing or harmonious sounds, while seconds, fourths, sixths, and sevenths are less so. Experiments of a very curious nature have been made on this subject. It may readily be observed by the naked eye, that when one of the longer strings of the harp or piano-forte is struck, there is not only a vibration along the whole length, giving it an elliptical appearance, but there are also vibrations of shorter lengths of the same string going on at the same time. It has been found, when light pieces of paper are hung across the string, that they settle at certain places, showing that the principal subordinate vibrations correspond with octaves, fifths, and thirds. A drum, or a sonorous board, over which sand has been strewn, will, if beat, throw the sand into curious figures of a determinate and regularly recurring character. This is the result of similar subordinate vibrations along the extent of the sounding body.

There are even more curious facts connected with the harmonious notes. The *cries* of a city—that is, the scarcely articulate, but often very musical, sounds uttered by persons selling things on the streets—generally rise on thirds or fifths, sometimes on octaves; and this although few of these poor people have ever been taught music. The cry of oysters by women in Edinburgh is always on an octave. Teachers of elocution are also aware that human beings in general make such transitions of voice naturally, under the influence of certain feelings. For example, a person indifferently surprised at hearing a friend say "I was the person who did so and so," will say, "Was it you?" rising only a third at the last word. If greatly surprised, the rise will be a fifth. There may even be so great a degree of astonishment, that the word "you" will begin on one note and terminate on its octave. The answers, "Yes, it was I," will show corresponding declensions or falls of voice. We thus see how truly music is a species of natural language. Unquestionably, every shade of human feeling can be represented by successions of its sounds, apart altogether from words.

With respect to the sounds produced by wind instruments, the effect is caused by the vibrations of a column of air confined at one end, and either open or shut at the other. The length of the sounding column determines the nature of the vibrations; but along with the fundamental tone, there are inferior and subordinate vibrations. The whole column divides itself into regular portions, equal to the half, the third, and so on, of the longitudinal extent, in the same manner as we showed was the case in stringed instruments. We may observe something similar to these vibrations in the contraction and expansion of a long and very elastic string, to one extremity of which a ball is attached. A spiral spring also shows, and perhaps more clearly, the repeated stretching and recoil. If suddenly struck at one end, it will exhibit not only a vibration throughout its whole extent, but likewise partial ones, which wind vermicularly along the chain of elastic rings. If the air be struck with great force, the subordinate vibrations sometimes predominate, and yield the clearest and loudest tones. This may be observed in the dying sounds of a bell, which rise one or two octaves, and expire in the acutest note. Upon the degree of force with which the instrument is blown, depends the performance of the bugle-horn, whose compass is very small, consisting only of the simplest notes. In other wind instruments, the nature of several notes produced depends upon the length and size of the tube, or the positions of the holes in its sides. In the organ, there is a pipe for each note, and wind is admitted from the bellows to the pipes by the action of keys similar to those of a piano-forte. The organ may be played also by a barrel made to turn slowly under the keys, and to lift them in passing, by means of pins projecting at certain determinate intervals from the surface of the barrel. In wind instruments which are furnished with reeds, the tone depends on the stiffness, weight, length, &c., of the vibrating plate or tongue of the reed, as well as on the dimensions of the tube or space with which it is connected.

With a view to impart some instruction in the practice and theory of music, we have, in a subsequent part of this work, offered a complete treatise on the subject.

WORKS ON OPTICS, LIGHT, AND ACOUSTICS.

The subject of Optics and Light has attracted more attention of late years than any other branch of natural philosophy. The researches and discoveries of Dr Brewster of Edinburgh, published in various scientific journals, have gained for him much reputation. Many of his speculations and experiments, however, are more curious than useful. The French savans have been even more successful than Brewster; and the discovery of Daguerre, by which the light of the sun is made directly instrumental in producing accurate representations of objects on metallic plates, is the most important that has been made since the time of Newton. It would exceed our limits to notice all the works on Light and its connection with heat, electricity, magnetism, and galvanism, which have appeared even during the recent period in which philosophers have been so earnestly engaged in examining these subjects. Among the many general works on Optics, may be mentioned the following, adapted to persons of different capacities and attainments in science:—Joyce's "*Scientific Dialogues*, vol. v.," intended for those who have a taste for the science without having entered much into the elements of it. "*The Elements of Optics*, by James Wood, B.D." This treatise enters largely upon the aberrations produced by the unequal refrangibility of different kinds of rays, and by the spherical form of reflecting and refracting surfaces. It is rather abstruse, requiring considerable mathematical knowledge. "*A Treatise on Optics, containing Elements of the Science, in two books, by Joseph Harris*," a more easy and popular work. In the first book the elementary part of optics is explained; in the second, the subject of vision. On the latter subject Dr. Porterfield's *Treatise on the Eye* is one of the best authorities extant. "*A New and Compendious System of Optics, by Benjamin Martin*," is a popular treatise, illustrated with experiments and examples; of the latter many are worked by common arithmetic.

"*A Complete System of Optics, in four books, by Robert Smith, LL. D., Professor of Astronomy and Experimental Philosophy, at Cambridge*, 2 vols. 4to." The first part of this elaborate work is designed for the use of those who would know something of optics, but who want the preparatory learning that is necessary for a thorough acquaintance with the subject. With this view the author has avoided all geometrical demonstrations, and substituted the more entertaining sort of proof, drawn from experiments that may be repeated with little trouble or apparatus. By this means any one with moderate application may make himself master of no inconsiderable part of the doctrine of optics. The second book is a complete mathematical treatise of the science; and will require, in the reader, a large portion of geometrical and algebraical knowledge. In the third book is given a description of a complete set of optical instruments, with explanations of the various uses to which they may be applied, in Astronomy, Geography, Navigation, Levelling, &c. A history of the telescopic discoveries in the heavens, is the subject of the fourth book, which modern discoveries have, of course, rendered imperfect.

"The elementary parts" of Dr. Smith's Optics, were published by Dr. Kipling, in 1778, who added, in the form of [illegible], [illegible] explanatory propositions from other authors, chi[illegible] Dr. Barrow and Descartes.

To [illegible] works on [illegible]ence of optics gener[illegible] be [illegible]ded the following on a particular branch of it.

"*Of Microscopes, and the Discoveries made thereby; illustrated with many plates, by Henry Baker, F.R.S.*" This work, which consists of two volumes octavo, contains much useful knowledge, exhibited in a simple and perspicuous method, for the sake of persons who have not had the advantage of a learned education. The reflections which Mr. Baker draws from the various parts of these volumes, all tend to impress the reader with just ideas of the wisdom, power, and goodness of the great Creator.

CHEMISTRY.

The material world immediately under our observation, including such parts of the earth's crust as have been explored, the plants and animals upon its surface, and the atmosphere which envelopes it, is found to consist of fifty-four simple substances, just as all the words which compose a language are resolvable into a few letters. These substances, having hitherto resisted all endeavours to divide or resolve them into any others, are termed the *elements of matter*, or *simple bodies*. From the earliest stage of creation most of them appear to have been in a state of combination with each other; they are scarcely ever found otherwise.

Matter has ever been, and is now, undergoing perpetual decompositions and recombinations, some of which take place upon an extensive scale, as part of the regular functions and operations of nature, while others are effected by the ingenuity of man, to serve the purposes of his ordinary economy. Of the fifty-four simple substances, six are gases, (three of which only are permanently gaseous), forty-one are metals, and the remaining bodies are reducible under no fixed class. The investigation of the laws under which these various elementary bodies have formed the numerous compound substances which we see in nature, and the means by which compound substances can be resolved into their original elements or thrown into new combinations, are the objects of the science of Chemistry.

The term *chemistry* is of doubtful derivation; but it seems to have been applied at an early period to various methods of melting or preparing metals, and was identified with the visionary science of alchemy, which professed to be the art of transmuting copper and other base metals into gold and silver. It is only within the last sixty or seventy years that chemistry has risen to the rank of a science; but during that period it has advanced towards perfection with a rapidity unparalleled in the history of philosophy. The applications of chemistry are universal. There is no science so immediately conducive to human comfort. To whatever art or manufacture we turn our attention, we find that it has either been created by chemistry, or owes to it some of its greatest improvements. In the present sheet, it is our object to present a simple and intelligible view of the principles of this exceedingly important science, with a description of the various elemental bodies, and their more immediate combinations. We shall commence with a view of the general leading principles on which the science proceeds.

CHEMICAL ATTRACTION.

When particles of different kinds of matter are brought into contact, they frequently unite and form new substances, differing widely in many instances from those by whose union they have been formed. This is called *chemical attraction*, or *chemical affinity*, because it is said that the particles of certain bodies, having an affinity for each other, will unite, while others, having no affinity, do not readily enter into union. It might almost be supposed that there are such things as preferences and dislikes among the particles of matter. Thus, if a piece of marble be thrown into vitriol or sulphuric acid, their particles will unite with great rapidity and commotion, and there will result a compound differing in all respects from the acid or the marble. This is at once an instance of affinity between two substances, and an exhibition of stronger and weaker affinity. The commotion or effervescence in the experiment, results from the disengagement of a gaseous (carbonic) acid in combination with the basis of the marble, in consequence of the vitriolic acid having a stronger affinity for it. When a piece of caustic magnesia is thrown into vitriol, we have a case of simple affinity, with a complete change, also, of properties. But the vitriol and magnesia are eminently hurtful to life. All their elements combine, without any disengagement, and the result is the production of Epsom salts, a compound with properties entirely new. Neither ingredient has been destroyed; they can again be extracted pure from the compound; but they have changed their characters through the force of affinity. But if a piece of glass, quartz, or gold be thrown into the acid, no change is produced in either, because their particles have no affinity. This process is termed in chemical language *combination*. It is quite distinct from *aggregation*, which is the union of particles of a similar kind, forming a mass which has the general properties of the particles of which it is composed, whatever may be its structure or form. It is also to be distinguished from *mixture*, in which the particles, although they may be intimately blended, are not as it were amalgamated with each other so as to lose their own individual properties. The difference between combination and mixture will be clearly seen from the following example:—if into a crystal bottle we pour a quantity of oil and a quantity of water, and shake them well together, the two substances can never be made to unite permanently together. Although they appear to do so for a short while after the experiment is made, yet if the vessel be allowed to stand for a sufficient length of time, the particles of water, being heavier than those of oil, will descend to the bottom, whilst those of the oil will settle upon the top. Here it is evident that no chemical attraction has been exerted between the particles of the two bodies, because no chemical change has taken place. In a word, there has been a mechanical mixture without any chemical combination. But if with the water in this experiment we mix a quantity of potash, so as to form a pretty strong solution, the results will be very different. The particles of the bodies will intimately combine with each other, and a compound will be formed having properties entirely different from either the oil or the potash. The substance thus obtained is the useful article soap; and if the water be evaporated by the application of heat, it assumes a solid consistency, as in the form in which it is commonly used for domestic purposes.

It sometimes happens that two bodies will readily combine with each other, but if a third body be added, the combination will be destroyed; the first of the two bodies having a stronger affinity for the third than it had for the second. Thus, if magnesia be dissolved in nitric acid, a complete union takes place; but if lime be added to the compound, the nitric acid unites with the lime, and the magnesia, which was formerly invisible, will fall to the bottom of the vessel.

Sulphur and quicksilver, when heated together, will form a beautiful red compound, known under the name of vermilion, and which has none of the qualities either of sulphur or quicksilver. Suspend a piece of aqueous sulphate of copper (common blue vitriol), by a thread, in a glassful of water. The particles of both combine and form a stream of blue fluid, which descends from the points where they are in contact. The solid is said to be *dissolved*, that is, the cohesion of its particles is destroyed, and the compound is called a *solution* of the solid.

The restoration of cohesion to a body after it has been deprived of it, is exhibited in a great variety of instances. For example, if a quantity of sugar be dissolved in water, and the solution be allowed to stand till the water has evaporated, the attraction of cohesion will take effect between the particles of the sugar, which will again resume the solid form. Here, however, a remarkable circumstance has occurred. Whatever the state of the sugar may have been originally, it invariably, in resuming its solidity, assumes a particular form, one of great regularity and beauty. It was formerly opaque, it is now transparent; originally a shapeless mass, it is now a prism of six sides, surpassing in lustre and symmetry the products of the lapidary's wheel. This solid spontaneous production is called a crystal; and the process by which it is produced is entitled

Crystallization.—Bodies, whether solid, fluid, or vaporous, are susceptible of assuming the crystalline form, and the substances which do so are numberless. The shapes which the crystals take, and the facility with which they assume them, are various. Instances of crystallization, such as sea-salt, Epsom salts, saltpetre, are familiar to every one. Water, it is well known, when cooled to a certain degree, assumes the form of ice, which is crystalline. There are three methods of producing artificial crystals: first, by dissolving the substance in a hot liquid, and either allowing the solution to cool, or evaporating it by a continued heat; second, by making the substance assume the aërial form; and, third, by melting it by fire without the presence of a liquid, and allowing it to cool slowly. The two first are the most common methods of forming crystals, and by the third, sulphur, spermaceti, bismuth, &c., may be made to assume the crystalline state. If as much alum be put into boiling water as the water will readily dissolve, crystals will be deposited as soon as the liquid cools. The presence of the atmosphere has considerable influence upon the formation of crystals. If as great a quantity of Glauber salt be dissolved in a flask half filled with boiling water as the water will hold in solution, and the flask be corked, no crystals will be formed as the liquid cools. Remove the cork, however, and crystallization commences as the air enters, a solid crystalline mass being almost instantaneously formed. If the weather is warm, crystallization will not perhaps take place even after the solution is cool. In this case, the introduction of a small crystal into the flask will cause the liquid to crystallize.

The same body does not invariably exhibit the same form of crystals; there may be several forms of crystals belonging to one body, but in one or other of these it is sure to crystallize, and not according to any other form. It is also to be observed, that very different kinds of matter may crystallize after the same model.

The general name for the substance formed by chemical attraction is a *compound;* the substances of which it is composed are called its component or constituent parts or principles. The separation of these is termed *decomposition;* and when decomposition is performed for the purpose of ascertaining the composition of a body, it is named *chemical analysis*. The reunion of the constituent parts is denominated *chemical synthesis*. Integrant particles of a body differ from the constituent particles thus:—The latter are the most minute parts into which a compound body can be resolved by decomposition, and are hence of a different nature, both with regard to each other and the substance itself which their mutual union gives rise to. The integrant particles are the most minute parts into which any body can be resolved *without* decomposition.

LAWS OF CHEMICAL COMBINATION AND DECOMPOSITION.

There are various laws connected with, and phenomena attendant upon, chemical attraction. While, of course, it can operate only between bodies of a different nature, the qualities which characterize these bodies when separate, are changed or annihilated by their combination, and it takes place only between the atoms or most minute particles of bodies. Chemical attraction can take place between two, three, or even a greater number of bodies. A change of temperature is almost always observable at the moment of combination. The force of chemical affinity between the constituents of a body, is estimated by that which is requisite for their separation. It has been already remarked that the degree of attraction varies very considerably in different bodies; and it is evident that from this variation all chemical compositions and decompositions take place. The preference of uniting with another substance which any given body is found to exercise, is metaphorically termed *elective attraction*, or *affinity*. It is of two kinds, each of which derives its appellation from the number and the powers of the principles which may be brought into contact with each other. When a simple substance is presented to a compound one, and unites with one of the constituents of the latter, so as to separate it from that with which it is combined, and by this means producing a decomposition, it is said to be effected by *simple elective attraction*. Some substances, however, will not be thus easily decomposed; and it is found necessary to introduce two or more principles, in order to effect the end in view. When two principles, therefore, are presented to a compound body, and when the principles unite each with one of those of the compound substance, two new substances are formed; and all instances of decomposition in this manner are said to be effected by *double elective attraction*. It is to be observed, that all changes effected in this manner are permanent, and that the new compound thus formed cannot be decomposed, until a substance having a more powerful attraction for one of its constituents than they have for each other, is brought into contact with them.

To Sir Isaac Newton we are indebted for the first attempt at a rational explanation of chemical combination. He was of opinion that the minute atoms of certain bodies attract each other with an unknown but enormous force, which begins to exert itself only when the particles are at very small distances from each other, and that, accordingly, this force exerts itself, and the bodies unite, when they are brought within the requisite distance. These views slowly made their way into the science; but towards the middle of the eighteenth century, they seem to have been almost universally adopted. The term chemical affinity was substituted for that of attraction, and the strength of the affinity existing in bodies came to be measured according to the order in which they were decomposed. It is unnecessary to mention the various tables of affinity which were published previously to that of Bergman, who in 1775 gave to the world a copious table of affinities, and appears to have fixed the opinions of chemists in general to his own views of the subject. According to this philosopher, the affinity of each of the bodies, say a, b, c, d, for x, differs in intensity in such a manner, that the degree of affinity in each may be expressed by numbers. He supposed affinity to be elective, in consequence of which, if a have a greater affinity for x than b, if a be presented to the compound $b\ x$, a decomposition will ensue, b will be set at liberty, and the compound $a\ x$ will be formed.

THE ATOMIC THEORY.

This theory was not discovered all at once, and immediately acknowledged by chemists; it was gradually brought to light by the repeated experiments of successive philosophers, whose labours, however, it will be impossible to exhibit a view of in this place. To Mr. Dalton we are indebted for the first development and demonstration of the fact, that bodies unite in definite proportions; and of which we shall now attempt to present the reader with as clear and simple a view as possible. Whilst engaged in determining the composition of the two gases called severally carbureted hydrogen and olefiant gas, Mr. Dalton discovered that for complete combustion they require *different* but *determinate* quantities of oxygen gas. A volume* of carbureted hydrogen requires two volumes, whilst a volume of olefiant gas requires three volumes of oxygen gas.

The conclusions at which Mr. Dalton arrived are, that bodies consist of *atoms* incapable of further diminution or division; that in chemical combinations it is these ultimate particles which unite; and that, in the case above mentioned of the combustion of the two inflammable gases, carbureted hydrogen is a compound of one atom of hydrogen and one atom of carbon; while olefiant gas is a compound of one atom of hydrogen and *two* atoms of carbon. The atoms he considered as spheres, and represented them by such symbols as a circle with a dot in the centre, a circle with a vertical diameter, and the like. In this manner the composition of a number of the best known bodies was represented by him, and the ratios of the weights of the atoms of the simple bodies inferred. For instance, he concluded from his experiments that carbureted hydrogen is composed of, hydrogen one, and carbon five; while olefiant gas is composed of, hydrogen one, and carbon ten. Now, as the former gas consists of one atom of hydrogen and one atom of carbon, then the weights of these atoms are to each other in the relation of one to five. If the weight of the atom of hydrogen, therefore, be represented by one, that of carbon will be five. In this manner, the ratios of the weight of the atoms of all the simple bodies may be ascertained by a careful analysis of the compounds formed by the union of the simple bodies.

The combinations of mercury or quicksilver with some other bodies, afford an illustration of the theory. Its first compound with oxygen, one of the gases of which the atmosphere is composed, consists of two hundred and two parts of mercury and eight of oxygen. If, however, the metal be subjected to a considerable degree of heat, it will be converted into a red shining mass, which is also a compound of the metal with oxygen; but in the latter case, sixteen parts of oxygen have united with the two hundred and two parts of the metal. The explanation of this is, that eight is the chemical equivalent of oxygen, and two hundred and two of mercury. In every successive compound which they make, their proportions form a multiple of these equivalents. Every other simple body has, in like manner, its equivalent number, and to its compounds the same rule applies. Innumerable instances of this might be adduced, but these are sufficient to prove the remarkable truth, that when different substances combine with chemical attraction, the proportions of the ingredients are always uniform; that for every atom present of one substance, there is exactly one, or two, or three, &c., of the other. If, for instance, any quantity of sulphur, intermediate between the two combinations of that substance with mercury, be added, it will not combine with it, but remain as a foreign ingredient in the sulphuret of mercury, as the compound is termed. All bodies, however, do not unite in several proportions, thus giving rise to several distinct compounds from two elements; there are many elementary bodies which will only unite with each other in one proportion, so that any two of such substances can only form one compound. This law, however, is not universal as it is well known that water and alcohol, and water and sulphuric acid, will unite in any proportions. Water will also unite in any proportion with soluble salt, until it becomes completely saturated. Bodies which unite in any proportions form an infinite variety of compounds, and are distinguished by their being united by a weak affinity, and also by the compounds formed differing little from their simple constituents or from each other.

These remarks must be held as applying to inorganic chemistry chiefly; vegetable, or organic chemistry, presents many exceptions to the principles of combination now laid down.

EQUIVALENT RATIOS.

The result of these investigations has been the formation of scales exhibiting the equivalent ratios of chemical bodies, and which are expressed by numbers. It is evident that some body must be fixed upon, and expressed by unity. Hydrogen gas, being the lightest known body in nature, and combining in the smallest proportion by weight with the other simple substances, has been taken as a standard of comparison for the combining proportions, or *equivalent numbers*, of all other bodies; and which, in all likelihood, are simple multiples of its number. Oxygen has also, by some chemists, been taken as the standard of comparison, and represented by ten. Water is a compound of eight parts by weight of oxygen. with one part by weight of hydrogen; which two gaseous bodies we shall afterwards describe. Whenever hydrogen and oxygen gases are burnt in any proportion whatsoever, they invariably form water; and they cannot be made to combine directly in any other proportion. From this, Dalton concluded that water is a compound of one atom of hydrogen and one atom of oxygen. But the weight of the latter gas being eight times that of the former, then it followed that the atom of oxygen was just eight times heavier than the atom of hydrogen. Hence, if the latter be represented by one, then will the former be represented by eight, according to those who take hydrogen as the standard. Those who take oxygen as the standard, and represent it by 10, make the equivalent for hydrogen 1·25: the result is of course the same, the proportion of 1·25 to 10, being exactly the same as that of 1 to 8.

These observations relative to water lead us to speak of the doctrine of volumes, so generally embraced by chemists upon the Continent. The union of gases is always effected in simple proportions of their volumes; and a volume of one gas combines with an equal volume, or two or three times the volume, of another gas; and in no intermediate proportion.

ELEMENTAL BODIES.

With regard to the elements of matter, chemists have agreed among themselves to consider all those bodies as simple which have not yet been decomposed. As already mentioned, the simple bodies are fifty-four in number, and for the convenience of study they have been arranged into classes. One system of classification

* Volume, in chemistry, is a term employed to denote any quantity in bulk of a substance. It is usually applied to the gases. Thus, one volume of hydrogen gas is, say, a cubic foot, yard, or any other quantity; then two volumes are of course just double the cubic foot, yard, or whatever other quantity was previously mentioned

is dependent upon the elements being metallic or non-metallic.

The non-metallic elements are divided into *gazolytes*, or bodies which are permanently gaseous; *metalloids*, or bodies which resemble the metals in their chemical relations; and *halogens*, or bodies which produce salts when in union with the metals. The non-metallic elements are thirteen in number; namely, oxygen, hydrogen, nitrogen, chlorine, iodine, bromine, fluorine, carbon, boron, silicon, sulphur, selenium, and phosphorus. The three first are the gazolytes, the next four the halogens, and the remaining six the metalloids. The metallic elements are forty-one in number, namely, potassium, sodium, lithium, calcium, barium, strontium, magnesium, aluminum, thorium, glucinum, zirconium, yttrium, manganese, zinc, iron, tin, cadmium, cobalt, nickel, arsenic, chromium, vanadium, molybdenum, tungsten, columbium, antimony, uranium, cerium, bismuth, titanium, tellurium, copper, lead, mercury, silver, gold, platinum, paladium, rhodium, osmium, iridium. These metallic elements are again divided into three orders, the first twelve being the bases of the alkalies and earths; the next twenty-one being metals whose oxides are not reduced by heat alone; and the remaining eight, metals whose oxides are reduced by a red heat. From these fifty-four elementary substances is formed all the beautiful variety of terrestrial objects. Nor is there any thing either very wonderful or mysterious in this fact, since, as we have seen, any given two of them, if made to unite in different proportions, can be made to produce the most opposite substances. These, again, united with each other, give rise to new compounds, which are susceptible of being combined, and so on through an almost infinite rotation of chemical union.*

HEAT OR CALORIC.

In our investigations of the phenomena of the material universe, we perceive two kinds of motion, which result from the two principles *attraction* and *repulsion*. Of the former we have already spoken, and it only remains to say a few words upon the latter. Repulsion, like attraction, takes place both at sensible and insensible distances. The former is exemplified by the flying off of the same light bodies which have been first attracted, after they have been some time in contact with a piece of excited resin or glass, and also by the recession from each other of the two similar ends of two magnetized needles. Repulsion at insensible distances, which is chiefly excited by heat, or, as it is called in chemical language, caloric, is exhibited in a great variety of phenomena.

The principal effects of heat are expansion, liquefaction, vaporization, evaporation, and ignition. With few exceptions, bodies are capable of expansion by means of heat; the gases being the most expansive, fluids less so, and solids least of all. When the iron rim of a coach or cart wheel is to be put on, it must first be heated to a considerable degree. The reason of this is obvious; when hot, the circle is larger than when cold, and thus slips easily upon the wheel; as it cools, the circle decreases, and thus firmly binds the woodwork together. The expansion of aeriform substances is illustrated by a bladder being partly filled with cold air, and held before the fire. The air will swell out with the heat, and become in some instances so expanded as to burst the bladder. As regards fluid bodies, the same fact is illustrated in the cases of the thermometer and barometer. By the accession or loss of heat, the alcohol or mercury expands or contracts, as shown by the index attached. The general law, therefore, is, that the expansion and contraction of matter are, with a few exceptions, dependent upon the increase and diminution of heat. The quantity or condition of heat that is discoverable by the thermometer, or by the organs of sensation, is called *temperature*. We are unacquainted with the extremes of temperature relative either to heat or cold. It has been compared to a chain, the extremities of which are concealed from view, whilst only a few of the middle links are exposed to observation. Although the universal result of an increase of temperature is an increase of bulk to the body thus subjected to heat, yet all bodies are not alike expanded by the application of the same quantity of heat. It of course follows as a general law, that different bodies at equal temperatures do not contain the same quantities of caloric. This quality of matter is called the capacity of bodies for heat, and the quantity of heat which is necessary to raise any particular body to a certain temperature, is called its *specific* caloric. Heat, however, in some cases causes contraction instead of expansion. Thus water is of greater bulk at a temperature of 32° (the freezing point) than it is at 39½° Some solids, also, as iron, antimony, bismuth, and many salts, contract when melted and expand as they become solid.

Vaporization is the rapid production of a thin vapour, as when water is converted into steam. The boiling point of water, in a vessel exposed to the ordinary atmospheric pressure, is 212°, and although more heat be applied to the vessel in which it is contained, the temperature of the water is not increased. If this degree of heat be continued, the watery particles separate from each other and become steam or vapour. Steam is colourless, transparent, and invisible, resembling the atmosphere, and is 1696 times greater in bulk than water. Steam may be condensed, or its particles brought nearer to each other, either by removing the heat which is the cause of the repulsion, or by mechanical pressure, and the result is its return to the form of water.

Water can be made to boil at a lower temperature than 212° by removing the pressure of the air. If a flask be half filled with water, the water made to boil, and as the steam escapes, a cork be put into the mouth of the flask, upon the heat being removed, the water will continue to boil, the heat in it being sufficient for that purpose when there is no pressure from the air. If the flask be put into cold water, the boiling will increase, from the steam being more effectually condensed; whereas, if the flask be put into boiling water, so as to prevent the condensation of the steam, the ebullition will immediately cease. Steam, as is well known, from its great force, and the manner in which it can be applied to propelling machinery, is of the greatest usefulness in manufactures.

Distillation is the converting of a liquid into vapour, which is afterwards carried off through a pipe and condensed in what is called a refrigerator. This is a vessel filled with cold water, round the inside of which the pipe is wound; and as the vapour passes through the pipe, it is condensed by the lower temperature of the water in the vessel.

Liquid substances give off vapour from their surface at temperatures below the boiling-point, which is termed *evaporation*. It is called spontaneous evaporation when this takes place at the ordinary temperature of the atmosphere. A large quantity of vapour is given off from the surface of the earth and sea, which eventually forms clouds, or is condensed into rain and dew. Evaporation always produces cold when heat is not applied; the heat necessary for it being derived from surrounding objects. A current of air or a higher temperature tends greatly to quicken evaporation, as may be observed in the rapidity with which the surface of the earth dries when a brisk wind passes over it.

* From recent experiments in chemistry, there is reason to believe that all substances whatsoever are but modifications of one primitive substance. The absolute truth of this startling theory remains to be practically demonstrated.

All substances become luminous when heated to 800° in the dark and 1000° in daylight, unless they are converted into vapour at a less elevated temperature. The light is red at first, and in this state a body is said to be in a state of *ignition*. If more heat is applied, the body becomes white, when it is said to be *incandescent*.

When a body changes from the solid to the fluid state, there is a quantity of heat absorbed, which has no effect in raising the temperature. This has been called *latent* heat, a discovery effected by Dr. Black, and which we shall shortly explain. For a demonstration of this doctrine, we may have recourse to water. If ice at a temperature below 32° be exposed to a warmer atmosphere, it receives caloric, and gradually rises to that point of the thermometrical scale. But as soon as it reaches it, the rise of temperature ceases, the ice begins to melt, and during the whole period of its liquefaction, its temperature, as also that of the water flowing from it, remains stationary at 32°. It is evident that, as caloric has continued to be communicated, a quantity of it has disappeared, and become absorbed during the fusion. The same phenomenon takes place when a liquid is converted into vapour; and the inference drawn from it is, that when a body passes from one state into another, a quantity of heat or caloric is lost, becomes latent, or passes into the body without raising its temperature. Dr. Black was of opinion that this latent heat became chemically combined with the solid, and was the cause of fluidity. Dr. Irvine, his pupil, took a different view of the subject. He supposed that the absorption of heat into the latent state is not the cause of liquefaction and vaporization, but the effect. The absorption he attributed to what is called change of capacity for heat, or that quality of matter which causes one kind to be more or less heated than another, by the addition of the same quantity of heat. He concluded, as a general law, that the capacity of all solids for heat is increased by fusion, and that of all fluids by evaporization. It is impossible to enter further into this interesting subject at present; but, before quitting it, we may mention an exception to the law of expansion by heat in the case of water. It is well known that water freezes at 32°, but it does not increase in density below 39½°. It is then at this maximum, and above or below that point its density diminishes. Hence ice is specifically lighter. The earth alumina, which will be afterwards described, also possesses the remarkable property of being contracted by heat.

LIGHT.

The nature of light, like that of heat, is still unknown to us. There are two theories respecting it: the first is, that light is a substance emanating from the sun and from all luminous bodies, from which it is projected in right lines with great velocity; the second is, that the sensation of light is produced by the vibration of a subtile fluid filling space—and is hence called the undulatory theory. Luminous bodies, according to this view of things, are merely stimuli, which excite these vibrations. An examination of these theories, however, cannot be here entered into. The connection between light and heat is so obvious, that it is scarcely possible to examine the one independently of the other. If a mass of iron be put into a fire for some time, no change is produced except the expansion of the metal and the elevation of its temperature. Gradually, however, as the heat is communicated, a remarkable occurrence will be observed. The iron becomes ignited or red hot; in other words, it emits light, and renders objects visible. The original sources of light are, first, the celestial bodies, as the sun and stars; and, secondly, terrestrial bodies, as a common fire or candle. Light passes freely through the atmosphere, and, striking upon objects, is reflected or thrown back by them; and thus they become visible. By means of a wedge of glass called a prism, light can be separated into seven colours, which are violet, indigo, blue, green, yellow, orange, and red. But it is only with the chemical agency of light that we have to do. Its influence in this way is conspicuous in a variety of natural and artificial processes. In vegetation it is indispensable, as without it plants do not acquire their due elementary constitution. They are weakly, inodorous, and fail to exhibit their natural colour. Vegetables which grow in the dark have a blanched appearance. The power of light to dispel vegetable colours is manifest in bleaching, where a dingy web becomes pure and white by exposure to the sun's rays. Its energy is still more decisively seen in the influence which it exerts in promoting chemical combination and decomposition, and the latter effect has been made use of as a measure of its power. Light enters into a kind of transitory union with certain substances, rendering them visible in the dark. Bodies which possess this property are called phosphorescent; such are the shells of fish, the bones of land animals, marble, limestone, and the like. The glow-worm is a remarkable instance of phosphorescence in living animals.

A remarkable recent invention, the Daguerreotype, is wholly dependent for success upon the action of light. It consists in having a thin plate of silver, prepared with iodine, so placed that the rays of light reflected from an object to be sketched will fall upon it. This is done by putting the plate in a camera-lucida, and the action of the light upon the iodine and silver is such, that when the plate is subjected to the vapour of mercury a complete representation of the object is given. A beautiful illustration of the action of light may also be seen in photogenic drawing. Paper for this purpose is prepared by steeping it in a weak solution of nitrate of silver or bichromate of potassa. The paper must be kept from the light during the preparation; and if it is now exposed to the sun's rays with a leaf or other object upon it, a complete representation of the object will be obtained. The part exposed to the sun becomes darkened, while that covered by the leaf remains of a light colour.

For a further definition of the principles of light, we refer to the article Optics.

COMBUSTION.

Combustion is a process not yet perfectly understood. It is usually described as the union of a *combustible body* with a *supporter of combustion*, attended with the evolution of *light* and *heat*. The combustible body is that which *burns*, but, in general, will neither support combustion, nor burn except in the presence of a supporter of combustion. The supporter, again, does not itself burn, though necessary to the burning of a combustible. Oxygen gas, the ingredient which enables the air to support combustion, possesses, when pure, a high degree of the supporting quality. If a lighted taper, a combustible body, be plunged into this gas, the taper burns vividly, but the gas itself is not ignited. If, on the other hand, the taper be plunged into a combustible gas, such as pure coal gas, the gas is instantly ignited, but the taper is extinguished. These are general rules, relating to supporters of combustion and combustible bodies. By examining the effects of combustion, in the case of a candle burning in the air of the atmosphere, it has been proved pretty clearly that a chemical action of the following kind takes place:—The combustible matter of the candle consists chiefly of two simple bodies, hydrogen gas and carbon, while oxygen is the supporter of combustion in the air. On burning a candle under a bell-shaped glass, filled with common air, a fluid gathers on the glass, which proves, on examination, to be pure water. The hydrogen of the burning body has here entered into combination with part of the oxygen of the air, forming water, a compound of the two. The carbon of the burning body also enters into union with a portion of the atmospheric oxygen, forming carbonic acid gas, which is left floating in place of the original quantity of oxygen. The presence of these can be proved, and the same process takes place in the case of coal, wood, &c. Thus it is seen that combustion only changes the forms of the burned bodies, and does not annihilate them. Plants, moreover, will soon extract the carbon again from the carbonic acid, and the hydrogen from the water, leaving the oxygen once more in the atmosphere to support combustion, and fulfil its other uses; while the other principles render wood combustible anew. This round of changes goes on unceasingly, without any ingredient being destroyed.

The phenomena of combustion are thus so far explicable, but unfortunately the source of the *light* and *heat* yet remains a mystery. It is unknown whether the chemical action is the cause of the light and heat being evolved, or the evolution of these the cause of the chemical action. Where all is doubt, it would be vain to dwell on this point. The laws stated respecting combustible bodies, and supporters of combustion, only apply generally, it is also to be observed, and under ordinary circumstances. Under the oxy-hydrogen blowpipe, the most incombustible bodies can be made combustible; and combustion can be shown to take place under an exhausted receiver, without the presence of any supporter, at least of a gaseous kind. We must wait in patience for a solution of these difficulties, until the genius of man has discovered more delicate instruments of philosophical investigation than any with which we are as yet acquainted.

AIR AND WATER.

Air.—By the examinations of modern chemists, it has been shown that air is not an element, but is a compound body, consisting chiefly of two gases, oxygen and nitrogen. It also appears that the oxygen is the really active agent in relation to animal respiration, and that the nitrogen is a mere diluent in the mass, on the same principle as water may be made a diluent of spirits. We subjoin the exposition of Mr. Hugo Reid (*Chemistry of Science and Art*) on this subject:—"The air consists mainly of nitrogen and oxygen, in the proportion, if these ingredients are alone regarded, of

	By measure.	By weight.
Oxygen, - -	210	231
Nitrogen, - - -	790	769
	1000	1000

It also contains, as constant ingredients in every situation, a little carbonic acid gas and vapour of water. In volume, the carbonic acid forms about 1-2000th part; or 0·5 parts in 1000 by measure; which is equal to 0·75 parts in 1000 by weight. In some situations the carbonic acid is so much as 0·62 volumes in 1000—at other places, only 0·37 volumes in 1000. Its proportion is greater in summer than in winter, during night than in the day time, in elevated situations than on the plains. The watery vapour is more variable in proportion. The mean is supposed to be about 10 parts in 1000 by weight, 15 by volume. The quantity is determined by the temperature, heat being the sole cause which sustains the vapour in the aërial state. The various methods of analyzing atmospheric air proceed upon the principle of withdrawing the oxygen. This may be done by a stick of phosphorus suspended over water or mercury in a jar of air; or, which is the best mode, by the combustion of hydrogen mixed with the air to be examined. The presence of carbonic acid gas is shown by agitating a quantity of air with lime-water. The carbonic acid and lime unite, and form the insoluble carbonate of lime, which, diffused through the liquid, renders it milky and opaque. On exposing to the air a saucer of lime-water, a thin crust or pellicle of carbonate of lime will be soon found on the surface of the liquid, formed in the same manner. The quantity of carbonic acid may be judged of by passing a little solution of caustic potash into a vessel of air over mercury, and observing how much of the gas is withdrawn, this substance removing the carbonic acid, or, by adding water of baryta gradually to a large quantity of air in a bottle, and agitating. The carbonic acid neutralizes the baryta; and the liquid is added until there is a slight excess of baryta, as indicated by a slip of turmeric paper being now rendered brown by it. The liquid added previously has exactly neutralized the carbonic acid; and in doing so has combined with an equivalent proportion of that substance, the quantity of which is thus indicated. The presence of watery vapour in the air may be demonstrated by exposing chloride of calcium or caustic potash. It absorbs the moisture, melts, and is found to have increased in weight. Strong sulphuric acid abstracts the moisture from air, increasing in bulk and becoming weaker. The dewpoint hygrometer also indicates the presence of moisture in air, and points out the precise quantity. The four bodies which enter into the composition of the air are regarded as mechanically mixed, not chemically combined with each other. It is known from the nature of aërial bodies that they would mix thus, though not combined—that they would not separate and arrange themselves according to their respective specific gravities—but would each be diffused through the whole space to which it had access. The only two likely to be chemically combined are the nitrogen and oxygen; and the great facility with which the oxygen is separated from the nitrogen, as well as not being in equivalent proportions, shows that they are not in close chemical union. The oxygen is the chief agent in the important operation of breathing or respiration of animals. Each individual is supposed, on an average, to breathe about twenty times every minute—to take in about sixteen cubic inches of air (12·8 nitrogen + 3·2 oxygen) at each inspiration—to return nearly the whole of the nitrogen (12·8 cubic inches), and 4·5ths of the oxygen (2·56 cubic inches), and to replace the remaining 5th of oxygen by an equal volume of carbonic acid (·64 cubic inch)." The oxygen of the air is the great means of procuring heat and light, by its action with combustible bodies.

Water.—Water was also at one period believed to be a simple element in nature; but this supposition has given way before the examination of chemists. Water is now known to be composed of oxygen with hydrogen gas, in the relative proportions of 8 of oxygen to 1 of hydrogen. Into these substances can it be resolved by the action of electricity or fire, but at such a cost as to render the process unsuitable for economic purposes. Pure water, in chemistry, is called an oxide of hydrogen. It may be formed by exploding a mixture of oxygen and hydrogen in a tube by the energy of electricity. Sea-water (see article OCEAN) contains, in 1000 parts, about 46 of foreign matters, chiefly chloride of sodium. Its specific gravity is 1·027.* Mineral waters, in a similar manner, contain various foreign bodies; as, for example,

* *Specific Gravity* is the relative gravity or weight of any body or substance, compared with that of some other body which has been fixed upon as a standard. By universal consent, pure distilled water has been assumed as a standard; and it fortunately happens that a cubic foot of pure water weighs exactly 1000 ounces avoirdupois. Water is indicated by unity—thus, 1. When, therefore, it is expressed that any body has a specific gravity of 2, then, bulk for bulk, it is just twice the weight of water. If there be more figures than one, and there be a dot or point between them—thus, 2·5—the unit is here divided into ten parts, and the body is twice and five-tenth times, or two and a half times, heavier than water. If two figures occur—thus, 10·40—the unit is supposed to be divided into a hundred parts, and the body is ten and forty-hundredth part times heavier than water. If there are three figures, the unit is supposed to be divided into a thousand parts; if four, into ten thousand parts, and so on; the number and value of the figures always indicating the exact specific gravity of the body according to the above principle. Common air is sometimes taken as a standard with which to compare gases, as in the instances mentioned in the text. It is a simpler and more intelligible way of comparing the relative weights or densities of aërial substances. But all the solids and fluids are estimated with regard to water

carbonated waters, which contain carbonic acid; sulphureous waters, which hold sulphureted hydrogen; and chalybeate waters, which contain sulphate or carbonate of iron. Water may be impure, either by the chemical union of these and other foreign bodies, or by the mechanical mixture of substances. The latter may generally be removed by filtration, but when the union is chemical, distillation and other processes are requisite to produce a pure liquid. In nature, water is never altogether pure. When it contains a chemical compound of lime, it is said to be *hard*, and in this condition it decomposes the soap which is employed with it.

ACIDS.

Acids are a most important class of chemical compounds and have the following characteristic properties:—The greater number of them have a sour taste, and are very corrosive. With few exceptions, they change vegetable blues to red, they are mostly soluble in water, and they unite with the alkalies, earths, and metallic oxides, forming what are called salts—an order of bodies of the highest importance in the arts, manufactures, &c. Some acids are destitute of a sour taste, but their affinity for the three classes of bodies above named is a universal characteristic. Acids are all compound bodies, and some of them have more than one basis or radical. There are a number of acidifying principles, but oxygen (which shall be immediately described) is the most extensive one. The acid is distinguished by the name of its base, and its degree of oxidation, that is, the quantity of oxygen it contains, by the termination of that name in *ous* or *ic*, or the prefix *hypo* (under). The highest degree of oxygenation is marked by the termination *ic*, as nitric acid, and the salt which is formed from it is made to terminate in *ate;* the next by that of *ous*, as nitrous acid, and the salt which is formed from it is made to terminate in *ite;* and the lowest by *hypo*, as the hyponitrous acid. Sometimes oxygen combines in a greater quantity with the acidifiable radicals, in which case the product is said to be superoxygenated. All acids are not susceptible of these various degrees of oxygenation, some being limited to only one. There are a considerable number of acids, and the number is continually increasing by the discovery of new ones; but of the most important there are few, and these we shall notice as we come to treat of their bases.

SALTS.

This term has been usually employed to denote a compound, in definite proportions, of acid matter with an alkali, earth, or metallic oxide. When the proportions of the constituents are so adjusted that the resulting substance does not affect the colour of infusion of litmus or red cabbage, it is then called a neutral salt, because the peculiar powers of both bodies are suspended and concealed; they are rendered neutral or inactive. When bodies combine in such a way as to satisfy their mutual affinities, they are said to *saturate* each other. When the predominance of acid is evinced by the red of these infusions, the salt is said to be acidulous, and the prefix *super* or *bi*, is used to indicate this excess of acid. If, on the contrary, the acid matter is deficient, or short of the quantity necessary for neutralizing the alkalinity of the base, the salt is then said to be with excess of base, and the prefix *sub* is attached to its name. These must be understood, however, only as general rules. There are exceptions to be found in the case of some salts, as the compounds formed by an acid and an alkali, an earth, or a metallic oxide, are denominated. For example, a certain salt formed by nitric acid and lead, though the acid be perfectly neutralized, reddens vegetable blues; and a salt formed by boracic acid with soda retains the powers of an alkali, in the respect in question, though with a double proportion of acid in it.

METALS, OXIDES, EARTHS, AND ALKALIES.

We arrange these classes of substances together, because, although they are to a certain extent distinct, yet they have all a very remarkable relationship, as we shall shortly see.

Many of the metals, such as iron, lead, &c., are familiarly known to every one, but there are a great many others which are very rarely to be met with. The following are some of the characters which distinguish metals from other bodies:—They are, for the most part, hard and heavy, and are all opaque; insoluble in water; they possess a peculiar lustre; admit of being so highly polished as to reflect light; are capable of being melted by heat, and recovering their solidity by cooling; most of them may be extended by hammering, and all are rapid conductors of electricity. They are of various colours, and require different degrees of heat to fuse or melt them. They generally occur in the earth in what are called *veins*, and are seldom found in the pure metallic state, but generally in combination with some other substance, in which state they are called *ores*. The metals, which are all simple bodies, will be individually described afterwards.

Most metals, when subjected to heat until they become melted, combine with the oxygen of the atmosphere, and form what are called *oxides*. Oxides are destitute of those properties which distinguish the metal from which they are formed. Instead of being bright, shining, elastic, and ductile substances, they are generally a dry, earthy-looking powder. Other substances besides metals, however, are capable of being converted into oxides; and it must be kept distinctly in view, that in every case there is not so much oxygen imparted as will produce *acidification*. Oxygen frequently combines in various proportions with a substance, rendering it an oxide, but without advancing it to the state of an acid. In order to distinguish each compound thus formed, the language of chemistry is very systematic. The first is called a protoxide; the second, a deutoxide; and a third, a paroxide.

The term *Earths* was formerly, and is still, but in a modified sense, applied to several substances which compose all the various rocks, stones, gems, mountains, and soils, covering the surface of the globe. They are tasteless, inodorous, dry, uninflammable, sparingly soluble, difficult of fusion, and of moderate specific gravity. These bodies will be more particularly described when we come to treat of their metallic bases. *Alkalies* may be defined as bodies which combine with acids so as to impair or neutralize their activity, and produce what are called salts. They are distinguished by properties the reverse of acids, and the two classes are generally looked upon as antagonist substances. Besides the power of neutralizing acids, there are four alkalies, namely, potash, soda, ammonia, and lithia, which possess the following properties in a high degree:—They change vegetable blue to green, red to purple, and yellow to a reddish brown; they have an acrid and urinous taste; they are powerful corrosives of animal matter, with which they combine so as to produce neutrality; they also unite with oils and fats, forming the well-known substance soap; they combine with water and alcohol in any proportion. Four of the earths, namely, lime, baryta, strontia, and magnesia, possess alkaline properties to a considerable extent, and are hence called alkaline earths. These bodies differ from the pure alkalies, inasmuch as they become insoluble in water when neutralized by carbonic acid. Moreover, alkalies possess the power of changing vegetable colours *after* being saturated with carbonic acid, and by this criterion they are distinguished from the alkaline earths.

It was long observed that the properties of earths very nearly resemble those of the compounds of oxygen and metals called metallic oxides; but it remained for the brilliant genius of Sir Humphry Davy to show that both the earths and alkalies are metallic oxides It thus appears, then, that the globe is one vast mass of various kinds of metals, disguised by various substances, but chiefly by oxygen. Earths and alkalies are simply metallic oxides; whilst a farther impregnation of these substances with oxygen produces an acid; and, lastly, the union of acids with alkalies, &c., gives rise to that very numerous and important class of substances called salts.

Of the elemental substances at present known, six seem capable of combining with all the others. When combined with a certain portion of the other simple bodies, they form *acids;* and when with the rest, they constitute *bases* or *alkaline bodies,* which are capable of uniting with and neutralizing the acids, as we have formerly observed. To these six bodies the name of *supporters of combustion* has been given. The eighteen bodies, which, when combined with the supporters, become acids, have been distinguished by the name of *acidifiable bases.* The thirty-one bodies, which, when united with the supporters, become alkalies, have been called *alkalifiable bases.* The *simple* supporters of combustion are as follow:—Oxygen, chlorine, bromine, iodine, fluorine, and sulphur.

OXYGEN.

Oxygen gas is a permanently elastic fluid, that is, one which no compressing force, or degree of cold, hitherto applied, has ever been able to reduce to a liquid or solid form. It forms, as we have already observed, one of the constituents of the atmosphere, is colourless, and destitute of taste and smell. Its specific gravity is 1·1111, that of common air being reckoned unity. Combustible bodies burn in it with more brilliancy, and more light and heat is evolved, than when combustion takes place in the atmosphere. If a candle, the wick of which is red-hot, be introduced into a vessel containing oxygen, the candle will instantly be lighted. Oxygen has the power of combining with every other simple body; the multifarious compounds which it thus forms, such as oxides, acids, and bases or alkalies, we have already adverted to. In the act of respiration, oxygen, in the nice economy of the human body, is made to unite with, and becomes a portion of the human frame. Vegetables also inhale and exhale it at certain seasons, so as admirably to supply what is absorbed by animals. It is the intensely rapid chemical union of oxygen with the combustible body, which gives rise to the light and heat in our common fires, candles, &c. It may be readily procured from a variety of substances, as, for instance, from saltpetre or the black oxide of manganese. These may be introduced into a gun-barrel, with the touch-hole plugged up. From the orifice of the barrel let a tube be conducted into an inverted glass jar, filled with water. When the other extremity of the apparatus is subjected to heat, the oxygen gas is expelled from the manganese, and entering the glass jar, displaces the water and fills the vessel. This is a cheap and easy method of obtaining this remarkable aëriform body.

Oxygen can be prepared by putting 1000 grains of binoxide of manganese into a retort with an equal weight of aqueous sulphuric acid. This is done by means of a retort fixed over a spirit-lamp. The bent tube of the retort enters a pneumatic trough, in which jars are placed for receiving the gas as it passes from the neck of the retort.

HYDROGEN.

Hydrogen gas is a permanently elastic fluid, transparent and colourless, and when *pure,* destitute of taste or smell. It can scarcely be said to exist in an isolated state, but it forms one of the constituents of water, from which it can be disengaged by various simple processes. It is the lightest body with which we are acquainted, and is employed in combination with other gases to inflate balloons. A bladder filled with this gas will ascend in the atmosphere, in the same manner as a piece of cork or wood plunged by force to the bottom of a vessel of water. Hydrogen will not support combustion, but is itself remarkably combustible. When one volume of oxygen is mixed with two of hydrogen, it burns with a loud explosion, by an electric spark, or the contact of a red-hot fire. The product of this experiment is water It is said that a few cautious draughts of this gas may be taken, but it cannot be inspired for any length of time without occasioning death. Frogs live in it for a long time, showing these animals to be very tenacious of life. By far the most important compound of hydrogen with any other substance is that with oxygen, forming the indispensable fluid which covers nearly two-thirds of our globe, water. It unites with the other supporters of combustion; but the compounds, except muriatic acid, already mentioned, are not of any great importance.

Hydrogen may be prepared by putting 500 grains of zinc into a common beer bottle, and pouring upon the zinc three ounces of water and five drachms of aqueous sulphuric acid. The hydrogen is disengaged, as the acid, the oxygen in the water, and the metal combine. By means of a bent tube from the bottle, the gas can be conveyed into jars placed in a trough.

AZOTE, OR NITROGEN.

This gas is permanently elastic, transparent, colourless, and inodorous. It is a very little lighter than oxygen. When breathed, it destroys animal life; and a burning body, if immersed in a jar containing it, is instantly extinguished. It is not combustible; it enters extensively into combination; it is an abundant element in animal matter; and its existence in such large quantity is a chief distinction between the constitution of animal and vegetable life. Its existence in the atmosphere we have already adverted to. Whether it is chemically united with oxygen in that compound, or only mixed with it, is not precisely known. That it has the property of combining with all the supporters of combustion, there can be little doubt; but the subject has not yet been thoroughly investigated. With oxygen it unites in no fewer than five proportions; by far the most important being

Nitric Acid, or Aquafortis.—This virulent substance is a compound of one volume azotic, and two and a half volumes of oxygen gas. Common nitric acid is of an orange colour, on account of its containing a little muriatic acid, as also a little sulphuric acid and water. Light has likewise an effect upon it. The specific gravity of the strongest procurable nitric acid is 1·55, and then it contains one-seventh of its weight of water; that of commerce is about 1·423, and contains two-fifths of its weight of water. Nitric acid has very remarkable effects upon water with regard to the production of heat. If diluted with half its weight of water, heat is evolved; but if the water be in the state of snow, intense cold is the result. Hence, this compound is employed to produce great degrees of cold. If nitric acid highly concentrated be thrown upon phosphorus, charcoal, or oil of turpentine, it inflames them. It is very extensively used in the arts, and forms a numerous and important class of salts, having the generic name of *Nitrates,* such as nitrate of silver, nitrate of potash, &c. Some of these we shall notice afterwards. *Nitrous acid* is a compound of the same kind, but with a lesser quantity of oxygen. Amongst the other compounds of azote and oxygen, that entitled the *protoxide of azote,* or, as it was formerly called, *nitrous oxide,* is the most remarkable. Davy discovered that we may breathe it for a short while without any effect being produced, except an exhilaration of the mind. Combustibles burn in it more brilliantly than in common air. There is also a *deutoxide of azote* and a *hyponitrous acid;* but these do not require minute detail. Azote combines likewise with chlorine and bromine. Nitric acid can be procured by filling a glass retort about one-third full of equal weights of aqueous sulphuric acid and common nitre. The retort is then subjected to heat, and a vapour is distilled over, which, condensed, is nitric acid.

Ammonia, or *Hartshorn*.—This important substance is formed by the combination of azote with hydrogen, and is obtained in the state of gas, by means of the salt called *sal ammoniac*, which is a compound of muriatic acid and ammonia. This substance is to be introduced into a retort, along with quicklime, and then subjected to heat. Ammonia is driven off in the form of gas, and is to be collected in glass jars standing over mercury. Ammoniacal gas is colourless, has a strong pungent smell, an acrid caustic taste, and cannot be drawn into the lungs. Its specific gravity is 0·59027. Water absorbs 780 times its volume of this gas, and in this state it is employed for chemical purposes. When the gas is mixed with chlorine, a sudden combustion and detonation take place. The chlorine unites with the hydrogen of the ammonia, and forms muriatic acid, whilst the azote is disengaged in the state of gas. The muriatic acid formed, combines with a portion of ammonia, and forms sal ammoniac. Ammonia is an alkali, and possesses the properties distinguishing this class of substances in a very decided manner. It of course neutralizes acids, and the salts which it forms are numerous, and of considerable importance.

CHLORINE.

This is a gaseous body, of a yellowish-green colour, a strong suffocating smell, and of a pretty strong astringent taste. Reckoning air as unity, its specific gravity is 2·5. If breathed undiluted, it destroys animal life; however, it not only supports combustion, but possesses the remarkable quality of setting fire to many of the metals, even at the common temperature of the air, when beaten out into thin leaves, and introduced into it. The combinations of metals with chlorine are called *Chlorides*. Chlorine possesses the property of destroying all vegetable colours, and of rendering vegetable bodies, exposed to its action, white. This property has occasioned the introduction of chlorine into bleaching; for if unbleached linens be exposed to its action, the matter which gives them their gray colour is destroyed, and the substance assumes a brilliant whiteness. Chlorine, however, must be used cautiously, for if applied in its pure and not sufficiently diluted state, it destroys the fibre of the cloth. Chlorine combines with oxygen in four different proportions; two of them contain so much oxygen as to form acids; these are, chloric acid and perchloric acid; but as the other two do not manifest any acid properties, they are to be considered as oxides, and are called protoxide of chlorine and peroxide of chlorine. Besides uniting with oxygen, chlorine combines with hydrogen, and forms the well-known acid called

Muriatic Acid.—If chlorine and hydrogen be mixed together in equal volumes, and exposed to common daylight in a glass flask, they will in a little time combine, and even explode in combining, if exposed to sunlight or the light of a candle; two volumes of muriatic gas result. Its specific gravity is 1·8244; in its pure state this gas is transparent, colourless, and elastic: under very strong pressure it condenses into a liquid. Water absorbs this gas with avidity. One cubic inch at 69° absorbs 417,822 cubic inches of the gas; heat is produced, and, when cold, the bulk of the water is increased to 1·3433 cubic inches. This is liquid muriatic acid. With these proportions of constituents, its specific gravity is 1·1958; one hundred grains of it consist of 40.39 of real acid, and 59·61 of water. It is a colourless liquid, and, when exposed to the air, it smokes, because the gas exhaled condenses the moisture of the atmosphere. It extinguishes both flame and life, and is not inflammable. It is of a pungent, suffocating, and somewhat aromatic smell. It powerfully reddens vegetable blues. The best method of obtaining it is by pouring sulphuric acid upon an equal weight of sea-salt, and collecting the gas which is given off, over mercury. An immense number of salts are formed from the combination of muriatic acid with oxides; such as common sea-salt, which is a muriate of soda. These are very extensively used, both in the arts and medicine. Chlorine combines with azote, and forms what is called

Chloride of Nitrogen.—This is an oily liquid, and the most powerfully explosive compound known. In this respect it is one of the most dangerous substances of nature; it consists of four volumes of chlorine combined with one of azote. Chlorine combines with carbon, but the compounds are unimportant.

BROMINE.

The term *bromine* is from a Greek word, signifying "a strong disagreeable odour." This substance was discovered only so lately as the year 1826; it resembles chlorine in many of its habitudes. It is of a brownish-red colour, very disagreeable smell, sharp strong taste, powerfully corrosive of organic bodies, and, when taken internally, a violent poison. Its specific gravity is 2·96; it destroys vegetable colours almost as powerfully as chlorine. Like chlorine, it sets fire to certain metals when brought into contact with it; it is not combustible, and it extinguishes combustion; it becomes solid at a little below zero; but if combined with water, so as to form a hydrate, it affords fine red crystals at 32°. An acid is formed by the combination of bromine with oxygen, and is called bromic acid; another with hydrogen is called hydrobromic acid. Chlorine also combines with it, and forms a chloride. There are numerous other combinations of bromine, but the compounds are unimportant.

IODINE.

This substance was first discovered in 1811, by a saltpetre manufacturer of Paris. It is derivable from sea plants, and in some of its properties much resembles chlorine, which is also a marine production. If common sea-weed be powdered dry, and treated with sulphuric acid whilst subjected to heat, a violet-coloured vapour is expelled, which, if collected in a vessel, condenses into scaly dark-gray crystals, with somewhat of a metallic lustre. These are iodine, so called from the violet-colour of its vapour; iodine being a Greek word, and signifying "violet-coloured." Its specific gravity is 3·0844. Its smell is disagreeable, its taste acrid and hot, and it possesses poisonous properties. It is a powerful stimulant, and has of late been much employed as a medicine. It destroys vegetable colours, but not so completely as chlorine. It melts when heated to 224½°, and volatilizes at 351½°. It forms a beautiful blue colour when mingled with water holding starch in solution; it is itself slightly soluble in water, but more so in alcohol and ether. Iodine combines with oxygen in three proportions, forming iodic acid, iodous acid, and oxide of iodine; with chlorine, forming chloriodic acid; with bromine in two proportions, forming bromides; and also with azote and hydrogen. A compound of iodine and azote is exceedingly explosive. But a particular account of these substances do not require to be given in this place.

FLUORINE.

The existence of this substance, strange to say, is conjectural; yet its separate identity is supported by the strongest analogies. It exists, or rather is supposed to exist, in fluor or Derbyshire spar, and is thus provisionally called fluorine. If some of this mineral in powder be distilled with strong sulphuric acid, from a leaden retort (a vessel somewhat of the shape of common Rupert drops) into a leaden receiver kept cold with ice, an intensely active fluid is produced. "It has," says Davy, "the appearance of sulphuric acid, but it is much more volatile. When applied to the skin, it instantly disorganizes it, and produces very painful wounds. When it is dropped into water, a hissing noise is produced, with much heat, and an acid fluid is formed." This substance has been called *hydrofluoric acid*, because it is conjectured to have fluorine as a base, combined with hydrogen, to form an acid, upon the principle which we have formerly described. Other views have been adopted with respect to this substance, but the above is the one now generally admitted.

CARBON.

Carbon or charcoal is found in many different forms, and can be prepared by burning wood, coal, &c., in close vessels. The diamond is pure carbon, and plumbago or black-lead is principally composed of this substance with a little iron. It burns in oxygen with considerable brilliancy, although in common air it emits but a feeble light. If carbon be burned in a close vessel, filled with oxygen, the carbon will be entirely consumed, and the oxygen so much changed, that if a lighted taper be put into it the light will be extinguished. Carbon combines with all the supporters of combustion, and with oxygen forms carbonic acid. This acid may be prepared in the pneumatic trough, by putting into the retort an ounce of hydrochloric acid, previously mixed with two ounces of water, along with a tablespoonful of the carbonate of lime. An effervescence takes place between the acid and the lime, carbonic acid gas being given off, which can be collected in the jars and condensed in water. Carbonic acid is fatal to animal life, and the gas will extinguish a candle introduced into it.

Oxalic Acid.—This substance, which is also a combination of carbon with oxygen, may be formed by digesting sugar along with nitric acid. The acid is deposited in small crystals, which have an intensely acid taste, and, when taken internally even in small quantities, destroys life. It combines with bases, and forms a genus of salts called *oxalates*. Carbon is capable of uniting with chlorine in three different proportions, with bromine in one or two, and with iodine in two. But we must pass from these compounds to those of far greater moment which it forms with hydrogen.

There are many combinations of carbon with hydrogen, and much uncertainty prevails both with regard to their number and nature; they are all designated by the name *hydrocarbons*, or more properly *hydrocarburets*.

COAL GAS.

Carbureted and bicarbureted hydrogen bear very different relations to the well-being of man: the former, when a spontaneous production of nature in mines, is one of the most terrific instruments of destruction, and a great obstacle to human industry; for, by mixing with a certain quantity of common air, it acquires the property of exploding when accidentally kindled, and thousands of human lives have fallen sacrifices to its violence, until Sir Humphry Davy's invention of the safety-lamp divested it of its terrors.

Davy's safety-lamp consists of a common lamp surrounded with wire-gauze. On analyzing the carbureted hydrogen or fire-damp, Sir Humphry Davy found that it would not explode when mixed with less than six times, or with more than fourteen times, its volume of atmospheric air, that air rendered impure by the combustion of a candle will not explode fire-damp, though the candle will still burn for a time; and that, if a candle be burnt in a close vessel, with small apertures only above and below the flame, no explosion will ensue. The flame within will be enlarged, but no explosion take place; and it was found that the gas from mines will not explode in a tube less than one-eighth of an inch in diameter.

Bicarbureted hydrogen is the chief, although not the most abundant ingredient in *coal gas*, now so generally used for illumination; the other ingredients are carbureted hydrogen, hydrogen, and carbonic oxide. Coal gas is made by introducing a quantity of bituminous coal into a large iron cylinder called a retort, close at one end, and furnished with a mouth-piece at the other, for closing or opening it; there is also a tube for carrying off the gas and other products as they form. A quick strong heat is applied round the cylinder, and a vast quantity of gas, composed of the four ingredients just mentioned, is thus extricated, with tar and an ammoniacal liquor, both of which are condensed by passing through pipes immersed in cold water. There is a great difference in the relative proportions of the gases in the mixture, as also in the quantity of tar, according to the quality of the coal and the mode of applying the heat. The more tar the gas holds dissolved, the more dense will be the flame when the gas is made to burn, and the more disagreeable will be the smell when it is not burning. A slow heat gives much tar and little gas, and that little of a poor quality; a quick heat gives much gas, of good quality, and less tar. Owing to these and other causes, the illuminating power of coal gas varies much. Before it is let through the conducting tubes for public consumption, it is well agitated in contact with a mixture of lime and water, or passed through strata of loosely strewed hydrate of lime; it is thus deprived of much of its smell, and also of some of its illuminating power. On an average, a chaldron of good Newcastle coal, weighing 25 cwt., will afford 12,000 cubic feet of gas, provided that the retorts are new. After being used a few months, the product will not exceed 11,000 feet, or even 10,000. An illuminating gas of this kind is sometimes presented ready formed by nature. A village of Fredenia, in the western part of the state of New York, is lighted with this gas as it naturally issues from a rock; the flame is large, but not quite so brilliant as that of coal gas.* A scheme was recently in agitation for lighting the towns of Newcastle and Gateshead with a natural gas which issues from the Wallsend coal-pits. This gas is diluted with about 10 per cent. of atmospheric air, but is otherwise remarkably pure. *Oil gas* being of a similar nature, it need not be particularly described. There are other less important compounds of carbon and hydrogen, and the whole correspond with the law of multiple combination already described. *Naptha* and *napthaline* are hydrocarburets; the former is a transparent volatile fluid, the other is a transparent volatile solid, which assumes the form of crystalline plates: both are obtained from coal tar by distillation.

Cyanogen.—This substance is a gaseous compound of azote and carbon. It burns with a purple flame, and destroys life on being breathed. Cyanogen unites with a variety of bodies, and forms many important compounds.

BORON.

The borax of commerce is a compound of boracic acid and the alkali called soda. Boracic acid is a compound of oxygen and boron, in the proportion, it is supposed, of one atom of the latter to three of the former. Pure boron is an opaque brownish-olive powder,

* Donovan's Chemistry, p. 117.

infusible, and not volatile at any temperature to which it has yet been subjected. It neither dissolves in nor acts upon water. At about 600°, it takes fire, and combines with oxygen, forming

Boracic Acid.—This substance evinces the usual properties of an acid, but it is not a powerful one at ordinary temperatures. At high temperatures, however, it displaces the strongest of the other acids, and is exceedingly useful in fluxing out the baser metals from the nobler. When the acid is detached from borax, by vitriol being poured upon that compound, it exhibits itself in scaly crystals. It dissolves in rectified spirits, and, if the solution be set on fire, it burns with a green flame. Borax itself, when heated, melts into a perfectly clear glass, which is the basis of some artificial gems of considerable beauty. Borax communicates its own fusible nature to other bodies, and hence is used as a flux. Flux is a general term made use of to denote any substance or mixture employed to assist the fusion of minerals. There is a considerable number of such bodies; the alkalies are those most generally used. Boracic acid is the only known compound of boron with oxygen. There has been no compound yet discovered of boron with either bromine or iodine, but it combines with chlorine, forming a gaseous acid, to which the name of *borochloric acid* has been given; and also with fluorine, forming

Fluoboric Acid, which exists in the gaseous state. It is colourless, has an exceedingly acid taste, and a smell similar to muriatic acid. It contains no water, but possesses a powerful affinity for that fluid, and is on that account sometimes used as a test of the presence of moisture in gases. Its specific gravity is 2·362; and it seems to consist of one atom of boron and three of fluorine. The combinations of boron with hydrogen, azote, and carbon, are still unknown.

SILICON.

Quartz, or *rock-crystal*, which constitutes so considerable a portion of the crust of the earth, consists essentially of a peculiar acid substance, called *silica* or *silicic acid.* This substance is a compound of oxygen with a base which has been entitled silicon. It is a powder of a deep brown colour, and very similar to boron in its appearance and in its relations to other matter. It stains the fingers, and adheres to every thing that comes in contact with it. It can be exposed to a very high temperature without being fused; after ignition, the specific gravity is about 1·837. It dissolves in a mixture of fluoric and nitric acids with great facility, although it is not acted upon by them singly. When mixed with dry carbonate of potash or soda, and heated far below redness, it burns vividly at the expense of the carbonic acid; carbonic oxide is disengaged, and the residue is tinged black by carbon being deposited. By this process silicon is converted into silica, which is a compound of one atom of silicon and one atom of oxygen. Silicon combines with chlorine, forming a *chloride of silicon.* This is a colourless volatile liquid, having a suffocating smell, and probably acid properties. With fluorine, silicon unites and forms

Fluosilicic Acid.—This is a gaseous substance, transparent, colourless, and having a smell like muriatic acid. It smokes when mixed with moist air, and it is rapidly absorbed by water. Its specific gravity is 3·6. It combines with carbon, but no other compounds are known.

SULPHUR.

Sulphur, or brimstone, is a substance whose appearance is too familiarly known to require a particular description. In many parts of the world it is found in a state of great purity. It occurs plentifully in volcanic countries, and is an abundant ingredient in various minerals. It is a non-conductor of electricity, and when rubbed, becomes highly electric. It has a specific gravity of 2·0332. When heated to 170°, it is volatilized, and the result is a fine powder called *flowers of sulphur.* It melts at 218°, but at 340° it becomes thick, and from 482° to its boiling point, about 750°, it gets thinner. When suddenly cooled, it remains soft, in which state it is used for taking impressions. It is extensively used in the arts; for instance, in the manufacture of gunpowder. With oxygen it combines in four proportions, forming four compounds, all of which possess acid properties.

Sulphurous Acid.—When sulphur is heated to 300° in the open air, it takes fire, and burns with a pale blue flame, at the same time emitting abundance of fumes of a suffocating nature, which are sulphurous acid. It is colourless, extinguishes flame, is not inflammable, converts vegetable blues to red, forms a class of salts called *Sulphites*, and has a specific gravity of 2·2222. This gas bleaches various textures, as those of silk, wool, and straw; the liquid acid bleaches sponge. Sulphurous acid is supposed to consist of equal bulks of oxygen and sulphur. Its proportions are one part of sulphur to two of oxygen.

Sulphuric Acid, or *Oil of Vitriol.*—This acid is made in great quantities for the use of bleachers, and other manufacturers, by burning sulphur in leaden chambers. At the same time, a quantity of nitric acid from the decomposition of saltpetre is admitted into the chamber. The sulphur is converted into sulphurous acid. Five atoms of this acid unite with one atom of nitric acid, and two atoms of water, and form a white solid salt, which falls to the bottom of the chamber into a quantity of water placed to receive it. As soon as it comes in contact with the water, a strong effervescence takes place: the nitric acid is decomposed, and converts the sulphurous into sulphuric acid, while at the same time a quantity of deutoxide of azote is disengaged. This gas, coming into contact with the oxygen of the air, is converted into nitric acid, which combines with an additional dose of sulphurous acid, and is decomposed as before. Thus the process goes on as long as sulphurous acid and oxygen gas exist in the leaden chamber.* Sulphuric acid thus obtained is a colourless liquid, possessing some viscidity; and when as much concentrated as possible, its specific gravity is 1·837. Sulphuric acid is one of the most powerfully corrosive bodies known to us. The following are some of its principal properties. When mixed with water, to which it has a very powerful attraction, a decrease of volume occurs, and a considerable degree of heat is generated. It freezes when sufficiently cooled, and the crystals are sometimes large, distinct, and hard. When exposed to the air, this acid discharges whitish gray vapours, which are sulphuric acid in a dry state. Acid of specific gravity 1·896, contains about one-tenth of water, and is so volatile that it boils at 120°. The constitution of sulphuric acid is, sulphur one part, and oxygen three parts. It forms a very numerous and important class of salts called *Sulphates.* The other two compounds of sulphur and oxygen, namely, the hyposulphurous and hyposulphuric acids, it is unnecessary to notice. Sulphur unites with chlorine in two proportions. It also combines with bromine, iodine, and fluorine, but its next most important combinations are those with hydrogen.

Sulphuretted Hydrogen, or Hydrosulphuric Acid.—This is a colourless gas, having a strong fœtid smell, something like rotten eggs, and a sweetish taste. It is a non-supporter of combustion, and, when breathed, destroys animal life. Its specific gravity is 1·1805. It is combustible, and burns with a bluish red flame. Water absorbs 3·66 times its bulk of this gas; and if it be passed through water tinged with a vegetable blue, it

* Thomson.

will change the colour to red. A few drops of nitric acid let fall into a vessel filled with sulphureted hydrogen, set fire to it. This gas blackens silver, and darkens the wood-work of rooms painted with white lead, from human exhalations containing a portion of it. Its atomic constituents are said to be one atom of sulphur and one atom of hydrogen. Double the quantity of sulphur to the same proportion of hydrogen forms what is called the *bisulphuret of hydrogen*. No compound of sulphur and azote is known, but with carbon there is more than one. With boron and silicon, sulphur forms sulphurets.

SILENIUM.

This is a substance nearly allied to sulphur in its nature, although it in some respects partakes also of the character of a metal. It melts at about 212°, and on cooling becomes solid, in which state it has a metallic lustre, and a deep brown colour. It is soft and easily reduced to powder, which is of a deep red. Its specific gravity is 4·3. It is a bad conductor of heat, a non-conductor of electricity, and is also non-electric. Like sulphur, it sublimes into flowers. It combines with oxygen in three proportions, forming *oxide of silenium*, a gaseous body; *selenous acid*, which has an acid and acrimonious taste; and, lastly, *selenic acid*, which resembles sulphuric acid in its consistence and in many of its properties. It is to be remarked, that the compounds of selenium and oxygen bear a strong analogy to some of those of oxygen with sulphur. Selenium combines also with sulphur, chlorine, and carbon.

PHOSPHORUS.

This well-known substance is commonly prepared from bones, which consist chiefly of the phosphate of lime. This salt is decomposed by sulphuric acid, and after going through a difficult process, the phosphorus is distilled into a receiver in the shape of melted drops. It is an amber-coloured and semi-transparent solid. Its specific gravity is 1·748. It is so very combustible that it takes fire in the air, emitting a white smoke having the smell of garlic, and appears luminous in the dark. At the temperature of 148°, it burns with a large resplendent flame, giving out a white smoke, which is—

Phosphoric Acid.—This substance can be obtained by other processes, in which case it exhibits itself as a transparent solid body like glass. It has no smell, but an exceedingly sour taste; it is not corrosive. Its atomic constituents are supposed to be two atoms of phosphorus to five atoms of oxygen. Phosphorus also produces another acid called *phosphorous acid*, containing a smaller proportional quantity of oxygen; and a third, called *hypophosphorous*, containing still less of the gas.

Phosphureted Hydrogen.—This gas is colourless, has a smell like garlic, and a very bitter taste; its specific gravity is 1·7708. It burns spontaneously. When mixed with oxygen, *rarefaction* causes them to explode, as *condensation* produces explosion in other gases—a very remarkable property of this substance. This gas may be detonated, also, with protoxide and deutoxide of azote. When mixed with chlorine gas, it burns with a greenish-yellow flame. It is composed of equal volumes of hydrogen gas and phosphorus vapour. There are other compounds formed of these two substances; and phosphorus combines also with chlorine, bromine, and iodine, in two proportions each. It likewise unites with fluorine, carbon, sulphur, and selenium.

ARSENIC.

The *White Arsenic* of commerce is a combination of arsenic and oxygen. When mixed with *black flux* (which is composed of cream of tartar and about half its weight of nitre, heated to redness in a covered crucible), and subjected to heat, it is reduced to the metallic state. It has a bluish-white colour, is soft, brittle and easily reduced to fine powder. Its specific gravity is 5·672. When moderately heated, it evaporates, combining with oxygen, and forming the arsenic of commerce, so well known for its destructiveness to animal life. With oxygen, arsenic forms two acids, the *arsenous* and *arsenic*. *Arsenous acid* is a white, brittle, compact substance, having a weak, acrid taste, which at last leaves an impression of sweetness. It is one of the most virulent poisons known. *Arsenic acid* is quite similar in its constitution to phosphoric acid. Arsenic combines with chlorine, bromine, iodine, fluorine, hydrogen, sulphur, phosphorus, and selenium.

ANTIMONY.

This is a metal which, when pure, possesses a silver-white colour. Its compounds are well known, being much used as a medicine. Its texture is fibrous, and it is easily reduced to powder by being pounded in a mortar. Its specific gravity is 6·4366. It melts when heated nearly to redness, and at a higher heat it is sublimated in white fumes. It combines with oxygen in three proportions, and forms three compounds, two of which possess acid properties. The other is an oxide, which constitutes the base of all the active medicinal preparations of this metal. With chlorine it combines in two proportions, forming two chlorides, which are analogous to two of the compounds formed with oxygen. It also combines with bromine, iodine, fluorine, sulphur, selenium, phosphorus, and arsenic. Antimony is extensively used in the arts, particularly in type-founding and stereotyping.

TELLURIUM.

This substance is a metal, having a silver-white colour, and considerable brilliancy. It has a laminated texture, is brittle, may easily be reduced to powder, and has a specific gravity of 6·1379. It fuses at a temperature rather higher than that which is necessary to melt lead. It combines with oxygen, and forms *oxide of tellurium*. This compound possesses at once acid and alkaline properties. When tellurium is heated before the blowpipe, it burns with a blue flame, emitting a white smoke, which is the oxide. Tellurium burns spontaneously in chlorine gas, and forms a *chloride of tellurium*. It also unites with iodine, hydrogen, and carbon. The other combinations of this metal are still unknown.

CHROMIUM.

This is a metal of a whitish colour and a brittle consistency. Its specific gravity is 5·9. It requires a very high degree of heat to melt it, and is only obtained pure in small grains. No acid readily dissolves it, except the fluoric. Chromium combines with two proportions of oxygen, forming two compounds, which have received the names of *green oxide* and *chromic acid*. Chromium unites with chlorine, sulphur, phosphorus, and probably fluorine. It is used in coloured glass making, and glass and porcelain painting. It is also used in enamelling, and as a rich, strong, and durable pigment. To glass and enamel it communicates a green colour, but to the painter it affords one of his prettiest yellows.

VANADIUM.

This is a metal which was only discovered a few years ago. It is white, resembling silver, brittle, a good conductor of electricity, and is easily dissolved in nitric acid and aqua regia. When heated rather under redness, it takes fire, burns with a dull flame, and is converted into a black-coloured oxide. It combines with oxygen in three proportions, forming, first, *black oxide* or protoxide, the *binoxide*, and *venadic acid*. It combines also with chlorine, sulphur, and phosphorus, but its other compounds are unknown.

URANIUM, MOLYBDENUM, TUNGSTEN, COLUMBIUM, AND TITANIUM.

These substances are all metals, but on account of their scarcity, or from the difficulty of reducing them to their metallic state from their ores, they are but imperfectly known, and have not been applied to any useful purpose. *Uranium* has an iron-gray colour, of considerable lustre, and, when heated to redness, takes fire. It produces a deep green protoxide, which gives a black colour to porcelain, and a fawn-coloured peroxide, which communicates to porcelain an orange colour. Its specific gravity is 9. *Molybdenum* has a silver-white colour, is brittle, and has a specific gravity of 8·636. *Tungsten* is of a grayish-white colour, is very hard and heavy, having a specific gravity of 17·4. *Columbium*, when burnished, assumes a yellowish-white colour and a metallic lustre. *Titanium* has a copper-red colour, and considerable brilliancy. It crystallizes in cubes, is hard enough to scratch rock-crystal, and has a specific gravity of 5·3. All these metals combine with oxygen and some of the other supporters; but the oxides and acids so formed are not deserving of particular mention.

ALKALINE BASES.

Potassium is the base of that well-known and very useful article potash. The properties of potassium were first determined by Sir H. Davy, to whom we are indebted for the discovery of the composition of the alkaline bodies. It is a white metal, like silver. At 30° it is hard and brittle, at 50° is soft and malleable, at 132½° melts, and at a low red heat evaporates. Its specific gravity at 60° is 0·865, being lighter than water. When exposed to the air, it rapidly absorbs oxygen, and forms potash. This latter body, as found in commerce, is always combined with water, which cannot be expelled by heat. When potassium is thrown on the surface of water, which it swims upon, it decomposes that fluid with such rapidity, that the metal takes fire, and burns with a red flame. Potassium combines with two proportions of oxygen; it also unites with chlorine, bromine, iodine, hydrogen, sulphur, and several other bodies.

Sodium is a metal so similar in most respects to the foregoing, as to stand in no need of particular description. It is the base of the alkali called soda, which is formed when the metal is brought into contact with water, or when it is heated in oxygen. It decomposes water, and in its relations to other bodies, bears a strong resemblance to potassium.

Lithium.—This metal is the base of the alkali called lithia, which is of a white colour, and has a taste fully as caustic as that of potash itself. It is of course an oxide of Lithium. Lithium likewise unites with chlorine, but its other combinations are unknown.

Barium.—This metal is the basis of barytes, an alkaline earth. It is of a white silvery appearance, absorbing oxygen rapidly by exposure to the air, thus forming barytes; and it also rapidly decomposes water. Barium combines also with sulphur and phosphorus, and forms compounds with chlorine, bromine, and iodine.

Strontium.—This metal is the base of strontia, an earth very similar to the foregoing. Strontium and barium resemble each other very much in most of their properties, and their combinations with oxygen have also a very strong resemblance. Strontium also unites with chlorine, phosphorus, and sulphur.

Calcium.—This metal is the base of the well-known and indispensable commodity lime. *Lime* has been known from the remotest ages, and appears always in combination with an acid, most commonly with the carbonic, constituting *limestone, marble, calcareous spar, chalk*, and frequently with sulphuric acid, constituting *gypsum, selenite*, and *sulphate of lime*. It combines also with various other acids. Calcium is white, like silver, solid, and much heavier than water. When heated in the open air, it burns brilliantly, and quick-lime is produced. Calcium unites with oxygen in two proportions, forming lime and peroxide of calcium. Pure lime has an acrid taste, and is sparingly soluble in water. It, however, readily absorbs water poured upon it, and swells, producing at the same time a great heat. The fact is, that the water becomes solidified, and of course gives out a great quantity of heat, which accounts for the rise of temperature. This process is called slacking lime. Lime combines with chlorine, and forms *chloride of lime*, a substance which has become an important article of commerce under the name of *bleaching powder*. It is a white powder, with a hot taste, having the power of destroying vegetable colours. Calcium combines with sulphur and phosphorus.

Magnesium.—This metal is the basis of magnesia, a substance universally known from its frequent employment in medicine. Magnesium is obtained in brown scales, which, when rubbed against agate, leave a metallic stain, of a leaden colour. It burns with a red light, and, by thus combining with oxygen, becomes *magnesia*. This is a soft, elastic, tasteless powder, not sensibly soluble in water, and slowly changing vegetable blues to green. Magnesium forms salts with chlorine, bromine, and iodine.

EARTHY BASES.

This family comprehends five substances, the oxides of which are white tasteless powders, distinguished by the name of *earths*.

Aluminum.—Alumina, which, when pure, is a fine light powder of brilliant whiteness, is an essential constituent in every kind of clay, and constitutes the base of *alum*, from which substance it may easily be obtained. It is a compound of oxygen and aluminum, consisting of two parts of the former to three of the latter. This metal, when burnished, assumes a metallic lustre resembling that of tin. It is not easily fused, but at a red heat it burns with great splendour, and is converted into alumina. This substance, so useful in the manufacture of every species of pottery, is the only compound known of oxygen with aluminum. Alumina possesses the remarkable property of shrinking into less bulk according to the intensity of the heat which is applied to it; hence, it was formerly employed as a kind of thermometer or rather pyrometer, for measuring very high degrees of temperature, in furnaces for instance. A gauge is used for measuring the amount of the contraction. Aluminum combines with chlorine, phosphorus, sulphur, and selenium.

Glucinum.—Glucina, which is the oxide of glucinum, exists to about fourteen per cent. in the beryl or emerald, from which it can be extracted. Glucinum is a dark-gray powder, which, when burnished, acquires the metallic lustre. It is very difficult of fusion. When heated in air or oxygen, it burns brilliantly, and affords the oxide glucina—the only compound which it forms with oxygen. Glucina, which consists of 100 metal and 44·44 oxygen, is a soft, tasteless, white powder, which, when wet, is somewhat plastic, like alumina. It neither dissolves in water nor melts in the fire. Its salts have a sweetish taste, like those of alumina; and both of these earths are in this respect opposed to magnesia, which with acids affords salts of a bitterish taste. Glucinum combines with chlorine, phosphorus, sulphur, selenium, iodine, and bromine.

Yttrium.—Yttria, which constitutes the oxide of this metal, is obtained from a scarce mineral called gadolinite Yttrium is procured from it in iron-gray scales. If heated in common air or oxygen, it burns brilliantly, forming the earth yttria; and as far as is known, this is the only compound formed by the union of oxygen and yttrium The latter substance combines with chlorine and the combustibles.

Cerium.—This metal exists in a reddish-coloured mineral found in Sweden, called *cerite.* Cerium is a dark-gray powder, having a metallic lustre, but its properties have not yet been properly determined. It, however, combines with oxygen, chlorine, carbon, sulphur, and phosphorus

Zirconium.—The earth called zirconia is a harsh whitish powder, destitute of taste or smell. The base zirconium is composed of brilliant scales, which are probably metallic, although the substance has not as yet evinced the metallic lustre. When heated in common air, it takes fire, and is converted into zirconia, which is perfectly white. This is the only compound which it forms with oxygen. It unites with chlorine, carbon, and sulphur.

Thorium.—This is a newly discovered metal, of a leaden-gray colour, heavy, and under the burnisher shows metallic lustre. If it be heated in open air, it burns with much splendour, and the resulting snow-white oxide is the earth called thorina. This is the only compound of thorium with oxygen, and the resulting substance is distinguished from the other earths by various properties. Thorium, when heated in vapour of sulphur, burns, and it also unites with chlorine and phosphorus.

DIFFICULTLY FUSIBLE BASES.

Iron.—This well-known substance is one of the seven metals with which the ancients were acquainted; these were gold, silver, copper, iron, tin, lead, and mercury. Iron is a metal of great utility, and it is fortunately found abundantly. Almost every mineral contains it. The ore from which the iron of Great Britain is obtained, is a *carbonate of iron.* Iron, after passing through a fiery ordeal, has a grayish colour, a metallic lustre, and, when burnished, a good deal of brilliancy. Its hardness exceeds that of most metals, and, when in the state of steel, it may be rendered harder than most bodies. Its specific gravity is 7·843 after hammering. It is attracted by the magnet, and may itself be converted into a permanent magnet. It is malleable at every temperature, very ductile, and very combustible, for we see a thin wire burn in the flame of a common candle. It burns brilliantly in oxygen, with which it combines in two proportions, forming oxides. It combines also with chlorine, bromine, iodine, boron, sulphur, selenium, phosphorus, arsenic, chromium, and antimony; but the most important of its combinations with simple substances are those with charcoal, which form the important compounds *cast-iron* and *steel.* Iron forms with the acids a numerous and valuable class of salts.

Manganese.—When this substance is pure, which is rarely the case, it is rather whiter than cast-iron, of a granular texture, and may be reduced to powder by pounding. Its specific gravity is 8·013. It is attracted by the magnet only at a very low temperature. It gradually absorbs oxygen from the atmosphere, and decomposes water, a property which it loses when alloyed with iron. It is much in use. Glass-makers use it for two purposes; first, for communicating a purple or violet colour, or for destroying all colour, and rendering the glass colourless. Manganese has a strong affinity for oxygen, with which it combines in seven proportions, forming acids and oxides. It unites also with chlorine, fluorine, carbon and sulphur.

Nickel.—This metal, when pure, has a white colour, like silver; is rather softer than iron; is malleable both hot and cold; is attracted by the magnet; and, like iron, can be converted into one. Its specific gravity is 8·380 after fusion. The preparations of this metal contain poisonous qualities. Nickel combines readily with oxygen, forming two oxides. It also unites with chlorine, carbon, sulphur, phosphorus, and arsenic.

Cobalt.—This metal has a gray colour with a shade of red, and is not brilliant. Its texture is granular; it is rather soft and brittle; its specific gravity is 8·7. It is used for giving a blue colour to glass and porcelain; the tint is beautiful, and hence the metal bears a high price. It unites with oxygen, and forms two oxides; these are the preparations of cobalt used in the arts. It also combines with chlorine, sulphur, selenium, and phosphorus.

EASILY FUSIBLE BASES.

Of the eight metals composing this family, all are malleable except bismuth, which is not very brittle. They melt at a comparatively low heat. A rod of zinc throws down these metals from their acid solutions in the metallic state.

Zinc.—This metal is of a bluish-white colour, and is composed of plates adhering together. It is a hard metal, being acted on by the file with difficulty; and, after fusion, its specific gravity is 6·896. It becomes malleable at 212°, and melts at 773°, or before it is quite red. When heated red-hot with access of air, it takes fire, burns with an exceedingly beautiful greenish or bluish-white flame, and is at the same time converted into the only oxide of zinc with which we are acquainted. It is of a snow-white colour, is tasteless, and insoluble in water. With copper, zinc forms that well-known and useful alloy called *brass.* Zinc combines with, and is set on fire by, chlorine; it enters into union with phosphorus, sulphur, selenium, iodine, and various metals.

Cadmium.—This metal, which is commonly associated with the ores of zinc, has a white colour with a shade of bluish-gray, and resembles tin in its appearance. It is very malleable, and has a specific gravity after fusion of 8·6040. It unites with oxygen, chlorine, and some other supporters, but the compounds are unimportant.

Lead.—This is one of the most abundant of all the metals, and one of the softest and most fusible. Lead has a bluish-white colour, and a good deal of lustre, but it soon tarnishes. Its specific gravity after fusion, which takes place at 600°, is 11·351. Lead is very malleable, it is also ductile, but its wire possesses little tenacity. By exposure to a very strong heat, it is volatilized, and at the heat of burning hydrogen, urged by oxygen, it burns with a bluish flame. While exposed to the atmosphere during fusion, it imbibes oxygen, and is converted into an oxide. There are three oxides of lead—the protoxide, which is known in commerce and the arts as a yellow paint, under the name *massicot,* or if it be semi-vitrified, *litharge;* the deutoxide is also a paint of a brilliant red colour, inclining to orange; it obtains the name of *minium,* or *red lead;* and the peroxide, which is of a deep puce *brown* colour. When heated with sulphur, spontaneous combustion takes place. Lead also combines with chlorine, bromine, iodine, sulphur, selenium, arsenic, &c. It is rendered hard by antimony, and the alloy, mixed with a little tin, constitutes the material from which printer's types are elaborated. The salts of lead are numerous and very important. *White lead* or *ceruse,* the only white used in all oil paintings, is made by subjecting thin plates of lead, rolled up spirally, to the fumes of vinegar. The lead soon becomes corroded, and assumes a white appearance and a brittle consistency. If this substance be dissolved in acetic acid or vinegar, it becomes *sugar of lead.* Lead is never found native: by far the most common state in which it occurs in nature, is mineralized by sulphur. The common name for sulphuret of lead is *galena.* It is abundant in all quarters of the globe.

Tin.—This metal resembles lead in many of its properties. It possesses a fine white colour, with a slight shade of blue, and has a good deal of brilliancy. Its specific gravity after fusion is 7·285. It is very malleable. Tin leaf, or *tinfoil,* as it is called, is about the one-thousandth part of an inch thick, and it might be made much thinner, if requisite. It is ductile, but of inferior tenacity. It is very flexible, and produces a remarkable crackling noise when bended. It melts at 442°, but a very violent heat is required before it will evaporate. It slowly tarnishes with the air, and, when intensely heated, oxygen being supplied, it burns with great brilliancy. Tin combines with oxygen in three proportions, forming the protoxide, which is *black*, the sesquioxide, which is *grayish*, and the peroxide, which is *yellow*. It also unites with chlorine, bromine, iodine, sulphur, selenium, phosphorus, and fluorine. It alloys with various metals. It is used in coating vessels, either in a pure state or alloyed. Pewter is composed of lead and tin; the latter rendering the former, a poisonous metal, quite innocuous. English tin is the best of all, and it is affirmed that it was exported from this island 2200 years ago.

Copper.—This metal, in point of general utility, ranks next to iron. It possesses a rose-red colour, and a great degree of brilliancy. Its specific gravity, after being rolled out into plates, is 8.953. It has great malleability, and very considerable ductility. A bar of cast copper, one quarter of an inch thick, requires 1192 lbs. to break it, whilst hammered copper requires nearly 1000 lbs. more to break it. It melts at 1996°; and if the heat be increased, it evaporates in fumes, which are visible. When rubbed, it emits a smell. When heated in a hydrogen flame urged by oxygen, it burns brilliantly, emitting a dazzling green light; a piece of copper in a coal fire tinges the blaze green. When exposed to air, it oxidates into a green carbonate of copper, slowly, and when in contact with moisture. With oxygen it combines in three proportions, forming three oxides, two of which occur native; the other is not a permanent compound. Copper combines also with chlorine, iodine, sulphur, phosphorus, arsenic, and tin. Its alloys with the latter metal are very important. From eight to twelve parts of tin, combined with one hundred parts of copper, composed *bronze*, and the *metal of cannons*. Four parts of copper and one of tin compose *bell-metal*. The alloy used for the mirrors of telescopes was employed by the ancients for the composition of their mirrors. It consists of about two parts of copper united to one part of tin.

Bismuth.—This metal has a reddish-white colour, and is composed of broad plates adhering to each other. It is one of the most fusible of the metals, and communicates its fusibility to other metals. Its specific gravity is 9.833. Although not very brittle, it is not malleable, unless when heated, nor can it be drawn into wire. A mixture of tin, lead, and bismuth, is so fusible, that it melts when thrown into boiling water. A toy of this kind is well known; it is a spoon, which, when immersed in a very hot liquid, immediately melts. Bismuth combines with oxygen, chlorine, bromine, iodine, sulphur, and selenium. What is called Newton's fusible metal, is a compound of eight parts by weight of bismuth, five of lead, and three of tin. It melts at 212°.

Mercury or *Quicksilver.*—This metal has a silver-white colour, possesses great brilliancy, and remains fluid at the common temperature of the atmosphere. Its specific gravity, at 60°, is 13·56846; at 30° below zero, when it assumes the solid form, it is 15·612°. When solid, it may be beaten out with a hammer, or cut with a knife. When heated to 656°, it boils; and when heated in the open air, it oxidizes. The oxides and chlorides of mercury afford an admirable proof of the truth of the atomic theory. It combines also with bromine, iodine, sulphur, selenium, and phosphorus. The compounds which mercury forms with the other metals are usually termed amalgams. This metal occurs in South America and in Spain, in great abundance. But the mine of Idria, in Carniola, an Austrian province, is perhaps the greatest in the world, and has been wrought for more than three centuries.

Silver.—This metal is of a fine white colour, with a slight shade of yellow. When polished, it displays a great deal of brilliancy and beauty. It is very malleable, and may be beaten out into leaves so thin as 1-000,000th of an inch. It is softer than copper, and harder than gold; but its tenacity is inferior to the former metal. When melted and cooled slowly, its specific gravity is 10·3946; when hammered and rolled it is a little higher. Its melting-point is 1830°; and if it be kept melted for a long time, it absorbs oxygen; but it possesses the very singular property of parting with the oxygen on solidifying. Gay Lussac, a great French chemist, says that the presence of a little copper deprives it of this property. Silver forms with oxygen only one well-known oxide. It also unites with chlorine, bromine, iodine, sulphur, selenium, phosphorus, and arsenic. There are numerous alloys of silver, but few of much consequence. One pound of standard silver is coined into sixty-six shillings; the mint price of silver, therefore, is 5s. 6d. per ounce at present. Silver is found in all parts of the world, sometimes alloyed with a variety of other metals and substances, and sometimes in the native state.

NOBLE METALS.

Some might include silver, and even mercury, in this list, but it is more common to say that the family comprehends six metals, which all require a violent heat to fuse them. The name noble metals has been given to the family, because it contains gold and platinum, the most esteemed of all the metals; and because the other four metals belonging to it are usually associated with native platinum. Their oxides are reducible to the metallic state by the application of heat alone.

Gold.—This is the most valuable of all the metals. It always occurs in nature in the metallic state, although seldom pure. It has a beautiful yellow colour, and considerable lustre, which it retains, not being liable to be tarnished by exposure to the air. It is rather softer than silver, and after fusion it has a specific gravity of 19·2. It is the most malleable of metals, and may be beaten out into leaves no thicker than 1-282,000th of an inch, and the gold leaf with which silver wire is covered is only 1-12th of that thickness. Its tenacity is considerable, but inferior to that of silver. It melts at 2016°. It is insoluble in sulphuric, nitric, and muriatic acid; but it readily dissolves in aqua regia, which is a compound of the two latter. It is difficult to oxidize gold, and still more to burn it; but both can be accomplished. Oxygen combines with gold in two proportions, possibly in three, forming oxides. Gold also unites with chlorine, bromine, iodine, sulphur, phosphorus, and arsenic. There are a number of alloys of gold; the standard gold coin of the realm is an alloy of twelve parts of gold to one of copper or silver, or sometimes both. Gold occurs in almost all parts of the world; but Africa and America supply the chief European consumption.

Platinum.—This metal is white, like silver; its specific gravity is 21·47, so that it is heavier than gold. Its hardness is intermediate between copper and iron. It is very ductile and malleable, though much less so than gold. Its tenacity is considerable. It will not melt in the heat of our most powerful furnaces, but it may be fused by the oxyhydrogen blowpipe. Its property of resisting high temperatures without fusion is a most important one; and on this account, as well as its property of resisting the action of most chemical agents, it has been employed in the formation of vessels which it is necessary to subject to an extraordinary degree of heat. Like gold, it resists the action of all the single acids, but dissolves in aqua regia. It combines with oxygen in probably four proportions, forming oxides, and unites also, with chlorine, bromine, iodine, silicon, sulphur, selenium, and phosphorus. There are numerous alloys of platinum, but they are not of much importance. There is a form of this metal which possesses extraordinary properties; it is called *spongy platinum*. It is prepared by dissolving platinum in a mixture of nitric and muriatic acids by heat; muriate of ammonia is added, when a precipitate falls, which must be filtered and dried. If a small quantity of this powder be heated by a candle, it will become incandescent, as if it took fire. It is, when cold, fit for use. If a jet of hydrogen, from a tube of a very slender bore, be directed on it from a little distance, the metal immediately becomes red-hot, and it sets fire to the hydrogen. This may be repeated a great number of times; but the sponge at last loses its power; the smaller the quantity, the sooner its power is lost.

Palladium, Rhodium, Iridium, and Osmium.—These four metals occur in the platinum of commerce. They are procurable in very small quantities; they have not been applied to any use of moment; they possess no very remarkable qualities, and therefore do not require to be minutely described. They all unite with oxygen and chlorine, and some of them with the other supporters.

Such is a brief sketch of the fifty-four simple substances, whose numerous combinations give rise to the infinite variety of objects which are found ready formed in the laboratory of nature, or have been discovered in that of the philosopher.

ORGANIZED STRUCTURES.

The substances constituting the subjects of this branch of chemistry are those of which vegetables and animals are composed. In vegetables, for example, we have sugar, starch, gums, resin, &c.; and in animal bodies, albumen, muscle, bone, &c.

Vegetables.—Notwithstanding the infinite diversity of form which vegetable substances assume, it has been proved that they are all composed of the same ultimate elements, and these are only *four* in number; namely, oxygen, hydrogen, carbon, and azote. These, again, by uniting amongst themselves, form the compounds which constitute the vegetable structure; and being the more immediate objects of sense, in the investigation of any organization, these are called their *proximate principles*. Existing ready formed in woods, roots, &c., we find a considerable number of proximate principles, in the form of acids, alkalies, sweet principles, bitter principles, oils, exudations; some poisonous, others wholesome; some spontaneously separating, others remaining obstinately combined. We shall give a brief outline of these.

Citric Acid.—This acid exists in the juice of lemons, and, when crystallized, one hundred grains consist of—water 23¾, and pure acid 76¼, which is a compound of 42·1 oxygen, 31·58 carbon, and 2·63 hydrogen. *Sorbic acid* is the sour principle of apples, sorbus berries, and other fruits. It consists of the same ingredients as the former. *Tartaric acid* is the sour principle of grapes; when a large quantity of them are left to ferment, the result, it is well known, is wine. On the side of the vessel containing this liquor, crystals of the acid combined with potash are formed, and these, when purified, are *cream of tartar*. Twelve parts in the 100 are water; and the remaining 88 consist of oxygen, 52·97; carbon, 32·39; and hydrogen, 2·64 parts. *Oxalic acid.*—The plant called sorrel is valued for its acidulous taste, which is conferred upon it by this acid. It has no hydrogen in its composition, consisting merely of oxygen and carbon. It is an active poison, and from resembling Epsom salts in appearance, many persons have fallen victims to its virulence. The antidote is powdered chalk. *Gallic acid* is obtained from nut-galls. Its most remarkable property is that of changing the colour of solutions containing iron to an intense blue-black colour, as in the case of common writing-ink. One hundred grains consist of 56·25 carbon, 37·5 oxygen, and 6·25 hydrogen. *Prussic* or *Hydrocyanic* acid, found in various fruits and flowers, is a most powerful poison. It is formed of hydrogen and cyanogen, a noxious inflammable gas. There are a number of other acids, which, being of little use, are not worth naming. Those just described exist ready formed in fruits, &c.; they are simple *educts*. But there are others formed by chemical changes produced on certain elements contained in vegetables, which afford the base of the acid; these are acid *products:* some are produced by the agency of fire, others by the action of nitric acid. Several acids, when distilled at a high temperature, undergo decomposition, and new acids are formed. Their names remain the same, with the word *pyro* as a prefix. Thus we have *pyrocitric acid*, &c. There are other acids generated by similar means, having simple names without any prefix.

Vegetable Alkalies.—It has been ascertained that alkalies, as well as acids, exist ready formed in plants as one of their constituent parts. Those which evince alkaline properties of a weak character are entitled *alkaloids*. The alkalies are *quinina* and *chinchonia*, which resemble each other, have a bitter taste, and neutralize acids. *Morphia*, which is obtained from opium, is a white crystalline powder; *strychnia*, one of the most powerful bitters and poisons, which has of late been much used in medicine; *brucia*, also a violent poison; *digitalia*, which is procured from the leaves of foxglove; *hyosciamna*, *atropia*, *veratria*, *emetina*, &c., which are derived from henbane, deadly nightshade, &c. Of the other proximate vegetable principles, the first deserving of notice is the woody fibre which constitutes the solid basis of all vegetable structures. It is called *lignin*, from *lignum*, wood and consists of 52 carbon, and 48 of oxygen and hydrogen, in the ratio which forms water. With lignin are associated various other bodies, such as *resins*, which are various and abundant. In the different species of the pine-tree, we discover that peculiar liquid resin called *turpentine*. From resins are obtained what are called *essential oils;* because, after the resin has been heated in a distilling apparatus, an odoriferous oil distils over, and leaves the resin hard, dark, and odourless. The *essence* of the substance is supposed to have passed away in the aëriform state, hence the name. From its speedily evaporating on being exposed to the air, it is also called *volatile oil*. The seeds of plants yield another oil, which not evaporating, is called *fixed oil*. To these two oils there are two substances bearing some analogy, *wax* and *camphor*. The former, when melted, possesses some of the properties of a fixed oil, and the latter seems to possess the properties of a concrete volatile oil, although it possesses qualities distinct from those of all other bodies. *Gum*, for instance gum-arabic, has the following properties: namely, transparency, tastelessness, perfect solubility in water, viscidity of the solution, capability of cementing fragments and of affording a varnish, and total insolubility in spirit of wine. There is a class of bodies called *gum resins*, whose properties are intermediate between those of gum and resin; and somewhat allied to resins, although essentially different in most of its properties, is the substance called *caoutchouc*, or *Indian rubber*. It is the exuded juice of a peculiar tree, and is composed of carbon and hydrogen. From wheaten flour a substance is obtained, called *gluten*, from its glutinous nature. There are two principles in this substance—the one is called *gliadin*, and the other *zimomin*. A substance called *vegetable albumen* seems to be the basis of all emulsive grains in place of starch, and greatly resembles it. *Starch* is a fine white sediment, precipitated from the white and brittle parts of vegetables, particularly the tuberose roots, and the seeds of the gramineous plants. One of the most remarkable properties of starch, or, as it is called, *fecula*, is that of being convertible into sugar by the action of diluted sulphuric acid. Starch is not only afforded from various grains, but from potatoes; and, as extracted from this vegetable, it is much in demand as an article of food. *Arrowroot*, which is obtained from the roots of a West India plant, is the same kind of substance.

Sugar.—Every one, we suppose, should know what sugar is; being in particular a sweetener of the kindly beverages tea and coffee. It is derived from many sources—from the sugar-cane, maple-tree, beet-root, and grapes. Nothing is easier than its formation from grapes: grape juice is to be saturated with chalk, clarified with white of eggs, or blood, and evaporated; after a few days it assumes the form of a crystalline mass. *Tannin.*—From oak bark, or nut-galls, a peculiar substance is obtained, called tannin—so named from being the material employed in tanning leather. It is inodorous, colourless, and possesses a rough, astringent, bitter taste.

THE ANIMAL COMPOUNDS.

The chief substances which enter into the composition of animal matter, are oxygen, hydrogen, azote, carbon, phosphorus, and lime. We also find some other kinds of matter, as certain acids and metals, but in quantity so small as not to affect the truth of the above statement, that the foregoing six ingredients constitute the great bulk of the animal fabric.

Bone consists of phosphate and carbonate of lime, and two other ingredients, *cartilage* and *gelatine*. The latter is the coagulating, or rather elastic, principle in all *animal jellies*. When bones are burned in a close vessel, they form *ivory black*. *Fibrin* is obtained from the vessels; when recently obtained, it is elastic; but when perfectly dry, it is somewhat horny and transparent. There is an important substance called *osmazome*, which communicates to soups and broths their peculiar taste and smell, and the greater the quantity present, the better is the soup. The *tendons*, *ligaments*, and *membranes*, are nearly allied to gelatine in their nature.

Of the fluids of the animal body, *blood*, one of the most important, is viscid, of a red colour, exhaling a vapour of a peculiar odour. When left at rest a few hours, its appearance is very much altered, having separated into two parts—one quite liquid, of a greenish whey-like colour, and called *serum;* the other an elastic firm jelly, of a crimson red colour and thick consistence, resembling a deposit, which is called the *crassamentum*, or *clot*.

If the clot of blood be repeatedly washed with cold water, it parts with its red colour to the water, becomes white, and a fibrous matter remains, which, when subjected to analysis, proves to be *fibrin*. Serum coagulates when heated to about 160°, nearly in the same manner as the white of an egg, but the colour is not pure white. If the serum thus coagulated be cut in slices, a fluid will exude, which is called the *serosity* of blood; it consists chiefly of water, holding a little altered albumen and a little common salt in solution. Serum is composed of water, albumen, soda, and some salts of soda. Clot is composed of fibrin, albumen, red colouring matter, a little iron, and carbonic acid.

During the conversion of arterial into venous blood, nitrogen, hydrogen, and other elements, are spent in the formation of new products, while the proximate principles of the blood remain, with an increased proportion of carbon. In this state it is exposed to the atmospheric air in the lungs, the oxygen of which abstracts its excess of carbon, and forms the carbonic acid expired; and this constitutes the conversion of venous into arterial blood.

Fatty substances, as lard and oils, are formed chiefly of carbon, with a little hydrogen and oxygen, one or both. *Albumen* is a substance very abundant in animal matter. It occurs nearly pure in the white of eggs. Of this substance in the coagulated state, along with gelatine are *horns*, *nails*, and *hoofs* composed. The *brain*, the thinking organ of man, consists of water 80, white fat 4·53, red fat 0·7, osmazome 1·12, albumen 7, phosphorus 1·5, sulphur and various salts 5·15 parts in the hundred.

[WORKS ON CHEMISTRY.

The numerous applications of chemistry to industrial and commercial purposes, have served to multiply books on the subject to an almost unlimited extent. Among the general treatises on chemistry are the well-known work of Turner, which is very extensively used in schools and colleges in this country; Kane's "*Elements of Chemistry*," edited by Draper, and recently published by the Harpers, esteemed one of the best and most complete; "*First Principles of Chemistry, with Questions, by Professor Renwick*," intended for beginners, and much used in schools; "*Conversations on Chemistry*," admirable for its familiar explanations, and formerly used exclusively for schools; and Liebig's "*Chemical Letters*," entertaining essays for the general reader. For reference, Dr. Ure's "*Dictionary of Arts, Manufactures, and Mines*," already referred to, and Brande's "*Encyclopædia of Science and Art*," (Harpers, New York,) are indispensable to the student who desires to be thoroughly versed in chemistry.

Of the larger works, adapted to those who have made some progress in the science, we may mention, and recommend to general notice: "*An Epitome of Chemistry*," by William Henry, which, from a very small volume, has grown to two large and closely printed octavos, illustrated with numerous plates. "*A System of Chemistry*," in 5 vols. 8vo., by Thomas Thomson, M. D. The object of the author of this work has been to facilitate the progress of the science, by collecting into one body the numerous facts which lay scattered through a multiplicity of writings, by blending with them the history of their gradual development, and by accompanying the whole with exact references to the original works in which the discoveries have been registered. "*A System of Chemistry*," by J. Murray, in 4 vols. 8vo., to which there is added a very valuable supplement containing a view of the recent discoveries in the science; also "*Elements of Chemistry*," by J. Murray, in 2 vols. 8vo., 3d edition, which contains a very able and luminous statement of the general doctrines of the science, and forms one of the best introductions to chemistry ever given to the public. "*Chemistry applied to the Arts*," by M. T. A. Chaptal, in 4 vols. 8vo.; a very useful and entertaining work. "*A Manual of Chemistry*," containing the principal facts of the science, arranged in the order in which they are discussed and illustrated in the lectures of the Royal Institution; a new edition, in 3 vols. 8vo., by W. T. Brande, is a very useful, practical introduction to the science. "*A Dictionary of Chemistry*," on the basis of Mr. Nicholson's, in which the principles of the science are investigated anew, and its applications to the phenomena of nature, medicine, mineralogy, agriculture, and manufactures, detailed, by Andrew Ure, M. D., professor of the Andersonian Institution, at Glasgow. "*Elements of Chemistry*," &c., by M. Lavoisier, translated ino English by Mr. Kerr. Notwithstanding the various improvements and important discoveries which have been made since the death of the illustrious author of these elements, his work will still afford much satisfaction to every person who makes this science his pursuit.—*Am. Ed.*]

CHEMISTRY APPLIED TO THE ARTS.

Chemistry, or that department of physical science which recognises the nature and composition of bodies, and the changes which they undergo, is now indispensable to the proper carrying on of almost every useful art. Agriculture, which may be considered the most important of all the arts, is radically dependent on chemistry; for, without a knowledge of that science, the husbandman remains ignorant of the nature of his soils, the action of the atmosphere and sun's light, or the properties of those materials which are required to enrich his exhausted fields. Baking, brewing, distilling, and, indeed, all the operations by which food is prepared from the condition in which it is furnished by nature, are all in general a series of chemical processes. So likewise is the manufacture of pottery-ware, porcelain, glass, paper, the operations of bleaching, dyeing, and calico printing, the preparation of soap, gunpowder, ink, salt, drugs, paints, perfumery, and various other articles daily required. The applications of chemistry to the arts are in reality so numerous, that, to do the subject justice, we should require to take in nearly the whole circle of manufacturing industry. To do so, however, is beyond our limited means, even were it desirable; and our object in the present sheet is to give a short account of the manner in which chemistry is practically applied in those processes of art which we have not elsewhere alluded to. The design in view is not to teach any one art, but to incite to a *general study of chemistry* among those classes of the people who are engaged in such branches of manufacture as involve an elementary change in substance. We commence with a brief description of the apparatus requisite to carry on practical experiments in the science.

THE CHEMIST'S LABORATORY.

A laboratory is a chemist's workshop. It is the place in which he performs his experiments, and requires to be airy and spacious, to have a command of water, to be provided with suitable tables and shelves, mortars, filters, and other apparatus. Correct weighing being indispensable to every chemical experiment, an exact and very delicate balance is an essential requisite. There should be at least two balances; one for weighing heavy matters, and another for very minute quantities. The last instrument should be sufficiently delicate to weigh from 600 to 1000 grains, and downwards, indicating, distinctly and certainly, differences of an exceedingly minute amount. As it is by carefully weighing substances, both before and after being experimented upon, that the exact constituent parts of bodies are determined, and the most important chemical truths ascertained, the balance and weights should be carefully examined at intervals, and their accuracy tested. Measures are necessary for ascertaining the bulk of liquids or gases, and two integers are sufficient, the pint and the cubic inch. Measures should be made of glass, and have a graduated scale marked on both sides. They are commonly of a cylindrical shape, like a phial bottle, and possess a small spout at the orifice. The graduations on these instruments are sometimes very minute, and indicate exceedingly small quantities of the bodies put into them. The measures should be verified by weighing into them successively portions of mercury and water. A cubic inch of the former, at a temperature of 62°, weighs 3425·35 grains, and the same quantity of the latter, at the same temperature, weighs 252·458 grains. Water answers well enough for estimation down to the cubic inch, but for the tenths and the hundredths of an inch, mercury is both more exact and more expeditious.

Furnaces, Blowpipes, Retorts, &c.—Heat is one of the most powerful and extensively useful agents employed by the chemist for ascertaining the properties of bodies, and the methods of its production become of great moment to him. One of the most convenient forms in which heat can be applied to any chemical operation, is that of placing a spirit-lamp, as in fig. 1, under a glass retort, fixed to a simple kind of stand. The lamp is trimmed with cotton wick, and fed by alcohol, which gives a pure flame, and the heat which it generates is very intense.

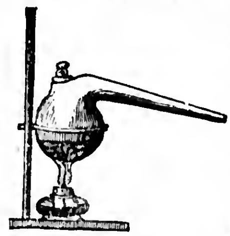


Fig. 1.

Operations on a more extended scale are carried on by furnaces. Dr. Black's portable furnace, which is much used, consists of a stout iron case, like a round stove in shape. Above is an aperture for an iron pot, to contain sand; and other openings may also be observed, for introducing tubes and different kinds of apparatus. The pipe carrying away the smoke must be prolonged or connected with a chimney. Furnaces upon a large scale are constructed in various ways of fire-brick, which resists an intense heat without fusion. This degree of heat can be produced either by propelling air upon the combustible matter by means of bellows, in which case the furnace is called a *blast-furnace*, or by forming long flues and raising a high chimney. The higher the chimney is raised, the more powerful is the draught. Upon the top of a furnace of this open kind, and also upon the flues, close by the fire, vessels containing sand, and hence called sand-baths, are placed. In these, bodies can be raised to a high degree of temperature. Charcoal is the substance most commonly used in furnaces. It produces an intense heat without smoke, but very soon consumes. Coke, or charred coal, produces a strong and lasting heat.

The blowpipe is an indispensable article in the laboratory of the practical chemist. The principle on which it operates, is that of a blast-furnace, on so minute a scale as to be capable of being held in the hand. The pipe, which is made of tin or brass, of a shape resembling that represented in fig. 2, is usually eight or ten inches in length. M is the mouth or upper end, through which the breath is impelled, and O is the small orifice, at the point of the side tube, from which the blast comes. By placing the upper end of the instrument in the mouth, and urging a stream of air upon the flame of a lamp or candle, an intense degree of heat is produced, which may be brought to bear upon any substance placed in a small spoon of pure gold or platina. If the body to be fused be not of such a nature as to sink into the pores of charcoal, that substance is commonly used. A great many important and beautiful experiments may be performed by this cheap and convenient instrument, but the proper way of blowing it requires practice. If the two gases, oxygen and hydrogen, be mixed together in the proportions which form water, and compressed to the amount of many atmospheres in a metallic box provided with a small tube, what is called an oxy-hydrogen blowpipe is formed. By this apparatus which is quite safe when properly constructed, an almost incredible degree of heat can be produced.

Fig. 2.

Crucibles are open vessels, which resist very high temperatures. They are made of various shapes, triangular or circular, and of different kinds of materials, but by far the greater number are formed of earthenware. To promote chemical action, what are called *fluxes* (which will be afterwards described) are employed. Now, it is important that the crucible be made of a substance which is not rendered more fusible by a flux. Wedgewood's crucibles are made of a close white ware; and although thin, they are not easily dissolved; and they retain fluxes at moderate temperatures longer than other crucibles. Those made of a mixture of coarse plumbago and clay are also excellent in these respects. But the most valuable in the laboratory are the Hessian and the Cornish crucibles. Charcoal and metallic ones are likewise used; those formed of platina being the most generally useful, although they are at first very expensive.

Retorts are vessels employed for many distillations, and most frequently for those which require a degree of heat higher than that of boiling water. This vessel is a species of bottle with a long neck, so bent that it makes with the globular belly of the retort an angle of about sixty degrees. One of a common form is represented in fig. 1. The most capacious part of the retort is called its belly, its upper part the arch or roof, and the bent part the neck. They are composed of different kinds of materials, those of glass being by far the most common. They answer for all operations conducted at temperatures less than that at which glass softens; and from their transparency, they admit of constant observation of the materials within: they are, besides, acted upon or injured by few substances, and may be easily cleaned. To the bent neck of the retort various tubes can be fitted, and the evaporated substance conducted into a refrigerator. For distillations or sublimations requiring high degrees of temperature, metallic and earthenware retorts are had recourse to.

A pneumatic trough is a vessel constructed so as to retain water, and large enough to admit of jars being filled in it. Shelves and supports are fixed in it beneath the surface of the water; on these, vessels may be firmly placed. If now a large open-mouthed glass jar be filled with water, inverted beneath the surface of the water in the trough, and put upon one of these stands, a tube from a retort or other distilling vessel, introduced into the inverted mouth of the jar, will convey the gaseous matter, which, displacing the water occupying the jar, can thus easily be collected in it. In this manner gases are obtained. If the jar be provided with a stopcock, they can easily be withdrawn into vessels fitted to retain them. Instead of water, mercury, which is fluid at ordinary temperatures, is used in experiments where water would absorb the gases, or where exceeding nicety is required.

A great variety of other apparatus besides those enumerated are either necessary or useful in a laboratory. Electrifying machines, galvanic batteries, air-pumps, syringes, tubes bent into various forms and of different sizes for fitting into the necks of retorts, &c., dishes for holding both solids and fluids, as well as other materials which it is unnecessary to name, are frequently required; but a very convenient small laboratory, where a vast number of interesting experiments can be performed, may be furnished at very little expense.

Portable Museums.—With a few glass retorts, jars, a spirit-lamp, blowpipe, trough, crucible, several slips of glass, and other simple apparatus, many highly interesting experiments may be performed in chemistry; and those requiring instructions in this practical method of studying the science, are recommended to peruse the small work of Dr. D. B. Reid, entitled "Rudiments of Chemistry," published in connection with *Chambers's Educational Course*. In connection with the course of experiments pointed out by Dr. Reid, there has been prepared by Mr. Macfarlane, druggist in Edinburgh, and Mr. Midgely, chemist, Strand, London, portable museums of different sizes and prices (from £1 to £10), which will be found extremely useful, because they contain a neat assortment of every elementary substance in separate phials, with some of the smaller parts of a chemical apparatus.

Tests, Fluxes, Lutes.—Acids and alkalies in a free state possess the power, even in very small quantities, of effecting certain general and regular changes in the tints of some vegetable colours. Accordingly, colours of this description are used for ascertaining the presence of these bodies when in excess or uncombined, and are called *tests*. Litmus and turmeric papers are most generally used. They are prepared by dipping unsized and bibulous paper in concentrated infusions of these substances. The litmus imparts a fine blue tinge to the paper, the turmeric a yellow one. In using these test-papers with a fluid suspected to contain free acid or alkali, or knowing that one of these substances is predominant, in order to ascertain which is so, all that is necessary is to moisten the papers with the liquid, and observe the change which is effected; if the fluid be acid, the blue colour of the litmus will immediately become red; if alkaline, the yellow colour of the turmeric will be changed to brown.

A *flux* is a substance made use of to assist the fusion and union of minerals or metals. It acts by protecting the substance from the air by dissolving impurities which would otherwise be infusible, and by conveying active agents, such as charcoal and reducing matter, into contact with the substance operated upon. Upon a large scale, limestone and fusible spar are used as fluxes. What is called crude flux, is a mixture of nitre and cream of tartar, put into the vessel along with the substance to be fused. White flux consists of the same ingredients, in equal quantities, but they are first deflagrated in an earthen crucible heated red-hot at the bottom. Black flux has the same constituents as the preceding, but the weight of the tartar is double that of the nitre.

Lutes are soft adhesive mixtures, principally earthy, used either for closing apertures existing at the junction of different pieces of apparatus, or for coating the exterior of vessels which have to be subjected to very high temperatures. The lutes employed for junctions pass into the nature of cements, which are substances used for uniting or joining together things of the same or different kinds, so as to form a whole. The best lute used for coating a vessel is made of Stourbridge clay. It is formed into a paste, which should be beaten until it becomes perfectly ductile and uniform, flattened into a cake, and then applied to the vessel which it is wished to coat. What is called *fat lute* is prepared by beating dried and finely pulverized clay (pipeclay or Cornish clay) with drying linseed oil, until the mixture be soft and ductile. Caustic lime, when mixed with various mineral and vegetable substances in solution, affords numerous cements and lutes, which become hard when dry, and are impervious to vapours. One of the best is that obtained by using white of egg diluted with its bulk of water. The fluids are to be beaten together until the mixture pours with perfect liquidity. There is then added a quantity of dry slaked lime in powder, until the mixture assumes the consistency of thin paste. A solution of glue or the serum of blood is sometimes substituted for the white of egg. White lead ground with oil also makes a very useful lute or cement. Soft cement consists of yellow wax (which alone is sometimes used as a cement) melted with its weight of turpentine, and a little Venetian red to give it a colour. When cold, it is hard like soap; but when pressed by the hand, the heat renders it pliant.

PROCESSES IN CONNECTION WITH THE ARTS.

Trituration.—As a general principle, the more minutely matter is divided, the more rapid will be the chemical action exerted between the particles. This division of matter is effected in various ways. First, by trituration, or the reduction of substances to a state of powder, which is a mechanical action not affecting the physical state of the body, and only relating to solids. In accomplishing this, the pestle and mortar are generally used. Externally, mortars are usually shaped like a flower-pot, the inside, at the bottom, being curved like the thick end of an egg. They are made of various materials, such as metal, porphyry, agate, and so on, according to the purposes to which they are applied. The pestle is generally of the same material as the mortar, and is a solid rod having a rounded bulb at one end for pulverizing the substance in the mortar. Trituration answers very well the purpose of promoting chemical action in a number of experiments, but by fusion and solution it is rendered more complete.

Fusion.—Bodies are said to be in a state of fusion, when, heat being applied to them, they assume the liquid form, a state in which all the particles of a substance move easily among themselves. When a solid body, such as a piece of sugar, is put into water, it is gradually dissolved; and when the lump of saccharine matter has disappeared, and become mixed with the water, and remains so, it is said to be held in solution by it. Heat greatly promotes the rapidity of solution; and glass vessels having a rounded bottom, such as a Florence flask, and placed upon a spirit-lamp, are very commonly employed. In processes connected with the subdivision of matter, when hot water is merely poured upon the substance, the process is called *infusion*; and when the substance is boiled, the result is called a *decoction*. There is a process of solution called *lixiviation*, which consists in the separation of a soluble body from an insoluble one by means of washing. Metals, as is well known, may be reduced to a liquid condition by melting or fusing them in a crucible over a sharp heat, or in a furnace. For the degree of heat at which most metals fuse, we refer to the previous article.

Vitrifaction is a peculiar kind of fusion, by which certain materials, when exposed to an intense heat, melt, and form that transparent substance called glass or crystal. The materials employed to form common glass are silica or sea-sand, and alkali, such as carbonate of potassa, and a metallic oxide. (See *Glass-making*, in article Miscellaneous Manufactures.) It is less generally understood that a kind of glass, soluble in water, may be made from silica and carbonate of potassa. "Mix intimately 200 grains of fine sand, and 600 of fine carbonate of potassa; fuse the mixture in a crucible capable of containing four times as much. Carbonic acid escapes, the silica and potassa combine and produce glass. Pour out the glass, which is commonly termed *silicated potassa*, on an iron plate, and dissolve it in water, the large quantity of alkali rendering it soluble in this fluid. The compound formed in this manner constitutes pure *silica soap*, having all the detergent properties of common soap; it is more active than ordinary soap, and leaves a harsh feeling upon the hand. Common silica soap is mixed with a considerable portion of common soap, and occasionally with sand."—*Reid's Rudiments of Chemistry.*

Desiccation.—The drying of substances, or desiccation, as it is usually called in scientific works, may be carried on without exhaustion by means of what are called desiccators or dryers. This is better effected in close vessels than in the open air, unless a current be taken advantage of. In these processes, sulphuric acid, chloride of calcium, carbonate of potash, quicklime, and similar absorbents, may be used. A basin of common quicklime, with a moist precipitate placed above it the whole being covered with a jar or receiver, will soon dry the precipitate.

Filtration consists in putting mixed substances into vessels which are porous enough to admit of the passage of one substance through them, but close enough to retain another. Unsized paper, cloth, flannel, tow, sponge, sand, pulverized glass, flints, porous stones, earthenware, and many other substances, are used on different occasions; but the first is almost exclusively used in a laboratory, a few of the others now and then being resorted to only on particular occasions. Evaporation is a process so simple as scarcely to require description; it is merely the assumption of the gaseous form by bodies either at ordinary temperatures, or when heat is applied to them. In this general characteristic it resembles distillation and sublimation, but it differs from these processes in this respect, that the substance evaporated is generally allowed to pass off uncollected by a refrigerator, not being that part of the mixture which is required.

Distillation and **Sublimation** mean nearly the same thing; both consist in the conversion of a body into vapour, its transference in that state, and consequent separation from other substances, and its ultimate condensation. The difference generally consists in the state assumed by the vapours when condensed; if the product be solid, the process is called sublimation; if liquid, distillation. The substance is exposed to such a temperature as causes it to assume the gaseous state, in which state it is conducted into a vessel containing water of a low temperature, where it is condensed into a fluid or solid state. A common still consists of a metal boiler for containing the substance to be distilled; a head terminating in a peak is adapted to it; the latter is made to fit into the commencement of a spiral tube, called a worm, fixed in a tub—the whole of this part of the apparatus being called the refrigerator. A worm wending through a tub of cold water is represented in fig. 3. The substance is raised into vapour in the still, and being condensed in the worm, runs out at its lower extremity. Distillations are usually effected in the laboratory by means of glass retorts and flasks; for substances, however, which require a greater degree of temperature to effect their distillation, metallic or earthenware retorts are employed. Bodies which are very volatile are distilled or sublimed in an alembic, which consists of a globular bottom and conical-shaped head, whence a nose or beak passes off in a downward direction into a receiver.

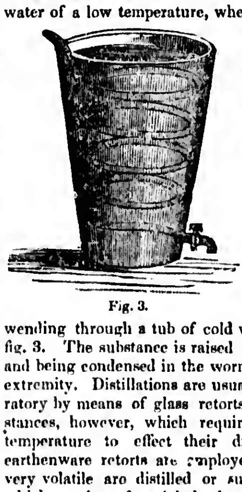


Fig. 3.

A great improvement in evaporation has recently been introduced into the refining of sugar, namely, its being boiled in vacuum pans. It is well known that there are few articles of vegetable production which are not injured by being boiled at a temperature of 212°; but to boil them at a lower temperature, it is necessary to remove the pressure of the atmosphere. This is now accomplished by using close copper vessels of a flattened spherical form. On the top is a raised part, from which a pipe proceeds, attached to an air-pump. At the side of this pipe another enters the vacuum pan, from which fresh syrup can be made to enter at pleasure by means of a stop-cock. At the bottom of the pan is another stop-cock, through which the boiled syrup can be taken out when sufficiently concentrated. The pan is heated by means of steam pipes which surround it; and the liquid boils at, or even below, 150°. The air-pump for removing the atmospheric pressure, in large sugar-refining establishments, is worked by a steam-engine. By this process the quality of any substance, particularly scents and medicinal extracts, from which liquid is to be evaporated, is greatly improved, and a saving effected by catching the vapour as it passes out.

FERMENTATION is the term which expresses the changes which animal and vegetable matter undergoes spontaneously when the principle of life is extinct; and is one of the means which nature adopts to destroy useless substances, and reduce them to their elementary properties. Chemists reckon up five distinct species of fermentation—namely, the saccharine fermentation, in which gum and starch are changed into sugar; the vinous fermentation, in which sugar is converted into alcohol; the acetous fermentation, in which alcohol and other substances are converted into vinegar; the mucilaginous fermentation, in which slime is produced instead of alcohol from sugar; and the putrid fermentation, which is the decomposition of animal and vegetable bodies.

The change of the substance of barley into sugar, or a material possessing the qualities of sugar, takes place on a large scale in making *malt*. Malt is dried barley, which has previously been caused to sprout and partially grow by steeping in water; in the course of germination or malting, a chemical union is effected between a portion of the water and the starch of the barley, and the saccharine matter is the result. A saccharine material can on similar principles be produced by boiling one part of starch in twelve parts of water, and allowing the compound to stand for a month or so. At the end of this time about one-half the quantity of starch is converted into sugar, a fifth into gum, and the remainder is found to be a starch paste somewhat altered.

Fermentation, whether of an infusion of malted grain or any other vegetable substance, is a necessary preliminary, in order to change the material into an alcoholic beverage. The actual process of fermentation, for example, in reference to wine, is as follows:—Ripe grape juice is put into a vessel, and allowed to stand for some time, exposed to the ordinary temperature of summer. At the end of a certain period, the liquor becomes muddy; an internal motion takes place, and sometimes the temperature is found to be elevated; air-bubbles rise to the surface, occasioning a bubbling noise when they break; and the bulk of the liquid being increased, it has a tendency to boil over. From this circumstance, the process is called fermentation, from the Latin word *fervere*, to boil. The bubbles created rise to the surface, involved in a viscid matter, the whole resembling froth, which, parting with the air, subsides to the bottom, and the liquor becomes tranquil and transparent. This viscid matter is well known under the name of *yeast* or *barm*, and it has the property of exciting fermentation in bodies not otherwise at the moment predisposed to it. The grape juice has now been entirely changed into an intoxicating liquor, the base of which is alcohol, and this process is termed *vinous fermentation*. A great quantity of carbonic acid is given out during this kind of fermentation, and the various chemical changes which take place have been thus briefly described:—Some of the carbon and some of the oxygen combine to form carbonic acid; while the remainder of the carbon, the remainder of the oxygen, and the whole of the hydrogen, combine to form alcohol: and we may totally neglect the decomposition of the yeast it amounting to almost nothing. Thus is this inert, solid, fixed, sweet matter, resolved by a new arrangement of its principles into substances which possess none of these properties, and one of which exert a control of so singular a nature over the animal economy.

Liquor, vinously fermented, is subject to a new series of phenomena. On being put aside for some time, a fresh commotion is observable, accompanied with the disengagement of a small quantity of gas; and floating filaments or shreds begin to thicken in the liquid, collecting into a gelatinous cake. This is indicative of another change. The vinous flavour and the alcoholic or intoxicating quality have disappeared, whilst the liquid has become at once sour and transparent. In short, the wine has become vinegar, called in Latin *acetum*; and the process is called the *acetous* fermentation. Let this vinegar be kept for a length of time, and another, and from the previous quality of the liquor, unexpected, change takes place. It becomes mantled with a green mould; the acidity and pungent acid smell disappear, and a fœtid odour becomes perceptible.

The most remarkable feature in the product of fermentation, is the intoxicating quality. This quality arises from the chemical change into *alcohol*, a concentrated spirit or essence, which, in one of its purest forms, obtained from distillation, is called spirit of wine. Alcohol exists to a lesser or greater extent in all fermented liquors, such as ale, porter, or beer; but it is more concentrated, or free of watery fluids, in the form of brandy, whisky, gin, rum, and similar intoxicating liquids. The amount of alcohol in stout porter is about 6 per cent., and in strong ale 8 per cent. The alcoholic part of such liquids stimulates but gives no actual nutrition; the only nutritive part is the undecomposed starch and gum not changed into saccharine material. Alcohol dissolves the greater number of acids, the volatile oils, the resins, tar, and extractive matter, and many of the soaps; while dissolving pure soda and potassa, it does not act on their carbonates. The composition of alcohol has been investigated by eminent chemists, and the result is, that of 100 parts there are 13·70 of hydrogen, 51·98 of carbon, and of oxygen 34·32. When alcohol is distilled along with certain acids, a peculiar compound is formed, called *ether*, an exceedingly volatile fluid, used in medicine.

While the various phenomena of fermentation, as above briefly noticed, are well understood by practical chemists, of the actual cause of the ferment little has yet been discovered. It is only known in a general sense, that fermentation is the rapid growth of microscopic vegetation (see article VEGETABLE PHYSIOLOGY), and that in the alteration of the liquor to vinegar, another wonder is performed—the change to microscopic animal life (see article ZOOLOGY, Radiati, class xix.) When this end has been accomplished, nature makes one other effort, by producing *putrefaction*, in which the material is resolved into invisible but odorous gases.

PRESERVING.—Animal and vegetable bodies may be saved from putrefaction, or the last process of dissolution, by putting them in a substance which will coagulate the albumen, that being the first part which suffers decomposition. This may be effected by steeping the bodies in alcohol, oil of turpentine, or other volatile oils. Pyroligneous acid, from containing a small proportion of creosote, has a strong power of preserving animal matter from decay. The earthy salts are also antiseptics; but common salt, saltpetre, and sal ammoniac, are the articles most generally used for the purpose of preservation. For the purpose of extinguishing the odour of offensive gases, arising from the decay of animal substances, none of the chemical products is so useful or so readily available as chloride of lime; by sprinkling a small quantity in an apartment containing an unwholesome putrefactive odour, the air is instantly deprived of its noxious properties, and is sweetened. Putrefaction goes on most rap'dly at a temperature of from 70° to 80°, but is altogether stopped at the freezing-point. Thus fish and flesh may be kept fresh for any length of time when embedded in ice. The abstraction of the oxygen gas will also preserve meat: the simplest manner in which this can be done is to enclose the meat in tin cases, leaving only a small hole in the closely soldered lid. The air may then be expelled by dipping the cases for a minute into steam; on lifting them out, a drop of solder, quickly placed on the hole, prevents the rush of air back into the vessel. On this principle of excluding the air, cases of preserved meats are now manufactured to a great extent for exportation. The proper drying of an animal substance is likewise an invariable preventive of putrescence. Animal matter should be dried at a temperature of from 120° to 140°; but even when dried, the addition of a little salt will be necessary. The salt is supposed to absorb the water from the albumen, and alcohol, sugar, &c., act in the same way.

Tanning.—Animal substances may be preserved for any length of time by being saturated with a vegetable extract, known in chemistry by the name of *tannin;* and this has given rise to the common process of tanning the skins of animals, and so making them into leather. Tannin exists in all vegetables possessing an astringent taste and quality, but is found in greatest perfection in oak-bark and nut-galls. It exists to a considerable extent in the fibrous substance of peat; bodies of men and of the lower animals, as also trunks of trees, impregnated with tannin, have been discovered in a perfect state of preservation in peat-bogs, after having lain for centuries. The principle upon which tannin acts, is the imbibing of an astringent and hardening quality by the mass of the substance, by which it is constitutionally altered. When the properties of tannin are present in a soil, the ground is said to have an antiseptic quality, and bodies buried in it are not apt to decay.

Kyanising.—All kinds of timber are liable to undergo a change of substance destructive of their useful properties, by the action of damp, seclusion from the atmosphere, and which may also be promoted by the subacid state of the wood—in common language, the timber rots. There is a peculiar kind of rottenness, called *dry-rot*, in which the decaying timber affords nourishment to the growth of fungi, which sometimes appear like a fibrous vegetation, but more ordinarily as toadstools. To avert the occurrence of dry-rot, which is a rapidly and insidiously spreading evil in the timbers of houses or ships, the only real method consists in steeping the timbers, previous to being used, in a solution of corrosive sublimate. This chemical substance may be prepared by dissolving red oxide of mercury in muriatic acid, and evaporating the solution to dryness; but there are other modes of procuring it from its basis of mercury.

The corrosive sublimate being procured, it is dissolved as a steep in water, in the proportion of one pound to five gallons of water. Such at least is the method of preparing steeps in tanks according to the plan suggested by Kyan, and for which a patent has been obtained. The process of *kyanising*, as this is termed, is very simple. The timber being immersed in the liquid, it becomes after a time saturated, and when taken out, the vegetative principle of dry-rot is completely destroyed. Only one day is required for each inch, in thickness, of boards and small timbers, commencing with two days for the first inch. On removal, the timbers require a few weeks to dry, in order to be seasoned for use. Being the subject of a patent, a license requires to be procured for liberty of steeping.

MEDICINAL PREPARATIONS.

Medicines are those drugs which in some form are applied to the alleviation or cure of bodily ailments; and they consist, for the greater part, of substances prepared from vegetable and mineral bases, by practical chemists. Retailers of medicines are usually spoken of as chemists but few are actually engaged in the elaborate processes, of drying, distilling, calcining, or chemically compounding the various drugs with which they supply their customers. The medicinal preparations of the ancients were principally vegetable, but being constantly liable to dry up and lose their virtues, no dependence could be placed on them, and they went greatly out of repute, till the method of obtaining extracts by distillation came into use. Since that was effected, the value of vegetable medicines has revived, though medical practice still relies chiefly on mineral products, which are generally more certain in their operation. A few medical preparations are from animal substances.

Some substances employed in the cure of disease, act mechanically, and others chemically, on the system; but by far the greater proportion of them act vitally. A medicine is said to act mechanically, when its effect on the body is the same as that which it exerts over inanimate matter. Demulcents, for instance, or remedies taken to remove the acrid effects of some other substance, operate simply by coating the stomach with a gummy fluid, an action which is entirely mechanical. The chemical operation of medicines may be thus explained. When an acid and an alkali are mixed in a glass of water, they unite together and form a third substance, a salt, having new properties altogether. The same chemical process takes place when sourness, or an acid, is neutralized in the stomach by soda, or any alkali. The vital action of medicines differs totally from the two former. In this case the substances are absorbed into the blood, and are conveyed by the vessels of the heart to the quarter whither their nature determines them. Diuretics, or medicines which stimulate the urinary organs, may form an example of vital action. From the stomach the diuretic is absorbed into the blood-vessels, and carried to the kidneys, stimulating them to the secretion of urine, though by what process of separation from the rest of the blood we know not. In these three divisions, mechanical, chemical, and vital agents, all the articles used in medical practice may be comprehended; and after this general explanation, we may examine the particular classes of each division, commencing with the most important, the vital agents. The class of purgatives (the strongest called *cathartics*, the weakest *laxatives*) is the best known and most commonly used of any description of medicines. They may be arranged under three heads: those of an oily or saccharine nature; those which are derived from vegetables, such as resins and extracts; and those formed by a combination of acids with earths, alkalies, and metals, termed neutral and metallic salts. The operation of all these three is of the character of an irritation upon the mucous or inner membrane of the bowels, though in their effects they differ considerably from each other. The first-mentioned seem simply to discharge the contents of the bowels; the second appear to increase the quantity of matter evacuated, by stimulating the mucous membrane, and increasing the natural flow of mucus; the third produce evacuations of a watery consistence. The principal purgatives of the oily or saccharine kind are, castor-oil, olive-oil (seldom used), manna, tamarinds, honey, and so forth; croton-oil, an essential oil (that is to say, procured by distillation, not by expression, as the castor-oil is), is scarcely to be included in the class of oils, as its great strength prevents its being used except in desperate cases. The medium dose of the castor-oil is one ounce, of the croton-oil a fraction of one drop. The former is imported in immense quantities into this country annually. It is one of the most useful and safe medicines of the purgative class. The rest mentioned are exceedingly mild in their operation, and are generally employed merely to palliate the bad flavour of some stronger drug. The second kind of purgatives includes aloes, scammony, jalap, colocynth, senna, and rhubarb. The general character of all these has been given above, though the rhubarb possesses one remarkable distinction from the others. It is supposed to act on the muscular membrane of the bowels, producing a natural discharge simply, without altering the character of the fæces. The principal neutral and metallic salts, which form the third order of purgatives, are sulphate of soda, Epsom salts (sulphate of magnesia), cream of tartar (super-tartarate of potash), phosphate of soda, and calomel (submuriate of mercury). The latter is the most universal in its application of all medicinal preparations. By proper regulation of the dose, and in conjunction with other drugs, it can be employed with benefit in almost every disease to which man is subject. But in proportion to its usefulness, so is its danger when misapplied. The dose should be very small at first, and cold ought always to be guarded against during its use. With respect to the others, little can be added to the general description already given, though it may be mentioned, that the pleasantest, though not the cheapest of all medicines, is the phosphate of soda, or *tasteless salts*.

Sudorifics, or medicines which increase the cutaneous perspiration, form another important class of vital remedies. Certain substances received through the stomach into the blood, excite through it the vessels of the skin to action, and increase the natural discharge. The mode in which this result is effected is not well known; all we know is, that, during the operation, the heart, and the blood-vessels which terminate on the surface of the skin, are roused to unusual action. Among the most active sudorifics may be enumerated warm drinks; the warm bath; the preparations of antimony, including James's powder; Dover's powder (compound ipecacuan powder); the preparations of ammonia; and all medicines generally which nauseate the stomach. Probably of all these, Dover's powder is the best. Sudorifics, in almost all cases, when early used, prevent the effects of colds, which, when neglected, prove so often fatal in their consequences.

Emetics are another class of remedies, acting through the blood, and of very general use. It may be supposed, that, as they are received into the stomach, and act directly and speedily upon it, there is no absorption into the blood necessary. Tobacco, for instance, taken into the stomach, excites vomiting; but it is from its reception into the circulation; because, if the tobacco be laid on the arm, the same effect will be produced. Some emetics, indeed, appear to act principally on the muscular covering of the stomach, exciting it to contraction, and thereby causing the expulsion of the contents. Most of them, however, simply produce nausea, which causes the inversion of the receptacle of the food. The most active emetics employed in medicine are tartar-emetic, ipecacuan root, chamomile flowers, mustard, and blue or white vitriol. The two first of these are most commonly used; the latter being the gentlest, and perhaps on that account the safest in ordinary cases.

Diuretics are those medicines which operate in promoting the flow of urine, by stimulating the action of the kidneys, the organs which secrete it. This class is very numerous, though the manner of their operation, like that of all the other vital agents, is not thoroughly understood. Those chiefly employed in practice are squills, foxglove, juniper-berries, potash, cream of tartar, acetate of ammonia, nitric ether, and Spanish flies. All these act powerfully on the urinary organs, those in highest repute being squills, foxglove, juniper, and cream of tartar. The first and the last of these are the most efficient, being more certain in their action than the others. Warm fomentations are useful accompaniments in all cases.

Expectorants are used to promote the expulsion from the lungs of those fluids which are secreted during colds, and lodge there, causing difficult breathing, and sometimes ending in injury of their structure. Thus, those remedies which promote expectoration are of great consequence to health, though often neglected. The principal medicines of this class are antimony, squills, ipecacuan, and gum-ammoniac. Syrup of squills is the preparation in greatest use.

Carminatives are those medicines which produce the discharge of flatulence from the alimentary canal. This malady is more annoying than dangerous, though it rises occasionally to a most painful height. The warm essential oils, such as caraway, anise, or peppermint, and some aromatic stimulants, as cinnamon and ginger, are the best carminatives.

All those classes of medicines which we have hitherto mentioned, are called evacuants, from the nature of their operation; and we may now describe another order of medicinal preparations, acting, like the former, through the medium of the circulation, but repressing instead of stimulating the powers of the system. There are only two distinct classes of medicines of this kind, narcotics and antispasmodics, though the first of these has sometimes been divided into two, narcotics and sedatives.

Narcotics are those substances which diminish the natural degree of action in the body, and tend to remove irritation or pain, inducing in general a state of repose. Before this quieting effect is produced, however, there is a primary excitement of short duration, which is well exemplified in the case of opium. Sedatives, viewed as a separate class, are believed to allay pain and promote sleep, without possessing any stimulating qualities; but it is far from being clear that we have any simple sedative medicines at all. Opium, which is almost exclusively employed as a sedative, is universally admitted to have a primary exciting quality. Unless where excessive pain is present, narcotics may be regarded as a class of medicines only to be used with great caution, and never free from danger. Opium and its preparations, lettuce extract, henbane, foxglove, hemlock, and tobacco, are some of the strongest narcotics. It is difficult to say which of these is the safest, when a sedative is required, though probably the preparation from lettuce has the slightest stimulating powers. Morphia, a drug procured from opium, is said to possess the sedative without the exciting effect.

Antispasmodics are used to remove spasms or convulsive contractions of the muscular fibre in the body, and are so similar in their action to the last-mentioned class, as scarcely to require a separate notice. Opium, camphor, ammonia, valerian, and assafœtida, with most of the narcotics, are the antispasmodics generally in use.

Stomachics.—There is another class of medicines, acting by absorption into the blood, or as vital agents, which cannot be ranked either amongst those which excite action, or those which repress it. These are stomachics and tonics; the former increasing the digestive powers of the stomach, the latter renovating the tone, or contractile energies, of the muscular fibre. They are slow in their operation, and augment the strength of the body without materially exciting its actions. As these two kinds of medicines are not very distinctly separable, it may be better to enumerate them together. Good nutriment is the most natural and best supporter of the bodily powers, but to effect this purpose, it is necessary that the function of digestion should be in a proper condition. Gentian root, quassia, chamomile, columba, and canella, assist powerfully this object. Amongst the tonics, Peruvian and cascarilla barks, the preparations of iron, the sulphuric and nitric acids, are in greatest repute.

With respect to the two kinds of medicinal agents, which act chemically and mechanically on the system, they are generally ranged into five classes—caustics, astringents, antiseptics, antacids, and demulcents.

Caustics are a class of substances employed to create artificial sores or ulcers, for the purpose of relieving some deep-seated malady. The operation of caustics is considered chemical, being the result of some attraction between the animal body and the substance employed. The same action takes place on the application of caustics to a portion of the dead subject. Where suppuration is going on in any internal part, they are exceedingly useful in creating a drain on the surface of the body. The principal caustics employed in medicine, are potass, blue vitriol, nitrate of silver, arsenic, and some preparations of mercury. The nitrate of silver, or lunar caustic, is the substance in most common use.

Astringents.—The action of this class of medicines is rather obscure. Their power appears to depend in a great measure on the presence of the principle called tannin, and they produce their effect by bringing into closer contact the particles of the body to which they are applied, without, in other respects, affecting its mechanical structure. They are believed to be often of service in restoring tone to the stomach, and it is evident that their astringency will be of great advantage when any laxity of the surface of that organ exists. All the vegetable astringents contain tannin, and those most generally employed are gall-nuts, catechu, kino, oak-bark, and logwood. A number of the acids, and some of the salts, those particularly in which the acid preponderates over its base, as in alum, which is a compound of vitriol and the earth alumina, possess astringent properties, although they contain no tannin. Some of the metallic salts, as superacetate of lead (sugar of lead), and sulphate of zinc (white vitriol), are ranked in this class. Cold is also a direct astringent, and is often employed in this character with great advantage in checking bleedings.

Antiseptics, though still ranked as a distinct class of medicines, are very little trusted to in the present day. They were great favourites with the ancients, and were supposed to possess the property of resisting putrefaction, or that tendency to mortification which sometimes appears towards the termination of fevers and other complaints. Peruvian bark is commonly believed to have antiseptic qualities, and, with the exception of alcohol and vinegar, is the only drug of this class worthy of notice.

Antacids.—The stomach of many individuals is liable to a continued conversion of their food, particularly vegetable food, into a species of acid, which produces the annoying feeling called heartburn. This acid may be neutralized by any of the earths or alkalies, and the process of relief is as purely chemical as if it were performed in a glass of water for experiment. The three alkalies, potass, soda, and ammonia, the alkaline earth magnesia, and carbonate of lime (chalk), are the most useful medicines of this description. The relief obtained from them is, as might be expected, merely temporary, since they do not prevent the generation of the acid anew.

Demulcents are a class of medicinal agents, the operation of which seems entirely mechanical. A poultice is applied externally to soften an inflamed or irritated part, and with exactly the same views are demulcents used to soothe any irritation of the alimentary canal. Solutions of gum, and syrups, with barley water, and other farinaceous drinks, are employed for this purpose. Iceland moss (lichen Islandicus), liquorice root, almonds, sugar, marshmallow, and others, are included in the class of demulcents.

These are all the classes of medicines that can be said to have a chemical or mechanical action on the stomach; and to complete this brief view of the principal articles used in medical practice, of the order in which they are arranged, and the nature of their action, some account may be given of rubefacients, as they are called, from reddening or inflaming the skin, and of blisters.

Counter-Irritants.—The extremities of the vessels which convey the blood from the heart over the body, are supposed, when they terminate on the skin, to divide into minute tubes, one kind of which carries the red globules, and another the colourless serum of the blood. When strong stimulants, such as mustard or Spanish flies, are applied to the skin, they are supposed to excite these minute vessels so powerfully, that those which contain serum become filled with red globules. This can only be produced during an extraordinary flow of blood to the part, and is the cause of the redness consequent on the application of mustard cataplasms or blisters. A blister is simply a rubefacient allowed to remain on the skin until a deeper layer of it becomes affected, and pus or serum exudes. Like caustics, blisters are exceedingly useful in substituting a superficial inflammatory action for one existing in some deeper and more dangerous seat, and they are therefore called counter-irritants. The principal substances employed in exciting cutaneous inflammation are Spanish flies, mustard, tartarized antimony, ammonia, turpentine, and a few other drugs of a stimulant nature. The Spanish flies are almost exclusively used in blistering, and mustard, as a rubefacient, is held in a similar degree of estimation. Latterly a new and improved method of employing Spanish flies, or cantharides, has been introduced into practice. It consists in applying an extract, which contains the essential powers of the material to the skin, by spreading it on paper. The blister so formed, which bears the name of *tela vesicatoria* (blistering tissue), produces a much more rapid effect than the common fly blister, and does not give the same pain to the patient.

The principal medicines employed at the present day for the alleviation or cure of disease, have been now enumerated in an arrangement which may show their several properties and modes of operation. Each university of importance has a list of medicinal preparations drawn up for the guidance of its own members and pupils and this list is termed its *Pharmacopeia:* with the enumeration is given a full account of the processes by which the various substances are prepared for use. This paper, which gives a pharmacopeia of a simple and popular kind, will have the effect, we humbly imagine, of dissipating some portion of that veil of mysticism which enveloped the art of medicine, and of showing what are the rational objects to be expected from the action of drugs upon the animal frame. In regard to the quantities of medicine to be employed as doses, that is a branch of the subject which we leave entirely in the hands of the medical practitioners properly empowered to administer them. It may here, however, be mentioned, as an interesting fact, that the action of the dose by no means corresponds with the quantity. The general rule seems to be, that when a too large dose of medicine is taken, nature makes an effort to expel it, and it is accordingly vomited without doing the intended good. A dose of a moderate size pushes its way to the bowels, which it irritates and causes to act with a degree of violence. A dose of a smaller size will act only on the stomach. The action of medicines in the stomach is by absorption into the system; and as the stomach is always less or more filled with fluid materials, it follows that the medicines received are diluted, and have a correspondingly weak or at least slow influence on the absorbents. Thus it has been found that a few drops of certain medicaments dropped on the tongue, by which they are absorbed at once into the system, have as powerful an effect as twenty times the quantity poured into the stomach.

Mineral Waters.—These waters, which are expelled from the earth as springs, form a distinct order of medicaments, prepared in the great laboratory of nature, and depending for their character on circumstances over which mankind have no control. Mineral waters are generally divided into four classes—acidulated or carbonated, saline, chalybeate or ferruginous (that is, containing iron), and sulphureous. Some are thermal hot others are cold. "The substances which have been found in mineral waters are extremely numerous, but those which most frequently occur are oxygen, nitrogen, carbon, and sulphur, in different combinations; lime, iron, magnesia, &c. The saline springs consist in general of salts of soda and lime, or of magnesia and lime, with carbonic acid and oxide of iron. The principal are those of Pyrmont, Seidlitz, Epsom, &c. The ferruginous waters have a decided styptic taste, and are turned black by an infusion of gall-nuts. The iron is sometimes in the state of an oxide, held in solution by carbonic acid, sometimes exists as a sulphate, and sometimes both as a sulphate and carbonate. The waters of Spa, Cheltenham, Tunbridge, Pittsburg, &c., are among them. The acidulous waters are characterized by an acid taste, and by the disengagement of fixed air. They contain five or six times their volume of carbonic acid gas; the salts which they contain are muriates and carbonates of lime and magnesia, carbonate and sulphate of iron, &c. The waters of Bath, Buxton, Bristol, Seltz, &c., are acidulous. The sulphureous waters are easily recognised by their disagreeable odour, and their property of tarnishing silver and copper. The springs at Saratoga and Ballston, Harrowgate, Moffat, Aix-la-Chapelle, and numerous others, are of this class."—*Conversations Lexicon.*

The thermal or hot springs most frequented in Europe are those of Bath, and in the grand-duchies of Nassau and Baden (there called *brunnens*). In the town of Baden-Baden, there is a saline spring, called the *Ursprung*, which gushes out at a temperature of 153½ degrees of our Fahrenheit thermometer, which is too hot to be either immediately drunk or bathed in. The quantity ejected by the spring is enormous. For two thousand years, which is as far back as any thing is known of the place, there have been thrown up, by the Ursprung alone, at the rate of three millions of cubic inches of water every twenty-four hours, and always, night and day, of exactly the same steaming heat and the same taste and composition. According to the analysis of Dr. Kœlruter, quoted by Granville, a pint of water, weighing 7392 grains, contains 23 3-20ths grains of solid matter, the principal ingredient of which is common sea-salt, there being not less than sixteen grains of that substance present. Next in importance are the sulphate, muriate, and carbonate of lime, which altogether amount to six and a half grains. The remainder consists of a small portion of magnesia and traces of iron, with about half a cubic inch of carbonic acid gas in addition.

Artificial mineral waters are now prepared of different kinds by chemists, for by analyzing these waters, their properties can be imitated. The article called *soda-water*, usually sold in bottles, is well known. Its chief ingredients are carbonate of soda and tartaric acid.

CHEMICAL ANALYSIS.

The art of analyzing the compounds of matter, or, in other words, of resolving them into the various elements of which they are framed, constitutes one of the most difficult yet important branches of chemical science. More particularly is it important in relation to numberless practical purposes of life. There are few trades which do not owe much of the success with which they are conducted, in an advanced state of society, to the light which chemistry has thrown on the nature of the substances employed in them, and the consequent improvements therein introduced. To the highest moral interest, even, of the social body, chemical analysis is of vital moment. It is the basis of medical jurisprudence. Without the knowledge of poisons possessed by the professors of that science, and their ability to separate by analysis the most minute portions of these from any compounds with which they may have been mixed, innocence might often perish under the erring severity of the laws, and guilt escape the penalty justly incurred.

The mode in which chemical analysis, so important in every respect, is conducted, may best be explained by individual examples; but a few general observations will not be out of place. As respects the apparatus necessary for the chemical analyst in his laboratory, notice has already been taken of it; and it is only necessary to add, that in performing analyses, the principal tests and preparations are also required. The latter articles amount in number to about sixty or seventy. They consist chiefly of the sulphuric, nitric, and hydrochloric acids; sulphur, phosphorus, iodine; the principal alkalies and earths, with their most important compounds; mercury, iron, lead, tin, cobalt, antimony, gold, silver, and a few other metals, pure or in a compound state; with a few of the vegetable acids, such as the tartaric, and oxalic. Tests and test-papers, most important matters in chemical experiments, are also to be procured. By boiling red cabbage, one blue solution of this character is obtained, which detects acids and alkalies, uncombined or in excess, the former turning the blue to a red, and latter to a green. Boiled litmus gives another solution, which acids redden; and turmeric in solution is changed from yellow nearly to red by alkalies. Slips of paper, soaked in these solutions, and then dried in the dark, require only to be touched by the dissolved alkali or acid, to show the change of colour at once. Iron, again, is instantly detected by infusion of galls. The presence of acids and alkalies, in almost every compound in nature, renders these tests of vast consequence in analytic chemistry.

In taking up any body of unknown composition for analysis, very minute quantities only, finely divided, and weighed, are used. The body is then, if possible dissolved, commonly in water, that the particles may be further separated as widely as possible, which is the most favourable condition for the action of other bodies upon it, and display of chemical affinities. It is possible that the body may be insoluble, or but partially soluble in water at a common temperature. In these cases, the processes of infusion, digestion, or decoction, will be tried by the analyst, heat adding powerfully to the solvent powers of water. Lixiviation and maceration are also resources of the chemist. Sometimes alcohol or other solvents must be employed, and at times several solvents require to be used in succession, each having the power to take up something insoluble in the others. Once dissolved, the body, or portions of it separately, can be treated with tests; and, happily, there is not one substance in nature which has not such affinities for one or more substances, in preference to all others, as readily to betray its own nature. The common results of adding one body as a test to another in solution, are either alteration of colour, precipitation, or gasefaction. In the first case, the two bodies may form a compound, soluble, but of new colour; in the second place, an insoluble substance may be thrown down to the bottom of the solution; and, in the third, a gas may be set free. All of these results may be combined in some cases. The experimenter may, moreover, vaporize and crystallyze: fusion and condensation are processes also at his command. When simple solution can be effected in no way, and at no temperature, the experimenter may then have recourse to other agents. Chemical action may be induced by pressure, by electricity, and sometimes by light.

These are the general ways and means by which the chemical analyst prosecutes his investigations. By way of particular example, let us take a case in the department of medical jurisprudence. Let us suppose a medical man called upon to examine a case of poisoning, where the only cause of death that can be suspected is the use of copper vessels when corroded by articles of food. The object, then, is to analyze the vegetable or animal fluids remaining on the stomach, or preserved otherwise, in order to detect the copper, if it exists. Being boiled, the fluid in question is treated or mixed with diluted acetic acid or vinegar, which dissolves out the copper from among the other matters present. Well aware that sulphur has so strong an affinity for copper as to unite with it whenever they meet favourably in solution, forming a compound of both, called a sulphuret of copper, Professor Christison then directs the introduction of sulphur, in the shape of sulphureted hydrogen gas, after the following preparations have first been made:—"The suspected mixture having been prepared by the addition of acetic acid, is to be subjected to filtration, and any matter left on the filter is to be washed, collected, and dried, the washings being, of course, added to the fluid which first passed through. The process here divides itself into two; for the oxide of copper may be left on the filter in the form of an insoluble salt, or it may have passed through in solution. But it may be observed in passing, that very few of the salts of copper are insoluble in diluted acetic acid, so that if copper is present at all in a suspected mixture, there are many chances in favour of its being found by the first branch of the analysis.

"*First branch.*—The solution is to be examined first, both because it is the more likely quarter in which to find the copper, and because the analysis is more easy than that of the solid matter. The solution, then, is to be treated in the usual way with a stream of sulphureted hydrogen, and immediately boiled to expel the excess of gas. If a brownish-black, or even pale-brown precipitate is then thrown down, there is a presumption in favour of the existence of copper: if there is no precipitate or brown colouration, there is no copper in the fluid. In order to ascertain precisely the nature of the precipitate, which is some metallic sulphuret, the superincumbent fluid, after ebullition and subsidence of the precipitate, is to be cautiously withdrawn, and its place supplied with water; and when the washing has been several times repeated in the same manner, the precipitate is to be transferred into a watch-glass, or, still better, into a white porcelain cup, and dried. It is next to be collected, and incinerated in a glass tube, to destroy any adhering vegetable or animal matter. The last step in this branch of the process is to convert the sulphuret into the sulphate by the action of a few drops of nitric acid, aided by a gentle heat; and then to add to an excess of ammonia, either without or with previous filtration, according to the degree of muddiness in the nitrous solution. If copper is present, the usual deep violet-blue tint will be struck.

"*Second branch.*—If copper is not detected in the filtered part of the suspected matter, it will be necessary to examine also what remained on the filter. This proceeding, which constitutes the second branch of the analysis, will be seldom required in ordinary medico-legal researches, being rendered necessary only by the possibility of the oxide of copper having, either originally or after mixture with the suspected matter, assumed the form of an inorganic salt, insoluble in water or acetic acid.

"The matter on the filter is first to be well dried, and then heated to redness in a crucible till it be completely charred. The copper which is thus reduced to the metallic state, is next to be treated with nitric acid, diluted with its weight of water, and aided in its action by gentle heat. A solution is then procured, which is to be removed by filtration, and tested with ammonia, and the other liquid tests." Ammonia, or hartshorn, has a strong affinity for copper, and when added to a saline solution of the latter, throws down a deep blue powder, called the ammoniuret of copper.

The analysis of mineral waters, where the nature and amount of the whole ingredients, and not of one only, form the subject of inquiry, is a task of very great difficulty. Generally, however, non-professional experimenters upon liquids of this description, are anxious merely to ascertain the existence or non-existence of certain ingredients, without entering into minute proportional quantities, or the like details. The report of a case where a clergyman, the Rev. W. Robertson, junior, of Inverkeithing, examined a mineral spring at Fordel, now lies before us, having been communicated to the *Philosophical Journal* of Professor Jameson. It may give a fair idea of the way of going to work under such circumstances.

A gas bubbled up through the spring, which Mr. Robertson first examined. The elementary as well as compound gases have properties and affinities as well marked as those of fluids or solids, and can be as readily detected. For example, the gas called carbonic acid, present so largely in nature, has such an affinity for lime, that, on contact, it is at once absorbed by lime-water, and renders that liquid turbid. By trials with a graduated glass tube, where the gas or air containing carbonic acid is brought into contact with lime-water, the loss of the acid gas by absorption may be measured, and the proportion of it present in the examined air at once determined. So with other gases, when tested in relation to their respective affinities. Having satisfied himself about the gases present in the spring of Fordel, Mr. Robertson then tried the following preliminary experiments to determine the substances contained:—"Even when recent, it did not perceptibly redden tincture of litmus, though the tint was compared with the colour of the tincture diluted to a similar extent.

"It did not affect the colour of Brazil wood or turmeric test-paper. With tincture of galls it gave a slight tinge of purple, and ultimately a scanty purplish-brown flocculent precipitate, showing the presence of iron, and by the purplish tinge, also, the presence of earthy or alkaline salts.

"The water, next day, gave no tinge with the tincture, showing the iron to be principally in the state of a carbonate.

"When the water was evaporated by a gentle heat, flocculi of oxide of iron were deposited.

"The water, upon being boiled, gave a considerable yellowish-white precipitate, indicating carbonates. This precipitate was soluble, with considerable effervescence, in nitric acid.

"The water decanted off from this precipitate gave no tinge with tincture of galls, but, on boiling it with a few drops of nitric acid, to peroxidise the iron which it might contain, the excess of acid being afterwards neutralized by ammonia, it gave unequivocal traces of iron, by a darkish tinge with the tincture. From this it was inferred that the iron in it was in the state of protoxide. A portion of this water, after being thus treated, also gave a red tinge, with sulpho-cyanate of potash.

"With ferro-cyanate of potash, and a drop of muriatic acid, the water, when recent, gave a whitish precipitate, becoming blue by exposure to the air, indicating iron in the state of protoxide.

"With lime-water, the recent water gave a copious flocculent precipitate, the lime uniting with the excess of the carbonic acid, and the whole of the carbonates falling down together. This precipitate was redissolved, on adding more of the mineral water, which showed a considerable excess of carbonic acid; and it was also soluble with effervescence in dilute acetic acid.

"With the bicarbonate of potash there was no precipitate, the whole being kept dissolved by the excess of carbonic acid.

"With ammonia, and also with potash, a flocculent white precipitate took place, partly owing to the abstraction of free carbonic acid. With the carbonates of potash, soda, and ammonia, there were similar precipitates, but more scanty; they were all soluble in a dilute acetic acid.

"With a solution of soap in alcohol, a great milkiness

"With acetate of lead, a considerable milkiness, and a precipitate insoluble in acetic acid.

"With oxalate of ammonia, a considerable precipitate, indicating lime.

"With carbonate of ammonia and phosphate of soda, an immediate milkiness, and a precipitate, after standing, indicating magnesia; the precipitate soluble in acetic acid. With carbonate of ammonia or phosphate of soda, separately, no milkiness, after standing for the same length of time.

"With muriate of baryta, a slight precipitate, insoluble in muriatic acid, indicating sulphuric acid.

"With nitrate of silver, a copious precipitate, white while secluded from the light, becoming rapidly purple on exposure to light, indicating muriatic acid.

"Two ounces of the water, evaporated to dryness, gave, with nitro-muriate of platinum, slight traces of potash.

"The water, very much concentrated by evaporation, gave, with starch and sulphuric acid, no trace of iodine.

"From the above indications, it was concluded that the water contained sulphuric, muriatic, and carbonic acids, together with protoxide of iron, lime, magnesia, and a little potash. The presence of alumina was inferred to be incompatible with that of the earthy carbonates, neither could any be subsequently detected." The determination of the quantities of each substance present was the next object with Mr. Robertson; but it is not necessary here to carry our notice of the subject beyond generalities.

The agricultural chemist proceeds in a similar way and with similar instruments. He has the advantage, generally, of knowing beforehand the probable character of the matters on which he operates, and the point is to determine in what proportions they exist in the particular soil under examination. Where a less exact analysis will suit the purposes of the agriculturist, the following simple plan of ascertaining the qualities of soils may be adopted. We quote, with some slight alterations, from Mr. Young's "Letters of Agricola."

"In the field to be examined, take earth a little below the surface, from four separate places, about a quarter of a pound from each. Mix them together, and again separate them into four quantities of a quarter of a pound each. Then take one quantity and expose it to the sun, or before the fire, till completely dry; and turn it over frequently, that it may be well mixed together. Being thus powdered, pass it through a fine sieve, which will allow all the particles of sand and gravel to escape, but which will hold back stones, small fibrous roots, and decayed wood. Weigh the two parts—the fine and the rough—separately, and take a note of each. The stones and other bulky materials are then to be examined apart from the roots and wood. If they are hard and rough to the touch, and scratch glass easily, they are silicious and flinty; if they are without much difficulty broken to pieces by the fingers, and can be scraped by a knife to powder, they are aluminous or clayey; or if, when put in a wine-glass, and common vinegar poured upon them, small air-bubbles ascend to the top of the liquid, they are calcareous. The finely divided matter which ran through the sieve, must next undergo the test of experiment. After being weighed, agitate the whole in water, till the earth be taken up from the bottom and mechanically suspended, adding water till this effect be produced. Allow the mass then to settle for two or three minutes, and in that time the sandy particles will sink to the bottom. Pour off the water, which will then contain the clay in suspension, and the insoluble earth arising from animal and vegetable decomposition. The sand should be first attended to, and if from inspection it be thought either silicious or calcareous in its nature, the requisite tests may be instantly applied. By this time the mixture in the poured-off water will leave deposited at the bottom of the vessel the clay and other earths, with the insoluble animal and vegetable matter. After pouring off the water, dry the sediment, and apply a strong heat by placing it on the bottom of a pot ignited to redness, and the animal and vegetable matter will fly off in aëriform products. The remainder lying in the bottom will be found to consist of clay, lime, or magnesia.

"To obtain accuracy, another quarter of a pound may be taken, and the whole process gone over a second, a third, or even a fourth time, so that the operator may rectify any blunders he had previously committed, and be satisfied as to the results of the experiment. He should provide himself with a pair of fine scales, and a set of weights divided at least into half and quarter ounces and drachms. Although vinegar will detect lime by effervescence, it does not dissolve it so effectually as the nitric or muriatic acids, small quantities of which may be obtained from the druggists at a small expense."

Having ascertained by these, or any other inquiries, what is the composition of the soil, a pretty accurate notion, other things considered, may be obtained respecting its capacity for productive husbandry. If it be necessary to enter on a course of improvement, the defect in composition may be remedied by the application of materials of an opposite quality—an excess of calcareous matter being counteracted by sand and clay, an excess of clay by the admixture of sand, or an excess of sand by the application of clay, peat, &c. An excellent soil for bearing wheat has been found to contain in 100 parts—carbonate of lime, 28; silica, 32; alumina, 29; and of animal and vegetable matter, with moisture, 11. Oxide of iron, to the extent of 3 or 4 in the 100 parts, is not unusual in good soils.

COMBUSTIBLES.

The class of combustibles in the manufacture of which a knowledge of chemistry is more particularly required, includes gunpowder, fulminating powders, the material of Congreve and sky rockets, bomb-shells, percussion-caps, rapidly igniting matches, and of fire-works generally. The term *Pyrotechny* (from *pur*, fire, and *techne*, art) has been applied to the art of making and compounding these substances. Of each of them we shall present a short account, with an explanation of the principles on which they fulminate and explode.

The leading ingredients in most explosive combustibles are charcoal, saltpetre or nitre, and sulphur. In making fireworks of a varied kind, however, numerous other substances are employed. The chief are chlorate of potass, fulminating silver, and mercury, preparations of steel, copper, and other metals, with various oils, spirits, and resins. Charcoal, as is mentioned in the preceding sheet, is simply wood reduced to a charred condition (pure carbon), by being burnt to a kind of blackened cinder in a vessel closed from the atmosphere. For making gunpowder, light woods, such as the willow and alder, are the best, and the pieces are stripped of their bark before being used. In preparing this kind of charcoal, it is important that the vapours be allowed freely to escape, otherwise its combustibility will be impaired. The preparation is usually effected by iron retorts over furnaces; and by a connecting tube the vapour escapes, and is condensed into a tarry acid, from which pyroligneous acid is afterwards distilled. After being thus prepared, the charcoal is ground to a fine powder. It has been properly charred if it burns without leaving any residuum.

Saltpetre, nitre, or nitrate of potass, is abundant in nature, but may also be compounded by the artificial union of its two ingredients, nitric acid and potass. It is procured largely from India, and also from Egypt, Spain, and other countries, where it is found on the surface of limestones, marls, and chalky strata, being spon aneously generated and reproduced there by some atmospheric influence not well understood. The slight silky tufts of the nitre are swept up with a broom, and are lixiviated, allowed to settle, evaporated, and crystallized. In this state it is exported; but the impurities which it contains require its subjection to successive solutions and crystallizations, ere it can be formed into gunpowder. The last process is that of fusion, in iron pots at a regulated heat. Nothing can surpass, in these respects, the nitre prepared in the government powder-works at Waltham Abbey. It is tested by adding to its solution in distilled water nitrate of silver, with which it occasions no perceptible opalescence.

Sulphur is procured in many volcanic countries, and the great emporium for it is Sicily. At the gunpowder works, it is purified for use either by distillation or by fusion. In the first instance, the pure part is distilled over, and, in the second, skimmed off, the impurities being left behind.

Gunpowder.—The three ingredients, charcoal, nitre, and sulphur, being duly prepared by trituration, and passed through fine sieves, they are ready to be mixed. There appears to be a great difference of opinion and practice in determining the relative proportions of the ingredients. The following is a scale of proportions in 100 parts, adopted by different gunpowder makers:—

	Nitre.	Charcoal.	Sulphur.
Royal mills at Waltham Abbey	75	15	10
French, for war	75	12·5	12·5
" for sportsmen	78	12	10
" for mining	65	15	20
Chaptal's proportions	77	14	9
Mr. Napier's ditto	80	15	5

The mingled ingredients are now carried to a mill, to be properly blended by the pressure of a revolving stone on edge; the stone is of a calcareous quality, and goes round on a bedstone of the same nature; no metal or sandstone is employed either about the machinery or the mill-house, in order to avoid the danger of sparks. "On this bedstone," says Dr. Ure, in his history of the manufacture, "the composition is spread, and moistened with as small a quantity of water as will, in conjunction with the weight of the revolving stones, bring it into a proper body of *cake*, but not of *paste*. The line of contact of the edge-stone is constantly preceded by a scraper, which goes round with the wheel, continually scraping up the cake, and turning it into the track of the stone. From fifty to sixty pounds are usually worked at once in each mill-wheel. When the cake has been thoroughly incorporated, it is sent to the corning-house, where a separate mill is employed to form the cake into grains or corns. Here it is first pressed into a hard firm mass, then broken into small lumps; after which the graining is executed, by placing these lumps in sieves, on each of which is laid a disk of lignum vitæ. The sieves are made of parchment skins, perforated with a multitude of round holes. Several such sieves are fixed in a frame, which by proper machinery has such a motion given to it as to make the lignum vitæ runner in each seive move round with considerable velocity, so as to break the lumps of the cake, and force the substance through the sieves, forming grains of several sizes. These granular particles are afterwards separated from the finer dust, by proper sieves and reels. The corned powder is next hardened, and the rougher edges taken off, by being revolved in a close reel or cask, turning rapidly on its axis. This vessel somewhat resembles a barrel-churn; it should be only half full at each operation, and has frequently square bars inside, parallel to its axis, to aid the polish by attrition. The gunpowder is now dried, which is done generally by a steam-heat, or by transmitting a body of air, slightly heated in another chamber, over canvas shelves covered with the damp gunpowder."

Rockets—Fireworks.—The common modern rockets, which are generally employed as signals or tokens of rejoicing, may be described as tubular cartridges of paper, pasteboard, wood, or metal, filled with combustible substances, which, on ignition, cause the cartridge to shoot rapidly through the air. The movement may be irregular, parabolic, or perpendicularly upwards, according as a small stick or guide is attached, or otherwise, to the cartridge, to direct its movements. The principle on which rockets rise in the air is simple, and may be explained here, once for all, as it applies to all varieties of flying fire-works. A vessel containing a fluid which tends to expand, will be motionless so long as the vessel is closed on all sides, because the pressure is then equal everywhere; but if an opening exist, the pressure will not be equal, and the vessel will then tend to move in the direction in which the pressure exists. If the opening be below, the tendency will be to rise; and if the expansive force be great enough, and the vessel sufficiently light, the vessel will obey the pressure and ascend. When the expansive force is exhausted, it will again descend, by the ordinary influence of gravitation. In the case of the rocket, the combustion, commencing below, creates the expansive gas, and the pressure forces the rocket upwards. Were there no opening, the pressure would be equal, and, if the force were sufficient, it would simply burst the rocket.

"The rockets which rise into the air with prodigious velocity," says Dr. Ure, "are among the most common but not least interesting fire-works." The cartridge or tube, commonly of pasteboard or pasted paper, must be very strongly formed, if large, and intended to ascend high. Inside of it is a second tube, called the *soul* or *fusee* of the rocket, the purpose of which is to leave a vacant space round the axis, that the volume of elastic gas which the ignition produces may act on a vacant space. On account of its somewhat conical form, hollow rods, adjustable to different branches or skewers, are used in packing the charge, the cartridge being sustained by a copper mould or cylinder at the time. The charge of sky-rockets varies according to the bore of the cartridge. Nitre 16, sulphur 4, and charcoal 7, are the contents and proportions of the charge when the bore is three-fourths of an inch; and the charcoal is merely increased a very little when the bore is enlarged. This is the common rocket, with the usual light of gunpowder. When a rocket with a *brilliant* light is wanted, 3 parts of fine steel-filings are added; and when the light called the *Chinese-fire* is desired, 3 parts of fine borings of cast-iron form the addition to the three ingredients first-mentioned. These are the common rockets; the sources of other kinds and colours of light will be noticed immediately.

The *garniture* of a rocket, as the crackers, showers of fire, stars, serpents, &c., are called, which are commonly attached to it, with what is termed the *pot*, are of course added before igniting the charge in the central tube or fusee. "The pot is a pasteboard tube, wider than the body of the rocket, and one-third of its length. After being strangled at the bottom like the mouth of a phial, it is attached to the end of the fusee by means of twine and paste. These are afterwards covered with paper. The garniture is introduced by the neck, and a paper plug is laid over it. The whole (for still greater strengthening) is enclosed within a tube of pasteboard terminating in a cone, which is firmly pasted to the pot. The quick-match is now finally inserted into the *soul* of the rocket, and a light rod or stick attached to the end of the whole, to keep it in a perpendicular ascent."

The beauty of the rocket depends much on the style of the garniture. These, whether stars or serpents, are charged fusees, stronger or weaker, formed into the shape wanted, and giving kinds of light modified by the ingredients. Stars which give golden showers are formed of nitre, 10; sulphur, 10; charcoal, 4; gunpowder, 16; lamp-black, 2. Petards are sealed cartridges, which burst in the air, and crackers are square boxes of pasteboard, hooped, and charged with gunpowder. But the finest accompaniment of the rocket is the Roman candle, which is a fusee so formed as to throw out in succession, as the combustion reaches them, very fine stars. These stars are small cylindrical masses of nitre, sulphur, and gunpowder, steeped in spirits and gum. The variety of rockets of course depends on the difference of size and garniture. This remark, however, must not be understood to apply to the Congreve rockets, which have a special character and purpose. The *Popular Encyclopedia* thus describes them:—"The Congreve rockets, first used in the attack of Boulogne, 1806, are of various dimensions, and are differently armed as they are intended for the field or for bombardment. Those of the first sort carry shells or case shot; the others are armed with a very combustible material, and are called *carcass rockets*. Their form is cylindrical, and they are composed of strong metallic cases. The sticks employed for regulating their flight are of different lengths, according to the size of the rocket. The carcass rockets are armed with strong iron conical heads, pierced with holes, and containing a substance as hard and solid as iron itself, which, when once inflamed, is inextinguishable, and scatters its burning particles in every direction. When this substance is consumed, the ball explodes like a grenade. The rocket is projected horizontally, and whizzes loudly as it flies through the air. The ammunition is divided into three classes—heavy, medium, and light; the heavy including all above forty-two pounds, the medium, those from forty-two to twenty-four pounds, and the light, from eighteen to six pounds inclusive." The Congreve rockets were used at Leipsic and Copenhagen, but experience has proved them to be much less efficacious than common artillery, and, besides, the secret of their manufacture is now known everywhere.

To return to artificial fire-works, made for amusement. We have only noticed the *flying*-rockets or fusees, but *fixed* fire-works, or those whose motion is confined to a spot, can be made of a much more splendid appearance. Jets, wheels, suns, trees, lances, spirals, revolving suns, double or Catharine wheels, (two suns in one axis, revolving opposite ways), and many other beautiful contrivances, have been at times exhibited, and chiefly by the two Ruggieris, renowned pyrotechnists. These individuals even displayed in public the spectacle of a luminous serpent chasing a butterfly round and round a large space, their motions being governed by unseen machinery. In all preparations of a pyrotechnic nature, nitre, sulphur, charcoal, and gunpowder, are the chief ingredients. By means of spirits, gums, resins, and oils, the quality and duration of the light is modified, and the principal articles of that description in use are alcohol, bitumen, camphor, wax, turpentine, lard, and the like. Again, the colour of the fire, on which so much of the splendour rests, is modified by employing other articles. Copper-filings and sal-ammoniac give a greenish tint to flame; zinc a fine blue; amber and very dry common salt a yellow; lamp-black produces a deep red with gunpowder, and a pink with nitre in excess; camphor gives a fine white; lycopodium gives a rose colour; and sulphate of strontia a beautiful purple light. Many other substances are at the command of the pyrotechnist, which produce beautiful variations of colour.

Instantaneous Matches.—These matches, commonly known as *Lucifers*, are nearly all made of one substance, the chlorate or oxy-muriate of potass. This substance may be made by passing chlorine gas through a solution of carbonate of potass, when the chlorate is formed and precipitated; or in a dry way, by mixing oxide of manganese, common salt, carbonate of potash, and vitriol, in a peculiar way. But it is superfluous to describe in a popular sketch a process which can be safely attempted by none but the qualified. The chlorate of potass is in white crystals. Dr. Ure's formula for making the matches is as follows:—Thirty parts of the chlorate, in fine powder, are to be mixed gently with a knife upon paper with ten parts of very fine sulphur, eight of sugar, five of powdered gum-arabic, and enough of powdered vermilion to give a rose tint to the whole. The chlorate, gum, sugar, and vermilion are then gently but well-mixed, after which as much water as will make a thin paste is added; and then the sulphur is thoroughly mixed with the whole. A great, improvement, however, has lately taken place in the use. The matches were dipped formerly in sulphuric acid; but by adding a little more of the chlorate and sulphur than is in Dr. Ure's recipe, they are lighted by friction on sand-paper or any rough substance, such as a stone floor. The convenience of matches is thus doubly heightened. No other fulminate has been so effectually used for matches as chlorate of potass. Neat, but comparatively dear and inefficient lamps have been made with spongy platinum, which kindles on receiving a stream of hydrogen.

Fulminating Powders.—There are a number of these explosive compounds known to chemists, of which the principal are fulminating gold, mercury, platinum, and silver; and one longer known than either, a mixture of nitre, sulphur, and potass. None of these have any practical importance, comparatively speaking, excepting the fulminate of mercury, which is used for *percussion-locks*. We believe that a report to the government of Great Britain in 1831, made by Dr. Ure, had the effect of introducing the improvement of percussion-locks into the public service. The formula which that report gives for the manufacture of the fulminate is as follows:—Dissolve 1000 parts of mercury in 1000 parts of nitric acid, and add the solution to 830 parts of alcohol, a large vessel being used. A gas rises, which must be allowed to escape, and at a distance from flame. When the effervescence ceases, the contents of the vessel are to be poured out on a large double paper filter in a glass funnel, and cold water thrown over it till the drainings no longer redden litmus paper. The powder adhering to the vessel is also to be placed on a filter, with a little water. The superfluous acid thus washed away, the powder of fulminate of mercury, adhering to the filter, is lifted away and opened out on plated copper or stoneware heated by steam. The powder, when dried, is in the form of small gray crystals, and is then to be packed in small parcels, and kept close from the air in bottles or boxes. Dr. Ure examines several other modes of making the fulminate, but points out defects in all; and his own, though not free from them, was the one adopted most generally, we believe. Two and a half pounds of the fulminate, when prepared for the purpose, will charge 40,000 percussion-caps, according to the calculation of French manufacturers. The preparation consists in grinding the fulminate upon marble with 30 per cent. of water, adding six parts of gunpowder for every ten of the fulminate. A dough is obtained, which, when dried in the air, is introduced in small fixed portions into the bottom of the percussion-caps. The guns on which these caps are placed have, it is well-known, no pans on the lock. In place of them a small open tube projects horizontally, on which another small tube stands perpendicularly. The cock is a hollow hammer, fitted to descend on the tube mentioned, though large enough also to grasp the percussion-cap—a thin cone, when placed on the tube. The fulminate was formerly placed dry in the bottom of the cap; but of late a most important improvement has taken place, in as far as an alloy of copper is made for the purpose, which contains the fulminate within itself, so that all chance of injury by wet, or danger from the mixture, is put entirely out of the reach of possibility.

Bomb-shells.—This species of explosive combustible possesses little interest, as regards its structure or manufacture. In their various shapes, shells are merely a modification of one arrangement—that of a circular case of metal, fitted to be discharged by cannon, and containing a central charge of gunpowder, with an extensive charge of substances fitted to spread and inflict injury on the explosion of the powder. The bombs also spread combustion where they alight. The experience of the late sieges of Antwerp by the French and Acre by the British, has shown that this species of warlike machine is calculated to rise into greater importance than it has hitherto done, rendering forts and cities untenable, when it is well used.

Explosion of Combustibles.—When gunpowder and similar combustibles are fired, they explode with a loud noise, and with an extraordinary degree of force. The explosive sound is caused by the rapid disengagement of air in the combustibles, and the shock of striking upon the volume of the external atmosphere. The explosion is, indeed, a chemical process, in which a tangible material suddenly vanishes into air, and is no more seen. The velocity of movement in the flame of ignited powder, as it rushes through the tube of a gun, is an immediate consequence of the sudden disengagement of the confined air, and is calculated to be at the rate of 7000 feet in a second, or little less than seventy miles per minute. A cannon-ball, however, though projected with this velocity, immediately encounters a retardation from the atmosphere as well as its own gravity, and does not generally proceed at a greater rate than 2400 feet per second, or little more than twenty-seven miles per minute. The degree of force with which it is impelled, of course, depends on the strength of the charge, or the quantity of elastic fluid to be expended.

SOAP AND CANDLE MAKING.

Both these arts depend on chemistry for the perfection to which they have been brought. That exceedingly useful article, soap, of which the ancients were entirely ignorant, is a compound of certain principles in oils, fats, or resin, with a salifiable base. If this base be potash or soda, the compound is used as a detergent in washing clothes. When an alkaline earth or oxide of a common metal, such as lead, which forms litharge, &c., is the base, the compound is insoluble in water. The insoluble compounds, however, are very little used, except in some few cases of surgery. Animal fat, grease, or tallow, as it is variously termed, is a compound of a solid substance called, in chemistry, *stearine*, and of an oil called *oleine*, the basis of which is carbon, with a little hydrogen and oxygen. On subjecting tallow to a hot ley of potash or soda, a chemical change takes place in the constituents, and we have the material named *margaric acid*, and a fluid, *oleic acid*, and together they enter into a saline combination with the alkali. The result, a soapy substance, is thus said to be a union of an alkaline margarate with oleate. Saponification also takes place with oils.

The commonest hard soap is that made chiefly from kelp and tallow. Kelp itself is a result of chemical action. It is made by reducing certain kinds of seaweed to ashes by burning; the result in soluble material is a crude alkali, consisting of sulphate of soda, soda in carbonate and sulphuret, and muriate of soda and potash. It was at one time manufactured in large quantities on the shores of the Western Isles of Scotland, but has latterly been disused, in consequence of the substitution of barilla, and soda-ash from the decomposition of sea-salt. Supposing kelp to be employed in making soap; to every ton of kelp, about one-sixth of new-slaked lime is added. The whole, after mixture, is put into a large tub called a cave, having a perforation at the bottom, shut with a wooden plug. Upon the materials water is very slowly poured. The liquid, after digestion, is suffered to run slowly off into a reservoir sunk in the ground. The first portion, or ley No. 1, is of course the strongest, and is reserved for the last operation in soap-boiling. Six days are required to make one boiling of soap, in which two tons or upwards of tallow may be employed. The leys 2 and 3, mixed, are used at the beginning, diluted with water, on account of the excess of sea-salt in the kelp. A quantity of ley, not well defined, is poured on the melted tallow, and the mixture is boiled, a workman agitating the materials to facilitate the combination. The fire being withdrawn, and the aqueous liquid having subsided, it is pumped off, and a new portion is thrown in. A second boil is given, and so on, in succession. Two or three boils are performed every twelve hours, for six days, constituting twelve or eighteen operations in the whole. Towards the last, the stronger ley is brought into play. Whenever the workman perceives the saponification perfect, the process is stopped, and the soap is lifted out and poured into the moulds.

The compounds of tallow or oils with potash, remain of a soft consistency, and form what are termed soft soaps, useful in scouring. We can only afford space for an account of the process of manufacturing one of the common kinds of soft soap, as lately practised by an eminent soap-boiler near Glasgow. Whale or cod oil, to the amount of 273 gallons, is put into a boiler along with four hundred weight of tallow and 252 gallons of potash ley. On heat being applied, the mixture froths up very much, but means are adopted to prevent it boiling over. There are then added at intervals fourteen measures of stronger ley, each measure holding twenty-one gallons. After suitable boiling without agitation, the soap is formed, amounting in all to one hundred firkins of sixty-four pounds each, from the above quantity of materials.

What are called toilet soaps are made from purified hogs' lard, with the addition of olive, almond, or palm oils. These, when prepared, are perfumed with various scents. The soap is cut into thin shavings with a plane, and melted in a pan placed within a hot water or steam bath. When melted, the colouring matter and perfume are added, which generally consist of vermilion, ochre, bergamot, musk, essence of orange-blossom, cinnamon, &c. Although the French excel in practical chemistry, they make very inferior soaps, either fine or common. The English, on the contrary, manufacture soaps of a superior quality; and so well is this known, that the greater number of English tourists on the continent take soap as a necessary with them.

Candles.—The process of making candles by simply melting tallow, and pouring it in a liquid state into moulds containing wicks, requires no particular notice. It is of the improved mode of making tallow-candles to resemble those of wax, and involving an intimate knowledge of chemistry, that we wish to speak.

Some years ago, M. Chevreul, a French chemist, undertook an investigation into the nature of fatty substances, which he found to be composed of what we now know them to be—two materials, *stearine* and *oleine*. He ascertained that the oil does not combine directly with the alkali, but that its two components are converted by it into two corresponding acids, the stearic and oleic, which then combine with the alkali, like the mineral acids. He found, indeed, the analogy perfect between them in every respect. They unite with all the bases, forming compounds which differ in the degree of their solubility: with potash, for instance, a very soluble compound is formed (soft soap); with soda, hard soap, which is dissolved with more difficulty; while its combination with lime gives rise to a perfectly insoluble compound. These facts have been most important to the soap-maker, in enabling him to reduce his art to scientific principles; they explain why a solution of soap may be used as a test for the purity of water; why rain water is preferred to that from the spring for washing; and why we add soda to hard water before using it with soap, for soda separates the lime which the hard water contains, and thus enables us to dissolve the soap without producing the curdy precipitate which destroys the cleansing properties of the soap.

M. Chevreul separated these acids from their compounds, and found them possessed of the following properties:—Oleid acid is a liquid, clear when pure, and closely resembling oil; stearic acid is solid, and resembles wax in so striking a manner as to be with difficulty distinguished from it. On finding he could manufacture it at a price much inferior to that at which wax is sold, he, in conjunction with M. Gay-Lussac, another distinguished chemist, took out a "brevet d'invention" for the preparation and sale of "chandelles steariques," from which they never derived any benefit, solely on account of the name, which, merely implying candles prepared from tallow, attracted no attention; whereas manufacturers, who took up the trade after the expiration of the patent, and who announced, with less regard to truth, their productions as "bougies," or wax candles, speedily made large fortunes. If the reader wishes to prepare and examine the artificial wax himself, it may be easily accomplished. Let him dissolve a little hard white soap in hot rain or distilled water, and to the clear solution, while hot, add some vinegar or other acid. The stearic being a weak acid, is easily separated from its combination with soda, as it exists in soap. Acetate of soda is formed, and the stearic acid rises to the top of the liquid as an oily substance, which, on cooling, solidifies into a cake of artificial wax, mixed with a certain portion of oleic and impurities, which render it softer than if this fluid had been expelled by pressure. A similar process is pursued on a large scale, but regard must be had for economy. The tallow is saponified, not by soda or potash, as in the preparation of soap, but by quick-lime. It is only necessary to boil the lime, tallow, and water, in a large vessel for some hours, when these ingredients are converted into a kind of hard soap. From this substance, stearate and oleate of lime, also the stearic and oleic acids, are separated by the addition of oil of vitriol. They are melted like tallow, run into cakes, and subjected to the powerful action of a hydraulic press, which separates all impurities, and leaves the stearic acid as pure and white as the finest bleached wax, which may be used immediately for the formation of candles. In France, besides plaiting the wicks, they are dipped in a solution of borax, and then dried. The borax fuses during the combustion, and forming a globule on the summit of the wick, assists by its weight to bring it out of the flame in contact with the atmosphere, and thus ensures perfect combustion, and obviates the necessity of snuffing.

It was found that the artificial wax generally crystallized in the moulds, a circumstance which prevents the formation of a solid candle. In England this difficulty was overcome in some cases by the addition of arsenic. The French, more scientific than we, had recourse to their knowledge of the laws of crystallization for the remedy. It is known that regular crystallization only takes place when the transition of the mass from a fluid to a solid state is so gradual as to allow time for its molecules to arrange themselves in those determinate forms called crystals: this condition was fulfilled in the cooling of the moulds and their contents, but by plunging them in cold water as soon as the melted stearic acid had been poured in, crystallization was prevented, and a perfectly solid candle procured. Stearic candles, which can with difficulty be distinguished from wax candles, are now manufactured on a large scale in England, and, from their comparative cheapness, are coming universally into use in the houses of the middle and higher classes of society. So much for the value of a knowledge of practical chemistry in one of the commonest of the useful arts.

COLOURS—DYEING.

There are, as is well known, two modes of imparting colours—dyeing and painting; the former applied to articles coloured by a liquid infusion, and the latter applied to the laying of a colouring substance on the surface. We *dye* cloth, and *paint* a house. The materials employed in dyeing are usually drugs, salts of some kind, or vegetable fluids; but in painting, the prepared colours are chiefly pigments. The preparation of dye-stuffs and pigments is one of the chief departments of practical chemistry.

According to the definitions of men of science, there is no such thing as material colour. The colour is not in the substance; it is only a result of the operation of rays of light on the peculiarly formed particles in the mass. It is stated that when the rays strike upon the surface of a body, they are decomposed into their elementary tints, and some substances reflecting one colour and some another, the impression is made on the eye accordingly. When the particles of the body do not reflect any of the rays, the body appears black; and when they reflect them all equally, it appears white. A piece of blue silk, for instance, absorbs six rays and reflects one, the blue, by which a blue appearance affects our eye. What is the precise constitution or figure of the particles in a substance which produces the phenomena of colours, has never been ascertained. It is certain, however, as we have just mentioned, that colouring less or more depends on the well-known principle of the refrangibility of light. (See Optics.) Both dyers and painters require to be more conversant with chemical than optical science; yet there are cases in which a knowledge of the laws of light are of importance. It is a well-known truth, that the common white ray of light can be refracted into three primitive colours—red, blue, and yellow—and that these can be recombined into the white ray. A dyer could not expect to dye white by employing an infusion of red, blue, and yellow drugs, but it is certain that the application of a little blue improves a white colour; and this is perfectly understood by paper-makers. Mixtures of Prussian blue and cochineal pink are likewise used to improve the whitening of silks. The colours resulting from a mixture of two primitive colours, as green from blue and yellow, are only a delusion of the eye. Both the component colours are present and distinct, but they are so blended that we cannot separate them by the naked sight. For instance, a gray hair, when seen by a microscope, is not actually gray, but a composition of small black points on a whitish ground.

Paints.—The colouring substances used as paints are partly artificial and partly natural productions. They are derived chiefly from the minerals by certain chemical processes; and even when animal or vegetable substances are used for colouring, they are always united with a mineral substance (an earth or an oxide), because by themselves they have no body, which they acquire only by a mixture with a mineral. In painting, the colours are ground to a great degree of fineness, and applied by means of some liquid with a brush or camel-hair pencil. Different fluids are employed for this purpose; and the difference and the material used, with the method of employing it, has given rise to the modes of painting in water-colours, oil-colours, in distemper, and in fresco (painting on damp plaster as an absorbent). Oil-paints are usually prepared with boiled linseed oil, which is drying in its nature; the colours employed all consist of metallic oxides, or salts, or of combinations of sulphur. Among the metallic oxides used as pigments are minium and masticot, from lead; the ochres, burnt sienna, umber, from iron; smalt, from cobalt. Among the salts, or saline metallic combinations, are white lead, cremnitz white, from lead; Prussian blue, from iron; verdigris, mineral green, Brunswick green, from copper. Metallic combinations containing sulphur are cinnabar, from quicksilver, and orpiment, from arsenic. The lake colours have tin or alum for their bases, and owe their tint to animal or vegetable colouring substances. Among these are the red or pinkish lakes prepared from cochineal, madder, and Brazil wood; the yellow, from fustic, &c.; the brown, from several other colouring barks; finally, indigo, which, however, is entirely vegetable. In staining porcelain and glass, the metallic colours which are not driven off by heat, and are not easily changeable, are used. Gold containing tin gives a purple, nickel green, cobalt blue, iron and manganese black, uranium yellow, chrome green. From the chromate of iron, or rather ferruginous oxide of chrome, one of the most beautiful yellow pigments is now prepared for the use of painters.

The material principally employed by respectable house painters to give consistency to their paints, is white-lead or ceruse. This substance is an oxide of lead saturated with carbonic acid. It is prepared by exposing thin plates of lead in a closed vessel to the vapours arising from hot vinegar. The vapours of the acetic acid become saturated with the metal, and change the latter into a whitish substance, which is scraped from time to time off the plates. The whitish substance is afterwards pulverized, and mixed with properly prepared oil. Much of the white-lead in common use is adulterated with whiting, that is, purified and ground chalk, which is much less durable, and may be easily washed off by an alkaline solution.

Oil or spirit of turpentine is also largely used by house-painters, chiefly for the purpose of imparting a drying quality, or of deadening the glitter of the paint. Turpentine is a fluid extract from certain kinds of fir trees, from which it exudes, and being distilled, the oil or spirit of turpentine is obtained; the residuum is resin. Turpentine is of a powerful acrid quality, and is now employed for certain purposes in medicine. All the varnishes used by painters are of the class of gums or resins, properly prepared, such as copal, mastic, sandarac, lac, gum-lac, dragon's blood, &c. All are extremely inflammable, and great caution is necessary both in their preparation and general use.

INKS, either for writing or printing, are as much the result of chemical operations as paints or dyes. Black ink is a decoction of partly vegetable and partly metallic substances, the basis of the latter being iron. The ingredients commonly used are Aleppo galls in powder, logwood, gum-arabic, and sulphate of iron, in certain proportions; but, latterly, the art of manufacturing the article has been greatly improved, chiefly with the view of giving great fluidity as well as colour. Printing-ink is quite a different substance, being a thick viscid body, resembling a black paint. Its ingredients are boiled linseed or nut oil and lampblack, in the proportion of two and a half ounces of black to sixteen ounces of oil. The preparation of the oil is one of the most dangerous processes in the arts, and great care is required to prevent conflagration of the oleaginous material. There are various qualities of ink to suit different kinds of work. The prime object of attainment in making printing-ink, is to give it a deep black colour, which will endure after exposure on the pages of a book. Unless very great trouble be taken in grinding and mingling the materials in exact proportions, the ink, on being used, will gradually become brown, by the spreading of the oil. The French printing-inks are much superior to those made in Britain.

Indian Ink.—This article is used in China for writing with a brush, and for painting upon the soft flexible paper of Chinese manufacture. It is ascertained, as well from experiment as from information, that the cakes of this ink are made of lampblack and size, or animal glue, with the addition of perfumes or other substances not essential to its quality as an ink. The fine soot from the flame of a lamp or candle, received by holding a plate over it, mixed with clean size from shreds of parchment or glove-leather not dyed, will make an ink equal to the imported.

DYEING.—A remarkable circumstance connected with dyeing, is the different degrees of facility with which animal and vegetable substances imbibe the colouring matters applied to them. Tissues composed of the former, as silk and wool, receive more brilliant colours than those composed of the latter, as cotton and linen. The cause of this difference has not hitherto been discovered.

Although in the most numerous class of cases it is easy to impart colour to various tissues, yet when these become exposed to moisture, the dye-stuff is removed. It has therefore been found necessary to employ certain chemical substances, which shall have the property of permanently fixing the colour upon the body which is dyed. These substances have obtained the name of *mordants* (from the Latin word *mordere*, to bite), because they were supposed at first, figuratively speaking, to bite the dye into the cloth. The same name has also been applied to those preparations which possess the property of altering the shade or of heightening the colour, as it is called. The latter, at the suggestion of Berthollet, are sometimes termed *alteronts*. The principal mordants are alumina, employed universally, we believe, in the form of a salt, as that of alum; the oxides of tin, employed like the former in the shape of salts, which are prepared by dissolving tin in muriatic acid. Silk and woollen dyers, however, employ nitric acid or aquafortis for forming the salts of tin which they use. The salts of lead and copper are likewise had recourse to as mordants; and the nut-gall, which contains two very peculiar vegetable substances, tannin and gallic acid, is not only employed as a mordant, but also as a powerful dye-stuff.

By varying the mordant, a great variety of shades may be derived from the same colouring matter. Indeed, the mordant itself, in many instances, supplies a colour. For example, in dyeing with cochineal, when the aluminous mordant is employed, the colour produced is crimson; but when oxide of iron is substituted for the alumina, a black colour is the result. The whole phenomena are accounted for on the principle of chemical affinity or attraction. The mordant employed should have an attraction both for the stuff to be dyed and the colouring matter, and act as it were like a third party in reconciling two inimicals. The way in which it is used must depend entirely upon the degree of affinity exerted between the stuff and the colouring matter. Where that is slight, the former should be saturated with the mordant before the latter is communicated. A knowledge of the nature and chemical affinities of the substances used is necessary, before mordants can be had recourse to as a medium of union in imparting colour to cloths or other stuffs which we wish to dye; for by an indiscriminate use of them, results the very opposite of those anticipated may take place.

Calico-Printing.—In impressing the representation of figures on calico goods, the object generally held in view is the fixing of mordants on the cloth, which is afterwards dyed in the usual way, those parts which have received the mordant only retaining the colour, the rest remaining white. In some cases the colour is removed from certain portions of cloth already dyed, so that they may either remain white, or receive some new colour afterwards. Sometimes it is applied to cloth before it is dyed blue, in order to prevent the indigo from being fixed on those parts to which it is applied, that they may remain white, or receive other colours afterwards. Substances possessed of this property are called resist-pastes. Lastly, it

is frequently employed to communicate mordants and colouring matter at once to cloth. The thickening of the mordants is of considerable importance towards the successful practice of the art. The application, or the bringing out of the colours, is an ingenious chemical process. Madder is the substance commonly used for red by the calico-printers, and the addition of sumach, fustic, or quercitron bark, will produce a variety of tints with the various mordants at one operation. "Suppose we wish to produce flowers or figures of any kind, containing red, purple, and black colours, we may apply the three mordants at once by the three-colour cylinder-machine, putting into the first trough acetate of alumina thickened; into the second acetate of iron; and into the third a mixture of the two; then drying in the air for a few days to fix the iron, dunging, and dyeing up in a bath of madder and sumach. If we wish to procure the finest madder reds and pinks, besides the purple and black, we must apply at first only the acetate of alumina of two densities, by two cylinders; dry, dung, and dye up in a madder bath. The mordants of iron liquor for the black, and of iron liquor mixed with aluminous for the purple, must be now grounded in by blocks, taking care to insert these mordants into their precise spots; the goods then being dryed with airing for several days, and next dunged, are dyed up in a bath of madder and sumach. They must be afterwards cleared by branning."
—*Ure's Dictionary of Arts.*

After the cloth is dyed, it is washed either with soda, potash, soap, or fresh water, according to the nature of the ingredients used in the dyeing process. Great care is necessary in this department; for if the washing liquor be too strong, the mordant may be injured. Cow-dung diffused through hot water, is applied to calico goods in a particular stage of the manufacture. This is done in order to dissolve and carry off from the cloth a portion of the thickening matter, and also to prevent any undissolved mordant or acetic acid from ... the blank parts of the piece. The dunging, ... called, is performed several times, generally ... the washings. The piece should be immersed, if possible, without folds, and to secure this it is made to pass through rollers. As soon as it comes out of the dung-bath, it is washed in the dash-wheel as in bleaching. The cloth is then finished by being passed through a calender, which greatly improves its appearance. The action of the solution of cow-dung in cleansing from impurities is both mechanical and chemical; as respects the chemical part of the operation, it will be understood when we mention, that cow-dung contains muriate of soda, sulphate of potash, sulphate of lime, carbonate of lime, and other matters useful in deterging.

Bleaching is the art by which various articles may be deprived of the colours which they naturally possess, and so rendered white. Formerly, it was the custom to submit textile fabrics in a moist condition to the free action of the atmosphere and sun's light; but this process of bleaching was not only imperfect but tedious, and the substitution of a chemical effect, as suggested by the celebrated chemist Berthollet (1787), was a great improvement, such as the state of manufacturing industry required. Berthollet's plan consisted in employing chlorine, which possesses a wonderful power of removing vegetable colours. The bleaching-powder, or chloride of lime, as it is usually called, is manufactured by exposing slaked lime to the action of chlorine gas, till as much of the latter is absorbed as the lime is capable of combining with under these circumstances. The chlorine in the bleaching powder, which is not applied till after sundry preparatory washings of the cloth, acts upon vegetable substances by dissolving their hydrogen, which is the colouring agent; the air would have the same effect, but would require a much longer time than can be allowed. The cloth is left in a cold solution of the bleaching-powder for about six hours, and is then taken out and washed with water. The next part of the process is called *souring*, which is immersing the cloth in a solution of sulphuric acid, so diluted that it does not injure the texture of the goods, whilst it improves their colour. The sulphuric acid dissolves and removes the oxide of iron with which the cloth is always contaminated; it also removes the lime which may have attached itself to the cloth during its previous treatment with that substance. It is again washed, boiled in an alkaline ley, and once more carefully washed in cold water. Another solution of bleaching-powder, two-thirds the strength of the former, is then prepared, in which the cloth is immersed, and left for five or six hours; it finally undergoes another process of souring, by which means it is rendered perfectly white. The acid is carefully removed by washing; and after each piece of cloth has been stretched to its full length, it undergoes a process of mangling, by being passed successively between cylinders forced towards each other by levers, to which a considerable weight is attached. The cloth being thus stretched, smoothed, and wound upon a roller, is rendered fit for *starching*. The starch is that of flour, deprived of its gluten by remaining for twenty-four hours in water, and then passed through a sieve, which retains the bran, and allows the starch to pass. A little indigo is mixed with it, and sometimes porcelain clay. The starch is applied in the state of a pretty thick paste whilst the cloth is passing between a pair of rollers. The goods are then dried and passed through a calender for the purpose of giving them a gloss and texture.

Such is the process of bleaching as practised in the large bleaching establishments on the common class of goods. The number of processes which the cloth undergoes amounts to about twenty-five, but some of the earlier ones are occasionally omitted. The expense of bleaching and finishing a yard of cotton cloth is about one halfpenny, and the time required is trifling. A bleacher in Lancashire, we are told, received fourteen hundred pieces of gray muslin on a Tuesday, which on the Thursday following were returned bleached to the manufacturers, at the distance of sixteen miles; and on the same day they were packed up and sent to a foreign market.

CONDIMENTS.

Sugar—Salt.—Two of the most important condiments in domestic use are, as is well known, sugar and salt; both of which substances are the crystallization of liquids loaded with their respective properties; each is produced by an evaporation of the watery particles, leaving the solid crystals behind. Thus, sugar is a crystallization of the juice of the sugar-cane, beet-root, or other vegetables containing saccharine matter; the residuum or uncrystallizable material being that viscid and sweet fluid called *treacle*.

Salt, called by the chemists the muriate of soda, or chloride of sodium, is found to exist in a natural state in various quarters of the globe, among others, in the county of Cheshire in England, where it is dug from a mine, and purified by being mixed with water and subjected to evaporation. The principal source of salt, however, is the water of the ocean, which is boiled for a certain length of time, to drive off the watery particles. Sea-water differs in strength; that which contains the largest quantity of salt being in the middle of the ocean, far from the mouths of rivers. From 38 to 43 per cent. is the quantity commonly found in the seas round our coasts.

The method of making salt is simple; but from the length of time required in boiling, it is not economically performed unless near mines from which coal can be cheaply procured. The plan pursued is to erect a rever voir near the sea, into which at high water supplies are taken by means of a pipe extending a good way down the beach. The pipe is generally placed near the low-water mark, in order to get the water from a point as far from the surface as possible, so that it may be the more impregnated with salt, and require less boiling. The pans are built on a range on both sides of the reservoir, from which the water is pumped into them after the impurities have settled. The pans are shallow vessels, made of sheet iron, about twenty feet long and twelve broad, with a furnace below. These are contained in a small low-roofed house, the covering of which is of deals, with an opening at the meeting of the roof and the wall, to allow the vapour to escape. When the water is boiling, a little bullock's blood is put into the pan, which brings the impurities to the surface and allows of their being skimmed off. As the water boils down, more is pumped in; and this process is repeated before the salt is first drawn. From a pan of 1300 gallons fifteen or twenty bushels, of fifty-six pounds each, are obtained in this manner, the process requiring about twenty-four hours. The salt is at first very light and floury in proportion to its bulk, and in this state is most appreciated. A still finer article, resolving into large crystals, is made with a low fire, and when a longer time is allowed in the evaporation. For use at table, the salt is refined, and usually run into large lumps.

The water which remains after the salt is crystallized, called the *mother-water*, contains a considerable quantity of the chloride of magnesium or bittern, chloride of sodium, and sulphate of magnesia. If the mother-water is exposed in tanks during winter, it will afford three successive crystalline deposits, the last of which is sulphate of soda nearly in a pure state. The chloride of magnesium deteriorates the salt very much, but may be removed by the following simple expedient, mentioned by Dr. Ure:—"Let quicklime be introduced in equivalent quantity to the magnesia present, and it will precipitate this earth, and form chloride of calcium, which will immediately react upon the sulphate of soda in the mother-water, producing sulphate of lime and chloride of sodium. The former being nearly insoluble, is easily separated. Lime, moreover, decomposes directly the chloride of magnesium, but with the effect of merely substituting chloride of calcium in its stead. But in general there is abundance of sulphate of soda in brine springs to decompose the chloride of calcium. A still better mode of proceeding with sea-water would be to add to it in the settling tank the quantity of lime equivalent to the magnesia, whereby an available deposit of this earth would be obtained, at the same time that the brine would be sweetened. Water thus purified may be safely crystallized by rapid evaporation."

The finest table salt is made in the western parts of England, from the produce of the salt mines; and, along with salt of a common quality, is exported in immense quantities. In 1836, 240,560 tons of salt were exported from the United Kingdom, the greater part of which went to the United States, Russia, Belgium, the British North American Colonies, the West Indies, &c. M. Desormes calculates that the internal consumption of salt in France is rather more than 200,000 tons annually, which is about fourteen pounds for each individual. In this country it is thought to be about 240,000 tons annually, which is upwards of twenty pounds for each individual.

[BOOKS ON THE APPLICATION OF CHEMISTRY TO THE ARTS.

AMONG the works partially or wholly devoted to this subject the following will be found worthy of the student's attention. "*Applied Chemistry in Arts, Manufactures, and Domestic Economy.* By E. A. Parnell." "*Rural Economy in its Relation with Chemistry, Physics, and Meteorology.* By Bouissangault. Translated by G. Law." "*Dr. Fresenius's Elements of Chemical Analysis.* Edited by Bullock." "*Falkner on Manures and Agricultural Chemistry.*" "*Chaptal's Agricultural Chemistry.*" "*Liebig's Agricultural Chemistry.*" "*Draper on the Chemical Organization of Plants.*" "*Encyclopædia of Chemistry.* By Professor Booth." "*Farmer's Encyclopædia.*"

Of all the practical applications of chemistry which have been prosecuted of late years, the most important is undoubtedly that which brings the science to bear upon practical agriculture. The relation of soils and manures to cereal productions, and the alternation of crops, has recently been investigated with persevering zeal by the most enlightened chemists of Europe and America, and discoveries of very great practical importance have been made. The work of the German chemist Liebig on this subject is one of very special interest. It has been translated and published in the cheap pamphlet form in this country. It still remains for some American, who understands both chemistry and agriculture, to apply Liebig's science to the soil and productions of our own country and to reduce his principles to the form of axioms, and publish them in a cheap manual for the daily use of the American farmer.—*Am. Ed.*]

ELECTRICITY—GALVANISM—ELECTRO-MAGNETISM

ELECTRICITY.

It was observed in ancient times, that when amber was rubbed, it acquired a power of attracting and repelling such light bodies as hair and feathers; and this power afterwards came to be called Electricity, from *electron*, the Greek word for amber. Although the ancients were thus acquainted with some of the more obvious phenomena of electricity, they did not investigate the subject methodically, or attempt any generalization of facts into a scientific theory. It was only in modern times, when close reasoning from truths established by the evidence of the senses began to be practised by philosophers, that the phenomena connected with electricity assumed the dignity of a science. Dr. Gilbert, an English physician, made the first step towards generalization, in the year 1600. He published a valuable treatise, in which he observed, that not only amber, but various other substances, can by friction be made to draw light bodies to them. Boyle, Guericke, Newton, and some other philosophers of that period, contributed to extend human knowledge upon this interesting subject; but the real science of electricity took its rise in a latter age. About the middle of the eighteenth century, several very remarkable facts were ascertained, particularly by Benjamin Franklin, which identified lightning with electricity; but the extensive relations which connect it with so many other departments of physical science were not discovered until the present century, nor was their importance until then appreciated. In this short era a new science has arisen, founded on that modification of electricity which is known by the name of Galvanism. The galvanic battery (which will be afterwards described), as an instrument for analyzing or decomposing chemical substances, has connected it with chemistry in the most intimate manner. Hence has sprung Electro-Chemistry, one of the connecting branches between remote divisions of the philosophy of nature. Electro-Magnetism is a still more recently discovered province of science, and which identifies as one, two powers which were previously regarded as distinct.

As the best method of conveying a clear, and, at the same time, philosophical view of this interesting science, we shall, in the first place, independently of all theory, state the most general and remarkable facts connected with it. After these have been enumerated, the reader will then be prepared for a review of the theories which have been advanced for the purpose of explaining phenomena, and for connecting the various facts in the mind. The general facts relating to this subject we think may be classed under two heads—1st, The *Excitation* of Electricity; and 2d, The *Distribution* of Electricity. Connected with each of these heads are various phenomena, which we shall notice as they occur, during the gradual development of the subject.

EXCITATION OF ELECTRICITY, AND RESULTING PHENOMENA.

If a piece of sealing-wax, amber, the glass of a watch, or any other smooth piece of glass, be rubbed upon a piece of dry flannel or woollen cloth, or even the sleeve of a cloth coat, it will be found to have acquired a new and very singular physical property. This property is exhibited by holding the body which has been subjected to friction, over small and light substances, such as shreds of paper, gold leaf, feathers, straw, cork, &c. These will be first instantly *attracted* to it, some of them adhering to its surface, others falling back to the place whence they were withdrawn whilst others are thrown off from the body as if they were *repelled* from it. Here, then, is a distinct phenomenon—a process of attraction and repulsion at the same instant of time, which requires careful examination. It is observed, as above stated, that only certain substances will become endowed with these remarkable properties, and for convenience such are called *electrics*, those which cannot be excited in the same manner are said to be *non-electrics;* for example, stone is a non-electric.

The phenomena of attraction and repulsion may be exemplified in a striking manner by a small apparatus, of which we present a representation, fig. 1. A is a stand bent at its upper extremity, and having a hook to which a fine silk thread is attached, with a very small pith ball at its end, B. Rub an electric—for instance, a dry rod of glass—and, on presenting it to the ball, B, the ball will be immediately attracted to the glass, and will remain in contact with it. After they remain in contact for a few seconds, if the glass be withdrawn without being touched by the fingers, and again presented to the ball, the latter will be *repelled* instead of being attracted, as in the first instance. By being touched with the finger, the ball can be deprived of its electricity; and if, after this has been done, we present a piece of sealing-wax in place of the glass formerly employed, the very same phenomena will take place. On the first application, the ball will be attracted; and, on the second, repelled. It is clear, then, in the first place, that both these electrics have the power of attracting another body before they have communicated to it any of their own electricity; and, secondly, that they repel the body after they have communicated to it a portion of their own electricity.

Fig. 1.

But a very remarkable circumstance takes place, if we, after having conveyed electricity to the ball, B, by means of excited glass, which was for a moment or two in contact with it, should present to it, after the former was withdrawn, excited sealing-wax: the ball, instead of being repelled, as it would have been were the glass again applied, is attracted by the wax. If the experiment be reversed, and the excited wax first presented to the ball, and then the excited glass, the latter will be found to *repel* the ball. "Hence it follows," says Sir David Brewster,* "that excited glass *repels* a ball electrified by excited glass. Excited wax *repels* a ball electrified by excited wax. Excited glass *attracts* a ball electrified by excited wax. Excited wax *attracts* a ball electrified by excited glass. From which we conclude, that there are two opposite electricities; namely, that produced by excited glass, to which the name of *vitreous* or *positive* electricity has been given; and that produced by excited wax, to which the name of *resinous* or *negative* electricity has been given.

"If, when the pith ball, B, is electrified either with excited glass or wax, we touch it with a rod of glass, its property of being subsequently attracted or repelled by the excited glass or wax will suffer no change; but if we touch it with a rod of metal, it will lose the electricity which it had received, and will be attracted either

* Article Electricity in the *Encyclopædia Britannica*, the most comprehensive, philosophical, complete, and intelligible treatise upon this interesting science which we have ever yet met with

by the excited glass or wax, as it was when they were first applied to it. Hence, the rod of glass and the rod of metal possess different properties, the former being incapable, and the latter capable, of carrying off the electricity of the pith ball. The metal is therefore said to be a *conductor*, and the glass a *non-conductor*, of electricity."

In these experiments, electricity has been produced by *friction;* but there are other methods of obtaining it, which, however, will be afterwards explained.

With regard to attraction and repulsion, a few facts remain to be stated. Some substances remain longer in contact with the electric than others, and two bodies which have both been in conduct with the same electric, mutually repel each other. If electrics of considerable size are employed, the phenomena of course are best observed; and if the experiment be performed in a darkened chamber, flashes of bluish light will be seen to extend over the surface of the electric submitted to friction, and which we shall suppose is a cylinder of sealing-wax, sulphur, or glass. Sparks, accompanied also with a sharp snapping sound, will be seen to dart round it in various directions. If a round body, as a metallic ball, be presented to it, and moved from one end to the other, a succession of sparks will be obtained as the ball passes along the surface; and if the knuckle be presented instead of the metallic ball, each spark will be accompanied by a pricking sensation. If the cylinder be brought near to the face, an unpleasant sensation of tickling is felt in the skin, as if it were covered with a cobweb. If a metallic globe be suspended in the air by silk threads, and in that situation rubbed by an electric, it will also become electrical, and exhibit the same properties as an electric. It is essential to the success of this experiment that it be *insulated;* that is, cut off by means of an electric from all communication with any substance, except the air and the electric which sustains it. The instruments employed in experiments similar to those above described are termed *electroscopes.* Besides that one, of which a representation has been given, there are various others, all of which are formed upon the same principles.

It is now proper to mention the principal electrical substances in nature. They are, amber, gum-lack, resin, sulphur, glass, talc, the precious stones, silk, the fur of most quadrupeds, and almost all vegetable substances (excepting charcoal) which have been thoroughly deprived of moisture, as, for instance, baked wood, and very dry paper.

DISTRIBUTION AND TRANSFERENCE.

We have noticed that when the excited electric was brought near the pith ball, B, the latter was first attracted and then repelled. If we now remove the electric and present to the ball which has thus touched it, a second ball which has had no previous communication with an electric, we find that these two balls attract one another, and come into contact. The same actions are repeated between this second ball and a third which may be presented to it; and so on in succession, but with a continued diminution of intensity. This diminution plainly indicates a diminished power, in consequence, as it would seem, of its being distributed among a number of bodies. It is clear, therefore, that the unknown power which we have called electricity, can, like heat, be transferred or communicated from one body to another, and that its intensity, like that of heat, is weakened by being diffused among a number of bodies. An electrified ball can be deprived of its electricity by being touched with a rod of metal of any kind; but if we touch it with glass or wax, it will not be carried off. Hence, metals are said to be *conductors*, and glass and wax *non-conductors*, of electricity. Bodies greatly vary in their power of conduction, and many of them owe it to the water which they contain. The conducting power of any substance depends on the state of the atmosphere at the time with regard to humidity, and on the intensity of the electricity employed. The following lists of conductors and non-conductors are by Sir David Brewster, and have been collected by him from various authors, with great care. The bodies are placed in the order of their conducting or non-conducting power; "but it is probable," says Sir David, "that this order would be greatly changed, if the bodies were all submitted to a new and uniform examination."

List of Conductors.—Silver copper, lead, gold, brass, zinc, tin, platina, palladium, iron heated, iron cold, charcoal well burned, plumbago, concentrated acids, powdered charcoal, diluted acids, saline solutions, metallic ores, animal fluids, hot water, sea-water, spring-water, river-water, ice above 13 degrees Fahr., snow, living vegetables, living animals, flame, smoke, steam, soluble salts, rarefied air, vapour of alcohol, vapour of ether, moist earths, anthracite, powdered glass, flowers of sulphur, resins rendered fluid by heat, glass heated to redness.

List of Non-conductors.—Shell-lack, amber, resins, sulphur, wax, jet, glass, vitrifications, mica, diamond, transparent gems, various minerals, raw silk, bleached silk, dyed silk, wool, hair, feathers, dry paper, parchment, leather, air and all dry gases, baked wood, dry vegetable bodies, porcelain, dry marble, and siliceous and argillaceous stones, camphor, caoutchouc, lycopodium, dry chalk, lime, phosphorus, ice below 13 degrees Fahr., ashes of animal bodies, ashes of vegetable bodies, oils (the heaviest being the best conductors), dry metallic oxides.

The two qualities of a capability of excitation, and a power of conducting electricity, appear to be incompatible with each other, for the one always diminishes in proportion as the other increases. Hence it follows, as an invariable law, that *electrics* are *non-conductors*, and, on the other hand, that conductors are *non-electrics.* The most perfect *non-conductors* of electricity are also called *insulators*, from their power of insulating an electrified body, or preventing any of its electricity from escaping along its support. The insulating power of atmospheric air depends upon two circumstances—its density and its dryness. Air of the ordinary density of the atmosphere, if perfectly dry, is a remarkably good insulator, and no change of temperature appears to affect its insulating power; but rarefaction diminishes its power of confining electricity, and, when greatly rarefied, it may be classed among conductors. The conducting power of air of the ordinary density depends upon the quantity of moisture which it contains, water being a very good conductor of electricity. Changes of temperature and also of form affect the conducting powers of most bodies. Thus, though water, in its ordinary liquid state, is an excellent conductor, yet, when it appears in the solid form of ice, its conducting power is much impaired, and at a very low temperature it ceases entirely. Glass, when cold is a non-conductor, but when heated to redness it conducts tolerably well. Hence, although some bodies are said to be perfect non-conductors, yet this is not strictly true. In Dr. Faraday's interesting researches on this subject, he gives the following summary of conditions of conduction in bodies, which, although they apply chiefly to voltaic electricity, are yet true within certain limits of ordinary electricity:—

1. All bodies conduct electricity in the same manner, from metals to lac and gases, but in different degrees.

2. Conducting power is in some bodies powerfully increased by heat, and in others diminished, yet without our perceiving any accompanying essential electrical difference, either in the bodies or in the changes occasioned by the electricity conducted.

3. A number of bodies insulating electricity of low intensity when solid, conduct it very freely when fluid, and are then decomposed by it.

4. There are many fluid bodies which do not sensibly conduct electricity of this low intensity; there are some which conduct it and are not decomposed, nor is fluidity essential to decomposition.

5. There is but one body yet discovered (periodide of mercury), which, insulating a voltaic current when solid and conducting it when fluid, is not decomposed in the latter case.

6. There is no strict electrical distinction of conductors which can as yet be drawn between bodies supposed to be elementary, and those known to be compounds.

There are various other circumstances upon which the conducting power of bodies depends. That of silk, for instance, is affected by the colour of the thread, or rather by the nature of the dye-stuff by which it has been tinged. When of a brilliant white, or a black, its conducting power is the greatest; and a high golden yellow or a nut-brown renders it the best insulator. Mr. Coulomb, who has investigated the subject with great ability, assigns three causes as chiefly operating in depriving a body in a state of imperfect insulation of its electricity—first, the imperfection of the insulating property in the solids by which it is supported; secondly, the contact of successive portions of atmospheric air, every particle of which deprives the body of a portion of its electricity; thirdly, the deposition of moisture upon the surface of the insulating body, which establishes communications with its remote ends, thus virtually increasing its conducting power. There is another very remarkable circumstance relating to the dissipation of electricity, namely, the shape of the body which holds the electricity. Its retaining power is materially affected by the form which it possesses. The spherical shape is that most favourable to its retention; whilst, from bodies of a pointed figure, especially if the point projects to a distance from the surface, electricity escapes most readily. On the other hand, these bodies receive electricity more readily than those of any other form.

OF THE TWO KINDS OF ELECTRICITY.

It will be understood, from the preceding explanations, that there are two kinds of electricity—namely, a *vitreous* or *positive* electricity, and a *resinous* or *negative* electricity. Although we have thus two electricities, there does not appear to be the smallest difference between them when they are taken individually. The distinction is only observable when brought in contact; they then display a marked a contrariety, or mutually opposive force, that they may be viewed as agents having opposite qualities, which completely neutralize one another by combination, just like an acid and an alkali. It is remarkable that the excitation of one species of electricity is always accompanied by the presence of the other, and both are produced to an equal extent. Thus, when a piece of glass is rubbed by silk, just as much resinous electricity is produced in the silk as there is vitreous electricity produced in the glass; and whatever electrified bodies are repelled by the one, are attracted by the other. Of course, these two surfaces, having acquired opposite electricities, invariably attract each other. A white and a black ribbon rubbed against each other between the finger and thumb, exhibit electrical phenomena in a very marked manner. The black is resinously and the white vitreously electrified; of course, they attract each other; and, if separated, the one attracts the light bodies which the other repels. When two pieces of the same ribbon of the same length are rubbed, the one being drawn lengthways and at right angles over a part of the other, the one which has been subjected to friction in its whole length, acquires vitreous and the other resinous electricity. In like manner, when the whole length of the bow of a violin is drawn over a limited part of the string, the hairs of the former exhibit a vitreous, and the latter a resinous electricity. It is to be observed, that the body whose excited portion is of the least extent, is generally found to be resinously electrified.

To know the species of electricity evolved, it is merely necessary to communicate beforehand, to the slips of gold leaf, a known electricity, either from excited glass or sealing-wax. If they be divergent with the former, then the approach of a body similarly electrified will augment the divergence, but that of one oppositely electrified will cause their collapse.

No visible relation can be pointed out between the nature or constitution of substances, and the species of electricity developed by their mutual friction. The only general law among the phenomena is, that the rubbing and the rubbed body always require opposite electricities. Sulphur is vitreously electrified when rubbed with every metal except lead, and resinously with lead and every other kind of rubber. Resinous bodies rubbed against each other acquire alternately the vitreous and resinous electricity; but rubbed against all other bodies, they become resinously electrical. White silk acquires vitreous electricity with black silk, metals, and black cloth; and resinous with paper, the human hand, hair, and weasel's skin. Black silk becomes vitreously electrical with sealing-wax, but resinously with hares', weasels', and ferrets' skins; with brass, silver, iron, the human hand, and white silk. Woollen cloth is strongly vitreous with zinc and bismuth; moderately so with silver, copper, lead, and specular iron. It is resinous with platina, gold, tin, antimony, gray copper, sulphuret of copper, bisulphuret of copper, sulphurets of silver, antimony and iron. Dry air impelled on glass becomes resinously electrical, and leaves the glass in the opposite state. Silk stuffs agitated in the atmosphere with a rapid motion, always take the resinous electricity, while the air becomes vitreously electrified.

Numerous experiments have been made with the view of ascertaining the conditions that determine the species of electricity exerted in the respective bodies of which the surfaces are made to rub against each other, but they have led to no satisfactory conclusions. The mechanical configuration of the surface appears to have a greater influence in the result than the peculiar nature of the substance itself. If a plate of glass with a polished surface be rubbed against one which is roughened, the former always acquires the vitreous and the latter the resinous electricity. Various substances, if rubbed when polished, exhibit a different kind of electricity than that with which they are excited, if rubbed when roughened or scratched. No purely scientific explanation has ever yet been given of these remarkable phenomena.

If a body is charged with electricity, and insulated so perfectly as to prevent the escape of the electricity which it contains, it nevertheless tends to produce an electrical state of the opposite kind in all the bodies around it. Thus the vitreous induces the resinous, and the resinous the vitreous electricity in a body that is situated in the vicinity of either of them, and this to a degree proportioned to the smallness of the distance which separates the bodies. The electricity is in this case said to be induced, and the phenomenon is called *electrical induction*. The operation of this law is a key to the principal phenomena of electricity. In illustration of it, we shall quote an able writer upon the subject:

"If an electrified body, charged with either species of electricity, be presented to an unelectrified or neutral body, its tendency, in consequence of the law of induction, is to disturb the electrical condition of the different parts of the neutral body. The electrified body induces a state of electricity contrary to its own in that part of the neutral body which is nearest to it; and, consequently, a state of electricity similar to its own in the remote part. Hence, the neutrality of the second body is destroyed by the action of the first; and the adjacent parts of the two bodies, having now opposite electricities, will attract each other. It thus appears that the attraction which is observed to take place between electrified bodies, and those that are unelectrified, is merely a consequence of the altered state of those bodies, resulting directly from the law of induction; and that it is by no means itself an original law or primary fact in the science.

The effect of induction will be in proportion to the facility with which changes in the distribution of electricity among the different parts of a body can be effected, a facility which corresponds with the conducting power of the body. Hence, the attraction exerted by an electrified body upon another body previously neutral, will be much more energetic if the latter be a conductor than if it be an electric,* which these changes can take place only to a very small extent. This is confirmed by the following experiment:—"Suspend, by fine silk threads of equal length, two small balls of equal dimensions, both made of gum-lac, but one having its surface covered with gold leaf. Place these two pendulums, as they may be called, at a little distance from one another, so as to admit of a comparison of their motions; and then present to them an excited electric, which may be either a tube of glass or a cylinder of sealing-wax. It will at once be seen that the ball with the metallic covering, which readily admits of the transfer of electricity from one side to the other, will be much more readily and powerfully attracted than the other ball, which allows of no motion in its electricity. The latter ball will, by slow degrees however, assume electrical states of the same kind as the gilt ball, and will be fully attracted. As this change is very slowly effected, so it is more permanent when once produced; and the plain ball adheres for a considerable time to the electric which has attracted it. The gilt ball, on the contrary, is sooner repelled, by its readily receiving the charge of electricity imparted to it by the electric. A degree of permanent electricity, however, is also induced on this ball, in consequence of its gradual penetration into the substance of the gum-lac."

Electrical phenomena are generally accounted for by supposing that there is an extremely subtile and highly elastic fluid, which pervades all material substances, but is itself devoid of any sensible gravity. It is supposed to move with various degrees of facility through the pores or actual substance of various kinds of matter. Hence, in proportion as they admit of the fluid passing through them with ease or difficulty, bodies have been divided into conductors and non-conductors. According to the doctrine of there being but one species of fluid, it is supposed that the electrical equilibrium which constitutes the natural state of matter is disturbed by friction, and that one of the two bodies brought near to each other, attracts to itself a surcharge of the fluid, and is *over-saturated*, whilst the other is left in a deficient state, and is *under-saturated*. For this view of the subject we are indebted to Franklin; and hence, the terms of positive or plus, and negative or minus, have arisen. But as some of the appearances cannot easily be reconciled to the hypothesis of a mere excess or deficiency of one fluid, there is another theory which supposes the fluid to be a *compound*, susceptible of decomposition by friction and other means; and hence the origin of the terms vitreous and resinous electricities. With respect to the intensity of the electric force, it resembles that of gravitation, by being inversely as the square of the distance. Like gravitation, also, it acts at all distances, and it is not impeded by any intervening body, provided it be not in an active electrical state. But whilst the particles of each fluid repel those of the same kind, they exert, as we have seen, a high attractive power over those of an opposite kind. The intensity of this attraction, also, like that of gravitation, increases with a diminution of distance. It is evident, therefore, that from the powerful attraction which they have for each other, they would always flow towards each other and coalesce, were it not that the non-conducting properties of electrics offer an impediment to their motion. When these obstacles are removed, they immediately rush into union, and give rise to the remarkable phenomena already noticed.

ELECTRICAL MACHINES.

Rubbing or friction, it will be perceived, is always requisite to produce an artificial display of electrical phenomena. Thus, in rubbing the back of a cat, in rapidly drawing off a silk from a woollen stocking, or in performing any similar action with suitable, and in all cases dry, substances, we evolve electric sparks, of lesser or greater intensity. For the purpose of producing powerful electrical results, the aid of mechanism has been found essential. There are various kinds of electrical machines, but all constructed on similar principles. We here offer a representation of that which is most commonly used, in our description of which, the essential parts constituting such instruments will appear.

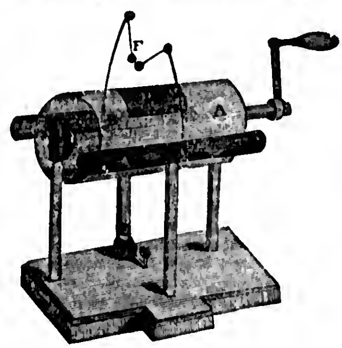


Fig. 2.

A B, fig. 2, is a hollow cylinder of polished glass which revolves upon a horizontal axis, and is from eight to sixteen inches in diameter, and from one to two feet long. For the purpose of insulation, it is supported on two upright pillars of glass, which are fixed in a wooden stand. Two hollow metallic conductors, equal in length to the cylinder, and about one-fourth of its diameter, are placed parallel to it, one on each side, upon two insulating pillars of glass, which are cemented into two separate pieces of wood, that slide across the base, so as to allow of being brought within different distances of the cylinder. To one of these conductors the cushion is attached, which is of the same length with the conductor C. The cushion is usually made of soft shammy leather, stuffed with hair or wool, so as to be as hard as the bottom of a chair, but yet sufficiently yielding to accommodate itself, without much pressure, to the surface of the glass to which it is applied. The prime conductor is a cylindrical tube, each end terminating in a hemisphere. As the electricity is only contained at the surfaces, it is made hollow, generally of thin sheet brass, copper, tin, or pasteboard covered with gold leaf or tinfoil. It must be carefully freed from all points and asperities; and if perforations are made in it for the purpose of attaching wires and other kinds of fixtures for the purposes of experiment, they should be made about the size of a quill, and should have their edges well rounded and smoothed off. The pressure of the cushion against the cylinder is regulated by an adjusting screw, adapted to the wooden base at E, on which the glass pillar that supports the conductor is fixed. From the upper edge of the cushion there proceeds a flap of thin oiled silk D, which is sewed on the cushion about a quarter of an inch from its upper edge. It extends over the upper surface of the glass cylinder to within an inch of a row of metallic points, proceeding, like the teeth of a rake, from a horizontal rod, which is fixed to the adjacent side of the opposite conductor. The motion of the cylinder, which is given by a single handle, or by a multiplying wheel, must always be given in the direction of the silk flap. That part of the cushion which comes in contact with the glass cylinder should be coated with an amalgam composed of a little tin-foil and mercury, mixed like a paste by means of hogs' lard. The amalgam should be placed uniformly over the cushion, until level with the line formed by the seam which joins the silk flap to the face of the cushion. No amalgam should be placed over this line, nor on the silk flap; and it is even requisite to wipe the silk flap clean whenever the continued motion of the machine shall have soiled it, by depositing dust or amalgam on its surface.

This machine acts in the following manner:—When the cylinder is driven round by the handle, the friction of the cushion upon it produces a transfer of the electric fluid from the latter to the former; that is, the cushion becomes negatively, and the glass positively, electrified. By the revolution of the cylinder, the fluid adhering to the glass is carried round, and its escape is at first prevented by the silk flap which covers the cylinder, until it arrives near to the metallic points, which absorb most of the electricity, and convey it to the prime conductor. This being positively electrified, the conductor connected with the cushion being deprived of this electricity, is negatively electrified; so that light balls, suspended by threads at F, being oppositely electrified, will attract each other. After the action has gone on for some time, the cushion and its conductor become exhausted of their electricity; so that a new supply must be brought from the earth, the great reservoir of the fluid. This is easily done, by establishing a communication between the cushion and the ground by means of a metallic chain or wire. In this manner, a constant stream of positive electricity flows to the prime conductor. Negative electricity is obtained by insulating the conductor to which the cushion is attached, and connecting the prime conductor with the ground, so as to carry off the fluid collected from the cylinder. If the person who works the machine be supported upon a stool having glass legs, and connected with the conductor by means of a metallic rod, or if he touch it with his hand, he is found to be in the same state of electricity; and another person standing upon the ground can draw sparks from him by presenting his knuckles to his body.*

By using the electrical machine in the above manner, we are enabled to collect a considerable quantity of electricity, and thus perform experiments upon an ample scale. A pith ball, or a fragment of gold leaf, is very strongly and immediately attracted by the electrified conductor, and, the instant after it has come into contact with it, it is repelled; but it is now attracted by the other bodies in its neighbourhood, to which it communicates its own electricity, and then is again in a state to be influenced by the conductor, and to be again attracted; and this alternation of effects will continue as long as the conductor remains charged. This alternation of attractions and repulsions accompanying the transferring electricity by movable conductors, is also illustrated by the motions of a ball suspended by a silk thread, and placed between two bells, of which the one is electrified, and the other communicates with the ground. The alternate motion of the ball between the two bells will keep up a continual ringing. This amusing experiment has been applied to give notice of changes taking place in the electrical state of the atmosphere.

The mutual repulsion of bodies that are similarly electrified gives rise to many interesting experiments. A small figure in the shape of a human head, covered with hair, when placed upon the conductor, and electrified, will exhibit the appearance of terror, from the bristling up and divergence of the hair.

The intensity of the electricity which bodies may contain, is measured by a delicate instrument, called an *Electrometer*, of which there are several invented by various distinguished individuals. Our limits, however, will not admit of our giving a minute account of them. They all depend upon the repulsive property of electrified bodies, and the distance to which the one is repelled by the other is indicated by an index of one kind or another.

We have already observed, that upon the extent of the surface of a body, its capacity for receiving electricity principally depends. Electricity is therefore supposed not to spread throughout the whole mass of a body, at least equally, but to remain principally, if not altogether, at the surface. This has been proved by experiments for trying the distance to which the electricity extended beyond the coating of the Leyden jar.

Several remarkable phenomena occur when electricity is drawn off by means of a conductor from those bodies in which the electrical equilibrium has been destroyed. A sharp snapping sound is heard, accompanied by a vivid spark, whilst intense heat is evolved in the path which the electric fluid takes. A perfect conductor offering no impediment to its course, it is unattended with light during its passage through such a body, light only appearing when there are obstacles in its path, such as imperfect conductors. Of the velocity with which it is transmitted, we have already spoken. It is so great, that in experiments performed with a chain of considerable length, each link becomes apparently instantaneously luminous. There are various methods of showing the intensity and colour of electrical light. Conductors having a rounded form give the longest and most vivid sparks, which are sometimes seen to take a zig-zag course, similar to that of a flash of lightning. This deviation in its course is supposed to be occasioned by this fluid darting to minute conducting particles, such as those of moisture floating in the air. Electrical light is similar to light obtained from other sources, and its brilliancy depends upon its intensity. Sir David Brewster found that it was capable of polarization. It displays every shade of colour, that quality being dependent upon the nature of the substance through which the fluid passes.

An interesting question arises—Whence comes the light—is it the electric fluid which thus renders itself visible? This was really supposed to be the case by the early electricians, but later philosophers have substituted other theories to account for the phenomena. That of M. Biot, a celebrated French philosopher, is, that electric light has the same origin as the light disengaged from air by mechanical pressure; "and that it is purely the effect of the compression produced on the air by the explosion of electricity." This hypothesis has been objected to, however, on the ground that electrical light is produced in the best vacuum that can be formed; and although he has replied to the objection, that no perfect vacuum can exist, yet his arguments, though they carry weight, do not bring conviction to the mind.

We have already observed, that various sounds accompany the various modes of transference of the electric fluid; a peculiar odour has also sometimes been felt

* In certain conditions of the atmosphere, electrical sparks are evolved in abundance from paper as it issues from the cylinders in the paper-making machine, the friction of the dry material on parts of the apparatus being the apparent cause of the phenomena. If a battery of Leyden jars were employed to collect these sparks, electrical experiments might be readily performed with them.

near a machine which has been sharply wrought; but whence its origin, is unknown. All sharp-pointed bodies, we have said, concentrate most of the electric fluid at their apex, from whence it has a powerful disposition to escape; and every discharge is accompanied by currents of air. Upon this principle many ingenious experiments are founded. An apparatus, consisting of wires terminating in points, and having balls annexed to them to represent the planets, may be constructed so as to revolve when electrified, and thus to imitate the planetary motions. We cannot enter further into this subject, but may state in general terms, that the appearances of the electric spark depend upon the nature of the surface from whence it issues, and towards which it is directed. When it escapes *from* a pointed body, the luminous appearance is that of diverging streams, resembling the filaments of a brush, and forming what is termed a *pencil of light*; but when the fluid goes *to* a point, the light concentrates at the point itself, and assumes the appearance of a star.

The most convenient mode of obtaining an accumulation of electricity arising from induction, is by the employment of coated glass; that is, of a plate of glass on each side of which is pasted a sheet or coating of tin-foil. Care must be taken to leave a sufficient margin of glass uncovered with the metal, for preventing the transfer of electricity from one coating to the other, round the edge of the glass; and all sharp angles or ragged edges in the coatings should be avoided, as they have a great tendency to dissipate the charge.

The form of coated glass best adapted to experiments is that of a cylindric jar; this is coated, within and without, nearly to the top. The cover consists of baked wood, and is inserted with sealing-wax, to exclude moisture and dust. A metallic rod, rising two or three inches above the jar, and terminating at the top in a brass knob, is made to descend through the cover till it touches the interior coating. The name of the *Leyden phial*, or *jar*, is applied to this instrument. It is used in the following manner:—The outer coating being made to communicate with the ground, by holding it in the hand, the knob of the jar is presented to the prime conductor when the machine is in motion: a succession of sparks will pass between them, while, at the same time, nearly an equal quantity of electricity will be passing out from the exterior coating, through the body of the person who holds it, to the ground. The jar, on being removed, is said to be charged; and if a communication is made between the two coatings, by a metallic wire extending from the external one to the knob, the electric fluid which was accumulated in the positive coating, rushes, with a sudden and violent impetus, along the conductor, and passes into the negative coating; thus at once restoring an

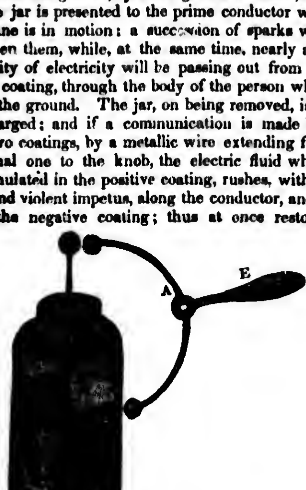


Fig. 3.

almost complete equilibrium. This sudden transfer of a large quantity of accumulated electricity is a real explosion; and it gives rise to a vivid flash of light, corresponding in intensity to the magnitude of the charge. The effect of its transmission is much greater than that of the simple charge of the prime conductor of the machine; and it imparts a sensation, when passing through any part of the body, of a peculiar kind, which is called the *electric shock*. The arrangement of the parts in a Leyden jar is shown in the foregoing figure, in which the simple bent *discharging* rod, for establishing a direct communication between the inner and outer coating of a jar or battery, and restoring the electrical equilibrium, without the operator receiving the charge of the jar, is exhibited. E represents the insulating handle, and A the bent rod of brass reaching from the ball to the external coating. When opened to a proper degree, one of the balls is made to touch the exterior coating, and the other ball is then quickly brought into contact with the knob of the jar, and thus a discharge is effected.

By uniting together a sufficient number of jars, we are able to accumulate an enormous quantity of electricity. For this purpose, all the interior coatings of the

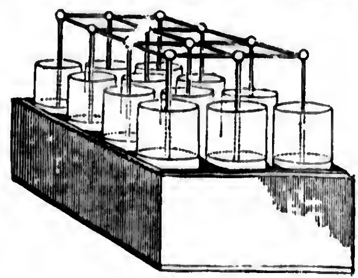


Fig. 4.

jars must be made to communicate by metallic rods, and a similar union must be established among the exterior coatings. When thus arranged, the whole series may be charged, as if they formed but one jar; and the whole of the accumulated electricity may be transferred from one system of coatings to the other, by a general and simultaneous discharge. Such a combination of jars is called an *electrical battery*. An arrangement of this description is here represented, in which twelve jars are united in one box, and the whole series connected together by wires and balls.

If we wish to send the whole charge of electricity through any particular substance which may be the subject of experiment, we must so arrange the connecting conductors as that the substance shall form a necessary part of the *circuit of the electricity*, as it is termed. With this view, we must place it between two good conductors, one of which is in communication with the outer coating; and the circuit may then be completed by connecting the other conductor with the inner coating by means of a discharging rod, to one branch of which, if necessary, a flexible chain may be added.

In forming arrangements for directing the passage of accumulated electricity, it should be borne in mind that the electric fluid will, on these occasions, always pass through the best conductors, although they may be more circuitous, in preference to those which are more direct, but have inferior conducting power; and it must also be recollected, that, when different paths are open for its transmission along conductors of equal power, the electricity will always take that which is the shortest. Thus, if a person holding a wire between his hands discharges a jar by means of it, the whole of the fluid will pass through the wire without affecting him; but if a piece of dry wood be substituted for the wire, he will feel a shock; for the wood being a worse conductor than his own body, the charge will pass through the latter, as being easier, although the longer circuit. During its traues through the human body, in like manner, the shock is felt only in the parts situated in the direct line of communication; and if the charge be made to pass through a number of persons, who take one another by the hand, and form part of the circuit between the inner and outer coatings of the jar, each will feel the electric shock in the same manner and at the same instant; the sensation reaching from hand to hand, directly across the breast. By varying the points of contact, however, the shock may be made to pass in other directions, and may either be confined to a small part of a limb, or be made to traverse the whole length of the body from head to foot.

By accurate experiments, it appears that the force of the electric shock is weakened, or its effects are diminished, by employing a conductor of great length for making the discharge. A retardation in the passage of electricity also takes place if the conductor is not of a sufficient size; and when this is the case, as well as in those instances where the conductor is not a good one, the discharge will not be effected so instantaneously or so completely. It has also a tendency to diverge from the direct line of its course, being drawn towards conducting bodies which may attract it. The motion of electricity through perfect conductors is attended with no perceptible alteration in the mechanical properties of the conducting bodies, provided they be of sufficient size for the charge of the electric fluid transmitted. On the contrary, very considerable effects are produced when a powerful charge is sent through a wire which is too small to allow the whole quantity to pass with perfect freedom, or through an imperfect conductor, though of large size, as is proved when a tree is struck by lightning.

ELECTRICITY APPLIED TO INORGANIC BODIES AND ANIMALS.

The effects of electricity passing through various substances are both of a mechanical and chemical nature. The former resemble those which would be produced by a material agent driven with great velocity through the substance of the body. But there are many changes induced by electricity, such as cannot be attributed to mechanical agency, and are undoubtedly of a chemical nature. Some of the mechanical effects have already been noticed. Dr. Priestley discovered that it expanded bodies. This is proved by passing a stream of the fluid through a capillary or thermometer tube filled with mercury; the latter will be so much expanded as to break the glass to shivers. The tendency to expand will of course be greater as the conducting power of the body which transmits it is less. Although we know nothing of the nature of electricity, yet it has been found convenient to speak of it as a fluid. Its action upon bodies which either obstruct its motion or afford it a ready passage, renders its analogy with a fluid very striking, and the laws of its equilibrium are just those of an imponderable fluid. Solid bodies are capable of being diffused into vapour by passing electricity through them, as is shown by the following experiment:—Take three strips of window-glass, each about three inches long and one wide, and having placed two narrow strips of gold leaf or leaf brass between them, so that the ends of the gold leaf project a little beyond the glass, transmit the charge of a large Leyden jar through the gold leaf. The gold leaf will be found to be melted by the shock, and driven into the surface of the glass. The outer plates of glass are generally broken in this experiment, and the middle one, which frequently remains entire, has an indelible metallic stain upon each of its surfaces. This stain is obviously the metallic vapour of the gold driven into the pores of the glass.

The metallic colours thus obtained have been employed for impressing ornamental figures upon paper or silk. In order to do this, trace the outline of the figures on thick drawing-paper, and having cut it out as in stencil plates, place it on the silk or paper intended to be ornamented. When a gold leaf is laid upon it, and a card above the gold leaf, the whole is placed in a press or beneath a weight, and an electrical charge sent through it; the metallic stain is limited to the portion of the drawing-paper that is cut away, and, consequently, any outline figure may be readily impressed upon the ground employed to receive it.

CHEMICAL CHANGES OF ELECTRICITY.

The effects of electricity as a chemical agent are strikingly displayed in its power of evolving heat, and, consequently, of inflaming and fusing bodies, and its power of promoting chemical composition and decomposition. Combustible bodies, such as a common candle, can be lighted in various ways, by passing the electric fluid through them. The heat evolved by electricity, like most other of its effects, is in proportion to the resistances opposed to its passage. Nor is its heating power in the smallest degree diminished by its being conducted through any number of freezing mixtures which are rapidly absorbing heat from surrounding bodies. Sparks taken from a piece of ice are as capable of inflaming bodies as those from a piece of a red-hot iron. Among the more striking chemical effects of electricity, or electro-chemistry, are the decomposition of water, the oxidation of metals, and the restoration of the oxides to their metallic state.

Many experiments have been made for the purpose of ascertaining the changes effected in *phosphorescent* bodies by electricity, and the results are not without importance. It has been discovered, for instance, that substances not naturally phosphorescent, such as statuary marble in its natural or calcined state, were not only rendered phosphorescent by heat after being strongly electrified, but acquired this property with a beauty, a variety, and an intensity of colour, superior to those which occur in specimens that possess natural phosphorescence. It has also very recently been discovered, that electricity exercises a curious influence upon odoriferous bodies. When a current of the fluid is made to traverse camphor, the odour gradually disappears. After being withdrawn from electrical influence, it remains odourless for some time, and then slowly resumes its former properties.

There are certain mineral bodies, which, from being in a neutral state at ordinary temperatures, acquire electricity simply by being heated or cooled. This property is possessed only by regularly crystallized minerals; and of these the most remarkable is the tourmalin. It is a stone of considerable hardness, and the form of its crystals is generally that of a nine-sided prism, terminated by a three-sided pyramid at one end, and by a six-sided pyramid at the other. When heated to between 100 degrees and 212 degrees, the latter extremity becomes charged with positive electricity, whilst the former remains negative. On cooling, the electric states are generally reversed, that end becoming positive which was formerly negative. Other gems possess similar properties, such as the topaz, some species of diamonds, &c. There are a great many substances which become electrified by passing from the liquid to the solid form, such as sulphur, gum-lac, and in general all resinous bodies. The conversion of a body into the aëriform state, is also generally attended by some change in its electrical condition.

There are some bodies which are rendered electrical by pressure. The substance which possesses this property in the most remarkable degree, is that variety of the carbonate of lime known by the name of Iceland spar. Cork, bark, hairs, paper, and wood also possess the property of producing electricity by compression. A number of substances, when reduced to powder, exhibit electricity, if they are made to fall upon an insulated metallic plate. The relation subsisting between electricity and the chemical properties of matter, is the most important branch of this inquiry. It is observed by Sir Humphry Davy, that most of the substances that act distinctly upon each other electrically, are also such as act chemically when their particles have freedom of motion; this is the case with the different metals, with sulphur and the metals, with acid and alkaline substances. Of two metals in contact, the one which has the greatest chemical attraction for oxygen acquires positive electricity, and the other the negative. There is little doubt, indeed, that electricity is not only elicited by, but is intimately connected with, all chemical action; and there is every reason to believe that electricity is essentially concerned in the processes that are carried on in the living system both of animals and vegetables.

The influence of electricity upon the human frame, whether it is administered in small quantities so as to excite and surprise us, or in the more powerful and awful form of a stroke of lightning, must be well known to every one. When the human frame forms part of the electric circuit, or when the charge of a Leyden phial is made to enter the body at one hand and pass out of it at the other, a violent concussion or shock is felt along the line of its passage across the breast and through the arms. This shock, and the motion which accompanies it, no doubt result from the body being composed of various substances of different degrees of conducting power, thus presenting various obstacles to the free passage of the fluid. If the charge is increased, the patient falls down paralyzed, suffering a temporary cessation of vital action; and if it be increased to a still greater extent, it produces instantaneous death. This is frequently exemplified in the cases of individuals who are killed by the lightning stroke. It is upon the nervous system that electricity produces the most powerful influence. A strong charge passed through the head, gives the sensation of a violent but universal blow, and is followed by a transient loss of memory and indistinctness of vision. If a charge be passed through the spine, the person who receives it loses his power over the muscles to such a degree, that he either drops on his knees, or falls prostrate on the ground. Small animals, such as mice and sparrows, are instantly killed by a shock from thirty inches of square glass. If a shock be sent through the whole body of an eel, it is irrecoverably deprived of life; but if only through a part of the body, the destruction of irritability is confined to that particular part, whilst the rest retains the powers of motion. Different persons are affected in very different degrees by electricity, according to their peculiar constitutional susceptibility.

M. Rousseau, as we learn from a paragraph in the *Athenæum*, No. 637, has suggested a means of "ascertaining the purity of certain substances, and of detecting any adulterations in them, by measuring their conducting power for electricity. Some years ago, he described a simple apparatus by means of which the purity of olive-oil might be tested on similar principles. He now states that, by these means, any adulterations in chocolate or coffee may be readily detected: he finds that pure chocolate is a non-conductor or insulator of electricity, but that in proportion to the quantity of farina or fecular matter with which it is adulterated, the more easily does it conduct electricity; and in the same way, he states that coffee is an insulator, whilst chicory, with which it is often mixed, is an excellent conductor, and hence the presence of only a small quantity of that substance is easily detected in coffee by its increased conducting power. M. Rousseau also considers that this test may be applied with advantage to the examination of pharmaceutical extracts and preparations, because they very much differ in conducting power, and therefore any mixture or adulteration will be readily discovered."

Electricity is exhibited in a remarkable degree in various living animals; for example, we find in certain fishes a regular system of electrical organs, by which they either defend themselves from the attacks of their enemies, or seize the prey nature has provided for their use. Among the most remarkable of these is the *raia torpedo*, which is capable of giving a great many shocks to a number of individuals connected together, in the same manner as in the experiment with the Leyden jar. Another is the electric eel, which, when provoked, discharges its electricity, and the shock is experienced if the hand be dipped in the water containing the fish.

Although many ingenious electrical experiments have been made upon *vegetables*, some of which seem to indicate that the fluid exercises considerable influence over vegetable life, yet the subject is still involved in too great obscurity to admit of our treating it as a branch of electricity. Plants, of course, are destroyed like animals, when a powerful charge is sent through them; but feeble electricity exerts no influence on either animal or vegetable life, as far as can be perceived.

THE ELECTRICITY OF THE ATMOSPHERE.

We have now arrived at that part of our subject which is perhaps the most generally interesting of all. The resemblance between the electric spark, and more especially the explosive discharge of the Leyden jar, and atmospheric lightning and thunder, struck the mind of Dr. Franklin with so much force, that he was determined, if possible, to verify their identity by experiment.

Having constructed a kite, by stretching a large silk handkerchief over two sticks in the form of a cross, on the appearance of an approaching storm he went into a field in the vicinity of Philadelphia, and raised it, taking care to insulate it by a silken cord attached to a key, with which the hempen string terminated. No sooner had a dense cloud, apparently charged with lightning, passed over the spot on which he stood, than his attention was arrested by the bristling up of some loose fibres on the hempen string: he immediately presented his knuckle to the key, and received an electric spark. Overcome with the emotions which his discovery evinced, he heaved a deep sigh, as if he felt conscious of having achieved immortal fame. The rain now fell in torrents, and, wetting the string, rendered it a conductor throughout its whole length; so that electric sparks were now collected from it in great abundance. The discovery of Franklin soon engaged the attention of all the philosophers of Europe, and the truth of the theory, that lightning and electricity are the same fluid, was put beyond all question.

The atmosphere is very generally in an electrical state. This is ascertained by employing a metallic rod, insulated at its lower end, elevated at some height above the ground, and communicating with an electroscope. In order to collect the electricity of the higher regions of the air, a kite may be raised, in the string of which a slender metallic wire should be interwoven. The atmosphere is almost invariably found to be positively electrified; and its electricity is stronger in the winter than in the summer, and during the day than in the night. From the time of sunrise, it increases for two or three hours, and then decreases towards the middle of the day, being generally the weakest between noon and four o'clock. As the sun declines, its intensity is again augmented, till about the time of sunset, after which it diminishes, and continues feeble during the night.

In cloudy weather, the electrical state of the atmosphere is much more uncertain; and when there are several strata of clouds, moving in different directions, it is subject to great and rapid variations, changing backwards and forwards in the course of a very few minutes. On the first appearance of fog, rain, snow, hail, or sleet, the electricity of the air is generally negative, and often highly so; but it afterwards undergoes frequent transitions to opposite states. On the approach of a thunder-storm these alternations of the electric condition of the air succeed one another with remarkable rapidity. Strong sparks are sent out in great abundance from the conductor, and it becomes dangerous to prosecute experiments with it in its insulated state.

The protection of buildings from the destructive effects of lightning, is the most important practical application of the theory of electricity. The conductors, for this purpose, should be formed of metallic rods, pointed at the upper extremity, and placed so as to project a few feet above the highest part of the building they are intended to secure; they should be continued without interruption till they descend into the ground below the foundation of the house. Copper is preferable to iron as the material for their construction, being less liable to destruction by rust or by fusion, and possessing also a greater conducting power. The size of the rods should be from half an inch to an inch in diameter, and the point should be gilt or made of platina, that it may be more effectually preserved from corrosion.

An important condition in the protecting conductor is, that no interruption should exist in its continuity from top to bottom; and advantage will result from connecting together by strips of metal all the leaden water-pipes, or other considerable masses of metal in or about the building, so as to form one continuous system of conductors, for carrying the electricity by different channels to the ground. The lower end of the conductor should be carried down into the earth, till it reaches either water, or at the least a moist stratum.

For the protection of ships, chains, made of a series of iron rods linked together, are most convenient, on account of their flexibility. They should extend from the highest point of the mast some way into the sea, and the lower part should be removed to some distance from the side of the ship, by a wooden spar or outrigger.

One of the main advantages of scientific study, *is the acquisition of that degree of knowledge which liberates the mind from superstition, and explains the natural causes of those phenomena which fill the ignorant with alarm.* The study of electrical science has been of peculiar service in these respects. We learn from it, that thunder and lightning are a natural electrical result of certain conditions in the atmosphere, and are no more wonderful than the occurrence of clouds or rain. We learn from it, also, that the meteoric appearances called falling-stars, fire-balls, streamers, will-o'-the-wisps, silent lightning, &c., are simply electric phenomena, which need give no cause of alarm whatsoever. That such is the case, we refer to our article METEOROLOGY, in which the aurora borealis, and the various other appearances just mentioned, are explained on the principles of intelligible science.

GALVANISM.

THIS branch of electrical science took its origin, about the close of the last century, from a trivial accidental circumstance which occurred in the house of Signor Galvani, an Italian philosopher. A recently killed frog, having been accidentally touched in the limb with the blade of a knife which was held by a person who was experimenting with an electrical machine, was immediately thrown into violent convulsions. Galvani was not present when this occurred, but being informed of the circumstance, he lost no time in repeating the experiment, and extending his observations upon the phenomenon. He found that other metals besides that composing a knife answered the purpose, and very justly inferred that they owed this property of exciting muscular contractions to their being good conductors of electricity.

Galvani proceeded with his experiments upon animals by means of metallic substances, and arrived at the conclusion, that the different parts of an animal are in opposite states of electricity, and that the effect of the metal is merely to restore the equilibrium. But this theory was proved to be erroneous by Volta, a celebrated philosopher of Pavia, who, about the year 1801, discovered the *Galvanic* or *Voltaic pile*. He was led to it by meditating on the development of electricity at the surface of contact of two different metals. He tried the effect of his compound plates of metal upon animals, and was led to infer that the electricity is derived, not from the living system, but from the action excited between the metal and the humid animal fibre; that the animal matter acts merely as a medium conducting this electricity; and that the effects produced are to be ascribed to the stimulus of the electric fluid passing along the nerves and fibres, as in a shock from a Leyden jar. Volta further discovered, that the metallic plates which he used, such as silver and zinc, are excited, the former negatively, and the latter positively; and also that the galvanic energy could be greatly augmented by employing several pairs of plates, connecting them in such a manner that the electricity excited by each pair should be diffused through the whole; and this constituted the voltaic pile. From these, and numerous other experiments, it became apparent that electricity could be produced from the action of two different metals immersed in a suitable menstruum, and in some manner connected with each other. On this elementary truth the structure of galvanic science was reared.

In order to form a galvanic circle on the principle now mentioned apparatus of the most simple kind is sufficient. For instance, if a small slip of zinc be laid *upon*, and a piece of silver *under*, the tongue, we have two perfect conductors in the metals, with one imperfect one, the tongue, or the fluids which surround it; and by this apparatus, simple as it is, galvanic action is produced. In all action of this nature, and particularly when powerful acids are employed, the metals, as a matter of course, are eaten away or decomposed, and precipitated in the liquid. The knowledge of this fact has explained the cause of the gradual disappearance of metals, when two of an opposite electric quality were adjoining each other. Thus, in the sheathing of ships, it is necessary to use bolts of the same metal which forms the plate; for if two different metals be employed, one of them oxidates very speedily, in consequence of their forming, with the water of the ocean, a simple galvanic circle.

Compound galvanic circles, or galvanic batteries, are formed by multiplying those arrangements which compose simple circles. Thus, if plates of zinc and of silver (or of zinc and copper), and pieces of woollen cloth of the same size as the plates, and moistened with water, or, what is better, with diluted acid, be piled upon each other in the order of zinc, silver, cloth; zinc, silver, cloth; and so on, for twenty or more repetitions, we have the voltaic pile. The power of such a combination is sufficient to give a smart shock, as may be felt by grasping in the hands, previously moistened, the wires connecting the upper and lower extremities of the pile. The shock may be renewed at pleasure, until, after a few hours, the activity of the pile begins to abate, and finally ceases altogether, till the plates are cleaned and new diluted acid added.

After various improvements in the mode of eliciting galvanic action, the apparatus found to be best adapted for experiments, is that of a trough or open box of wood, well joined together and secured from leakage by being lined with some kind of resinous material or pitch. Into a trough of this kind plates of zinc and copper are put vertically, like so many cross divisions, the supports being grooves cut in the sides; a wire is led from each extremity of the row of plates, to act as conductors in any experiment to be performed. One wire represents the positive, and the other the negative pole of the electricity. The liquid in the trough occupies the cells between the plates. Figure 5 is a representation of a trough of this kind. The plates are usually about eight inches long, by

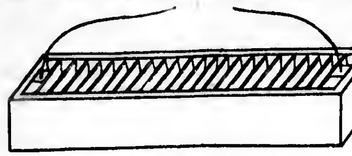


Fig. 5.

five or six inches broad; and in all arrangements, whether one or many troughs are employed, care must be taken to place the plates in one unvarying order, the zinc and copper succeeding each other alternately throughout the series. When several troughs are connected together, as in figure 6, the apparatus is called a *battery*. The cells

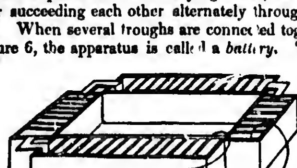


Fig. 6.

are usually charged with acids diluted with water to a certain extent; muriatic acid being diluted with five parts, and sulphuric acid with fifty parts of water. By experiments, it has been ascertained that increase of galvanic power is not in the ratio of an increased size of plates, but in the ratio of an increased number. Several troughs of small plates will thus have greater power than one trough with a greater superficies of metal. It may be farther mentioned, that if a battery is to consist of a certain number of square feet of plates, then, for producing calorific effects, or the ignition of metallic leaves and other combustibles, the plates ought to be large; for chemical effects, the size ought to be small, and the plates numerous; and for physiological effects, that is, for operating on the animal system, they ought to be made of an intermediate side.

The chemical changes effected by the electricity of galvanic action, are among the most remarkable phenomena in physical science. We shall instance a few of these facts, gathered from the best authorities. If a plate of zinc, and another of copper, be immersed in very dilute sulphuric acid, without touching or communicating with each other, the zinc will be acted upon by the acid; part of the water will be decomposed, its oxygen combining with the zinc, and forming oxide of zinc, and its hydrogen will be disengaged in the form of gas from the surface of the zinc plate. The copper is not acted upon. If the metals be brought into contact, the oxidation goes on with greater rapidity and energy, although without the evolution of the same quantity of hydrogen gas from the oxidating surface. But, from the whole fluid, hydrogen is disengaged in quantity exactly corresponding to that of the oxygen derived from the water, and the greater portion of it rises in a copious stream of bubbles from the surface of the copper plate, which remains unacted upon as before.

If, however, an acid, such as nitric acid, capable of acting upon the copper as well as upon the zinc, be employed instead of the sulphuric acid, similar phenomena will take place, with this additional circumstance, that the action of the acid upon the copper will cease the instant the galvanic circuit is completed; and instead of nitrous gas being formed on the surface of the copper, which happens before the circuit is formed, only bubbles of pure hydrogen will make their appearance; and the copper is protected from all further action, the zinc being, as in the former case, oxidated and dissolved with additional energy. It is on this principle that Sir Humphry Davy effected the protection of the copper sheathing of ships from the corrosion of sea-water, by placing in contact with it pieces of zinc or iron, on which sea-water exerts a greater chemical action than on copper. Among the simplest effects of galvanism upon fluid conductors, is the resolution of water into its two gaseous elements, oxygen and hydrogen. If the water employed be not perfectly pure, other substances besides the two components of water make their appearance at the two wires employed in the experiment. The apparent formation of these substances greatly puzzled the early experimentalists; but Sir Humphry Davy proved that, when the water is perfectly free from any foreign ingredient, only the two simple gases of which it is composed are obtained. He also discovered, that, under the influence of voltaic electricity, neutral salts existing in any solution were decomposed, the acid portion being accumulated around the positive wire on the same points where oxygen was disengaged; while the basis, whether earthy, alkaline, or metallic, were at the same moment transferred, along with the hydrogen to the negative wire.

Phenomena of a still more extraordinary nature presented themselves to Sir Humphry Davy in the further prosecution of these inquiries. It was discovered that the elements of compound bodies were actually conveyed, by the influence of the electric current, through solutions of substances, on which, under other circumstances, they would have exerted an immediate and powerful chemical action, without any such effect being produced. Acids, for example, may be transmitted from one cup, connected with the negative pole, to another on the opposite or positive side, through a portion of fluid in an intermediate cup, tinged with any of the vegetable-coloured infusions, which are instantly reddened by the presence of an acid, without occasioning the slightest change of colour. The same happens also with alkalies. If three cups be arranged, and connected with each other in a series by moistened cotton, the middle cup, and also the one next to the positive side of the battery, being filled with blue infusion of cabbage or of litmus, and the cup next to the negative side containing a solution of sulphate of soda on the series being placed in the voltaic circuit, a red tinge will soon be perceived in the water of the positive cup, which will become strongly acid. It is evident that the sulphuric acid so transferred must have passed through the fluid in the middle vessel, but without affecting the coloured solution in its passage. By reversing the connections with the poles of the battery, a similar transfer of the alkali will be made: it will be collected in the tinged water of the negative cup, which it will render green; but the intermediate portion of fluid will not, either in this or in the former case, exhibit any trace of the substance which is carried through it by the influence of electricity. Cohesion, however, where powerful, as might have been expected, intercepts the transmission of the substance. So powerful is this mysterious agent, that the minutest portions of a substance, acted upon by either of the wires, is collected around it.

"An interesting class of experiments are due to Mr. Crosse, on the employment of electricity, in a state of high tension, to form mineral and other substances. There is a cavern near Broomfield, of which the vault is covered with arragonite, and carbonate of lime, and fine crystals. The water which drips from this vault holds in solution ten grains of carbonate of lime, and a little sulphate of the same to each pint. A glass filled with this water was submitted to the action of a battery consisting of 200 pairs of plates, and at the expiration of ten days the negative pole was found to have formed rhomboidal crystals of carbonate of lime, accompanied by some gas-bubbles, and in less than a month after, the wire was covered with regular and irregular crystals; whence it follows that the bicarbonate was decomposed into carbonate and carbonic acid gas. He also let the water drop on a piece of brick subjected to a current from 100 five-inch plates, the brick being supported by a funnel which conducted the water into a vessel below; after four or five months the brick near the negative pole of battery was covered with carbonate of lime, while near the positive pole were disposed prismatic crystals of arragonite; and the same experiment being repeated with fluosilicic acid, regular hexahedral pyramids, similar in all respects to quartz, were obtained; those which were left in a dry place acquired sufficient hardness to scratch glass; the others had not that power, and gradually lost their transparency. In his varied experiments of this nature, he has succeeded in forming, by means of the galvanic battery, the following minerals:—carbonate of lime, arragonite, quartz, protoxide of copper, arseniate of copper, and its blue and green carbonates, phosphate of copper, carbonate of lead, chalcedony, &c."—*Penny Cyclopædia.*

Why compounds, when placed in a galvanic circuit, are decomposed, and why their elements collect, some around the positive and others around the negative pole of the battery, are questions which have never been satisfactorily solved. Sir Humphry Davy suggested the theory that all bodies possess natural electrical energies, which are inherent in them, whether they are in a state of combination or not. Oxygen, chlorine, iodine, and acids, according to the theory, are naturally negative; while inflammables, as hydrogen, sulphur, &c., and metals, are naturally positive. Hence, when the combinations of these substances are subverted by the galvanic influence, the substances are evolved in the electric state natural to them; and as it is a law of electricity that bodies in opposite states attract each other, the oxygen, being negative, is immediately attracted by the positive wire, while the inflammable or metallic base, being naturally positive, is attracted by the negative wire. In this way, the uniform appearance of these bodies at their particular poles are accounted for. Thus, if hydrogen is naturally positive, and oxygen naturally negative, according to the laws of electricity, they must attract each other; and if these opposite states are sufficiently elevated to give them an attractive force superior to the power of aggregation, they may be expected to combine; and, in like manner, other bodies, whose particles are in different states, may from this cause be united together. If a body, also, whose electrical energy exceeds that of one of the substances combined, be brought to act upon these, it may expel that ingredient, and take its place; and this may be the cause of what is called decomposition from elective affinity.

The agency of the galvanic apparatus, then, in producing decomposition, it is conceived, is this—that the two wires placed in contact with the compound are in states of electricity more intensely elevated than the natural states of the two ingredients; hence the attraction of these two highly electrified points overcomes that subsisting between these ingredients: they are separated, and immediately drawn to the respective poles—the positive constituent to the negative wire, and the ingredient which is naturally negative to the positive wire.

With respect to the physiological effects of galvanic action, it may be observed that the shock received by the human body from the voltaic pile is similar to that resulting from a large electrical battery very weakly charged. Twenty pair of plates are generally sufficient to give a shock which is sometimes felt in the arms. With a hundred pairs, it extends to the shoulders. A continued flow of the current through the body is accompanied by a continued aching pain. The impression made upon some of the nerves of the face when they form part of the circuit, is accompanied by the sensation of a vivid flash of light. When a piece of zinc and a piece of copper are placed, the one above and the other below the tongue, which must be in a moist state, a peculiar taste is experienced. This is supposed to arise from the saliva of the mouth having been decomposed by the galvanic action, and not merely the effect of a direct impression of the electric current on the nerves of the tongue. When the current of voltaic electricity is made to pass along a nerve distributed to any of the muscles of voluntary motion, they are thrown into violent convulsive contractions. The susceptibility of some animals is very great, and numerous curious experiments may be performed with them. If an earth-worm be placed upon a crown piece which lies upon a plate of zinc of larger size, it will suffer no inconvenience as long as it remains in contact with the silver only; but the moment it has stretched out its head, and touched the zinc, so as to complete the galvanic circle, it suddenly recoils, as if it had felt a severe shock. If the battery be powerful, small animals may be easily killed. Striking effects are produced by galvanism in the muscles of an animal after death, as long as they retain their contractility. The convulsions are so general, as often to impress the spectator with a belief that the animal has been restored to the power of sensation, and that it is suffering the most cruel torture. The eyes open and shut in their sockets spontaneously, as if re-endued with vision; the nostrils vibrate, as in the act of smelling; and the movements of mastication are imitated by the jaws. The experiments which are calculated to produce the greatest terror and astonishment are those made upon the bodies of recently executed criminals; but for any account of these operations we cannot afford room in our limited pages.

The effects of galvanism upon the functions of secretion are the most remarkable as well as the most inexplicable. That it acts especially, and in a peculiar manner, upon the gastric juice, a fluid essentially subservient to the process of digestion, there can be no doubt. Perhaps the various functional parts of the body form a sort of galvanic battery, by which a regular circulation of this subtile and mysterious fluid is kept up. On the supposition that such is the case, galvanism has been applied with good effect in medicine, in the cure of nervous disorders. Tic doloureux, which is a chronic derangement in the nervous energy, has been subjected to the influence of galvanic currents, and these, in particular cases, have completely removed the complaint. It is perhaps necessary, by way of precaution, to say that all such applications ought only to be made under the special direction of a skilled medical practitioner.

Galvanism has lately been applied to the protection of plants from worms and slugs, as appears from the following notice in a Liverpool newspaper:—"The protector consists of a conical ring of zinc about four inches in height, the top end flanked off about a quarter of an inch, and cut into numerous vandyked points; and immediately under is a ring of copper neatly fitted. The bottom of the zinc ring is pressed into the soil until the lower edge of the copper ring is an inch and a half above the surface, care being taken to enclose within the ring the stems of such plants as require them, otherwise the mollusca will find a road to them by the stems. The mollusca may crawl up the zinc with impunity, but on coming in contact with the copper, will receive a galvanic shock and fall to the ground. The apparatus acts in wet or dry weather, and is always in operation. Its appearance is like a flower-pot, and it is cheap and durable. After a trial of twelve months by Mr. Cuthbert, the inventor, he found that not a plant to which it was applied was injured."

Electrotyping.—In 1839, the galvanic principle, in relation to the deposition of metal from a metallic solution, was applied by Mr. Thomas Spencer of Liverpool, to the multiplying of plates of engraved copper, medals, &c. The nature of this most ingenious discovery, which was first brought into public notice at a meeting of the Liverpool Polytechnic Society, (Sept. 12, 1839,) will be best understood by describing the process which is now ordinarily pursued.

We take a trough or box, which may be represented by Fig. 7. This box is divided lengthwise by a thin partition P, composed of sycamore, that being a porous and durable material. C is a copper plate suspended in one of the cells by a wire attached to an upper rod of metal R, traversing the mouth part of the box. In the other cell is similarly placed a plate of zinc, nearly the size of the copper. The zinc is similarly suspended by a wire from the traversing rod above. A wire passing over direct from the copper to the zinc, would answer the same purpose of communication, but the plan of an intervening rod with attaching screws is found to be more convenient. Into the cell containing the copper we put as much water as will about four-fifths fill it; then into this we place crystals of sulphate of copper, which soon dissolve and form a solution. Into the other cell, containing the piece of zinc, we place a similar quantity of water, into which pulverized sal ammoniac is put, so as to form a solution likewise. The preparatory process may now be said to be complete; but, unless the copper has been previously prepared to receive the deposition on one part only, the deposition would take place all over it. To guard against this, the copper, before being placed in the trough, must have been coated on the back and edges with a mixture of sealing-wax dissolved in spirits of wine. This mixture or varnish may be of such a consistency as may be laid on with a camel-hair pencil. The copper is not put into the trough till the varnish is hard. The wire of the copper must likewise be varnished; and it is also necessary explain, that the wire must be flattened at both extrem es—one extremity being soldered to the back of the copper, and the other fastened beneath the screw to the rod. The wire for the zinc is to be flattened at the extremities, and attached in the same manner. No varnishing is necessary on the zinc.

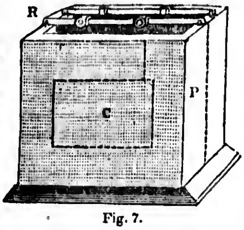


Fig. 7.

We have now described all that requires to be done in the first instance; and the trough may be put aside to allow the process time to operate. This operation will consist of a galvanic current, commencing with the action of the sal ammoniac upon the zinc, proceeding up the wire, and through the rod to the copper plate; porosity in the dividing partition being also essential to the current. As the action proceeds, it will be observed that an effervescence is going on in the zinc cell; and this indicates that the deposition of metal from the sulphate of copper is taking effect on the plate. The length of time occupied in perfecting the process will vary from four to six days; but during this interval it will be necessary to add fresh material, both of sulphate of copper and sal ammoniac. In some boxes a small shelf is put, to contain the sulphate of copper during its dissolution. The copper plate may be occasionally examined, to ascertain the extent of the deposition; and when this deposition is as thick as a shilling, it may be separated from the plate. We have now procured a fac simile of the engraved copper plate *in relief*—in point of fact, a substantial piece of copper formed from a solution. The copy in relief is of no value in the arts; and to be of use, it must be subjected to a fresh process, in which *it* receives the deposition. This second deposited cake of metal is a *fac simile* or duplicate of the original plate; and by thus using the relief plate again and again, we may obtain any number of engraved copper plates of the same subject that we may think proper. As engraved copper plates are soon worn out by printing, the value of the above simple and inexpensive means of creating duplicates is very evident. Such is the fidelity of the process, that the slightest scratch on the original plate will be shown on the duplicate copy.

Various other objects may be multiplied by this kind of *electrotyping*, as it has been named; for example, dies for seals, medals, plaster-casts, &c. Mr. Barclay, a seal-engraver in Gerrard Street, Soho, London, has carried the practice of electrotyping metal seal stamps to great perfection. A small tract which he has published on the subject, furnishes the following observations on the method to be pursued. It will be noticed that he multiplies the dies or seals from impressions taken in sealing-wax:—"The paper on which the impressions are to be taken should be thick and soft, like that on which music is printed, dried over the light, and spread flat—the wax should not be put into the light, or allowed to flame; when on the paper, it must be kept fluid, while by stirring to the required size and gradually diminishing the heat, all bubbles are removed: when nearly cool, make the seal of the same temperature as the wax, or sufficiently warm as to be bearable on the back of the hand. If the seal be too hot, the impression will be blackish, and unequal on the surface; if much too hot, the wax will adhere. A little dry vermilion, sparingly powdered over the seal with a camel's hair brush, will greatly assist in preventing adhesion, and considerably improve the appearance of the impression, without any apparent diminution of its sharpness; dry black-lead will answer also for this purpose. After powdering, strike the side of the seal smartly against the table, in order to shake off the loose and coarse particles. The seal must be put down and taken up perpendicularly and without hesitation; before the wax is cold a weight should be put round it on the paper to keep it flat, by means of a small box, wine-glass or tumbler, according to the size of the impression. The facility of taking impressions, or casts, in this or other non-conducting substances, called the attention of Mr. Murray, in January, 1840, to the best means of obtaining upon them conducting surfaces, and to him we are indebted for the use of plumbago, or black-lead, a discovery not the result of accident, but of judgment, and without which the electrotype would be deprived of half its advantages.

"In the application of black-lead, much misconception has arisen as to the quantity requisite to insure a deposit. On sealing-wax, barely a tint is sufficient. On waxed plaster, more is required; and it is liable to be washed off if disturbed in the solution before it is covered by the deposit; and this is also the case with fruit and vegetables, with smooth skins. Having the jar, porous tube, and zinc, with copper wire attached, take a wax impression, make the end of the wire warm, and press it against the side of the impression till it adheres firmly. Then take a soft tooth-brush, dip it into a little dry black-lead, and with it gently brush the wax every direction, until the black-lead is equally distributed. Scrape a small portion of the metal inserted into the wax clean; and, on the point of a knife, take a little damp black-lead, with which make good the contact between the black-leaded surface and the copper wire; varnish over the remainder of the wire, and those portions of the impression where a deposit is not required, except that part covered with the damp black-lead; place the whole in the apparatus as before the deposit will shortly commence on the damp black-lead, and subsequently spread over the whole surface not covered with varnish. When the deposit has obtained sufficient thickness, hold the wax in warm water, till it becomes gently heated, when it may be readily separated from the metal. The deposit will always accumulate most rapidly at the edges; therefore, to insure as great a thickness as possible on the subject, the extremity should be well varnished; but if the action be violent, it will extend over the varnish; in that case it should be taken out and washed in cold water, and that portion only on which deposit is not wanted, wiped dry, and again varnished.

"Plaster casts (Mr. Barclay proceeds to mention) are, next to seal impressions, most easy of attainment. To electrotype from these, it is necessary to soak them in melted white wax, stearine, or tallow, which is thus best effected:—Take a shallow vessel, in which put a little wax, and hold it over the flame of a lamp; when melted, drop in the plaster cast, face upwards, taking care the wax does not overflow the surface; in a short time, by keeping it warm, the wax will ascend in the plaster, and when it is observed to have equally pervaded the surface, it must be removed and placed on a piece of blotting-paper, to absorb the superfluous wax, which it will better effect by being kept warm for a short period. It must then be laid by for twelve hours at least, after which time it may be well brushed with a soft brush and black-lead, without fear of injury. To attach the copper wire, use melted bees-wax at the back of the cast, having a bent portion of the wire near the surface, with which to make the connection with the black-leaded surface, or the wire may be made to surround the cast. As in the case of the wax impression, varnish the wire and the parts of the cast on which no deposit is required. Having equally oiled the subject, a plaster cast may be made as follows:—Take *fresh* plaster, and having a little water in a basin, drop from between your finger the plaster into it, pour off the superfluous water, and then stir it gently; take a hog-hair brush and brush a portion of the plaster well into the subject, then pour as much as will make the required thickness. Coins and medals can be readily copied by means of sealing-wax impressions; if the relief be very prominent, they are best attained from plaster casts; a coin can be silvered, or gilt, as hereafter described, or bronzed, by brushing it well with black-lead, then making it hot, and again brushing it. Various degrees of heat will give different tints; should the first attempt not give satisfaction, it may be well washed with hot water and soap, and the process repeated. Having well black-leaded a wood-engraving, take a strip of tin-foil, and bind it close round the sides, carefully pressing the edge all round, to bring it in contact with the black-leaded surface; then, with the wire attached to the zinc, which being long enough to surround the whole, bind it tight, and varnish as before. Wood, from its buoyancy, will float, unless a firm, stout wire be used to retain it in its vertical position, which is essentially requisite; for, if it incline at an angle, with the lower part at the greatest distance from the zinc, the new deposit will be formed in ridges. After this has once occurred, it will be impossible to obtain an equal deposit: because the copper accumulates only on the most prominent parts, and the hollows remain proportionately thin, as at the first deviation from an equal surface. This applies to every kind of deposit, whether seals, medals, or copper plates. A similar result will also take place in a weak solution, or in a deep trough, from the liquid losing its particles of copper, and becoming lighter, rising in a regular channel to the surface; the deep trough giving space for a descent of the denser portion of the liquid containing the metal in solution. These copies from wood-engravings have an advantage above the ordinary process for obtaining duplicates for printing, being made perfect direct from the wood, whereas the stereotype copies frequently require re-touching by the engraver, arising from the friability of the plaster from which they are cast."

Mr. Smee, whose researches in electro-galvanism are well known to the philosophical world, has suggested a still more extraordinary kind of electrotyping, namely, the making a copperplate engraving without an engraving in the first instance. He describes it in a paper in the *Philosophical Magazine*, No. 105, from which we extract the following passage:—"First, draw the required subject upon a smooth copper plate, with any thick varnish or pigment insoluble in water, and then expose the plate in the usual way to the influence of the current, when first copper will be thrown down upon the uncovered parts and will gradually grow over the drawing, and the electrotype, when removed, will be ready for printing. Very thick oil paint should be used, else sufficient depth will not be obtained to hold the ink. As an additional advantage to its cheapness, this method does not require the artist to reverse the design. An opposite effect to this may be produced by placing a piece of copper similarly drawn upon at the oxygen end of the battery, when the metal will be acted upon, leaving a drawing in basso-relievo."

Electric Telegraphs.—Galvanism, and its twin-principle electro-magnetism, have performed other wonders in application to the arts. One of the most interesting of their powers in this respect, is that of transmitting telegraphic signals through wires to any assignable distance. The general principle on which such an operation is founded, is that of causing the galvanic current to deflect or turn a needle poised on a centre, and by certain arrangements the needle is made to point to any letter on a dial-plate. The discovery of this kind of telegraphic action is by no means new. From a passage in Arthur Young's Travels in France, published in 1787, it appears to have been at that period known, and to some extent practised, by a M. Lomond. But like many other remarkably ingenious devices, it was long in being heard of popularly after science had established its capabilities. Even now, it is one of those practical improvements which, to a certain extent, remain under public suspicion. Twelve years ago, Dr. Ritchie made some attempts to complete the plan of an electric telegraph; Sir Humphry Davy and others also engaged in a similar undertaking. In 1837, the model of an apparatus for communicating by galvanic action, was exhibited by Mr. Alexander before the Society of Arts in Edinburgh; and this, as far as we know, was the first time the thing was brought in a tangible form before the public. Mr. Alexander's telegraph was in the form of a chest, containing thirty copper wires, answering to the twenty-six letters of the alphabet, three points, and an asterisk to denote the termination of a word. At one end, in connection with the wires, were keys like those of a piano-forte, and underneath these were a pair of plates, zinc and copper, forming a galvanic trough: at the other extremity of the wires were thirty steel magnets, and, any one of these being affected by the electric agency produced by touching the key, it was turned to the right or left, and unveiled a particular letter. On removing the finger from the key, the magnet sprung back, and the letter was screened from observation. Thus any letter could be instantaneously exposed, or words spelled letter by letter, according to the will of the operator. As galvanism requires a complete circuit for its operation, it might be supposed that a duplication of the thirty wires would have been necessary, but by a happy arrangement of Mr. Alexander, with one return wire to serve for all, this encumbering of the apparatus was avoided.

Since this time, considerable improvements have been effected on the mechanism of electric telegraphs, by Professor Wheatstone and Mr. Cook, one material object having been the reduction of the number of wires, which has been effected with a surprising degree of skill. A writer in *Chambers's Edinburgh Journal*, (July 25, 1840,) thus describes what he saw of the process on the occasion of a visit to the professor's class-room at King's College, London:—"The professor showed two varieties of the apparatus, one being the latest invention, and the most deeply interesting from its simplicity. It may be briefly described as consisting of two small galvanic troughs or batteries; four lengths of copper wire; an object resembling a brass clock, with a small opening or dial on the surface sufficient to show a single letter at a time; close by this case of mechanism stood an upright pivot of brass about three inches high, having a circular top inscribed with the letters of the alphabet all round, and from each letter a spike pointing outwards like the spokes from a capstan. The whole stood on a table, except the wires, which, being four miles in length, and warped in numerous convolutions through the vaults of the college, were observable only at their extremities in connection with the apparatus.

"With respect to the principle of the process, it will suffice to state, that the electricity or galvanic property generated in the batteries, was made to proceed along the wires, and in its passage to affect the mechanism in the case. In the construction of this mechanism, the great merit of the invention consists. It is a beautiful combination of brass wheels, and other details, the object of which is to produce a desired letter or figure at the exterior opening or dial. To bring any particular letter into view, the capstan is turned by the finger till the metal point projecting from a similar letter upon it is made to touch a corresponding point near the side of the case. Thus, there is a sympathy, as I may call it, between the letters in the case and the letters on the capstan. A touch of the point opposite L, will bring L into view on the dial, and so on with any other letter. Nothing can be more perfect, or apparently simple. To appearance, the letters can be exposed at the rate of two in every moment of time. A lady, turning the capstan with her finger, brought into view the word L o n d o n, in the time it could be uttered letter by letter, although the idea had to travel through four miles of wire.

"In the transmission of the electric influence through the wires of this or any other apparatus, distance is of no consequence as respects time, for electricity is supposed, with some degree of probability, to travel with the velocity of light, or 192,000 miles in the space of a second. In point of fact, therefore, no longer time would be occupied in transmitting intelligence to the uttermost ends of the earth, than would be required for sending it across a room or a table. Distance is a matter for consideration only as regards expenditure of galvanic force. The electric agency has a tendency to weaken in its progress, according to circumstances, and this must necessarily be provided for by increasing the number of batteries to the desired amount and power. It has been supposed that the difficulty of perfectly isolating and preserving the wires from injury in their course, would be an insuperable bar to their establishment on an effective footing; but fears need be no longer entertained on this score. Each of the four wires in the above apparatus is wrapped round with a well-rosined thread, and the whole are then tied together with a cord, possessing a similar coating, so as to present the appearance of a tightly-bound rope. This it is proposed to place in a small iron tube, like that used for bringing gas into houses, and the tubes united to any length, are laid below the ground, or in a wooden case on the surface, to preserve them from injury. Yet another difficulty here presents itself. What if the rope, or any particular wire, should be fractured somewhere in its course? How would the precise point of injury be discoverable? This the professor has likewise provided for, as far as it possibly can be. He proposes that there shall be a signal-case at an interval of every ten miles along the whole line, and therefore should any injury be sustained by the wires, it will be speedily discovered in what portion it has taken place, and a new and complete section of rope inserted in connection with the other pieces. To avoid a very remote chance of delay in the transmission of intelligence from this cause, it would be easy to lay two sets of wires, one of which could be employed while the other was in course of being repaired.

"The capabilities of the principle have been fully tested in a practical manner on the line of the Great Western Railway. In September, 1839, when the wires of the electric telegraph were carried as far as West Drayton, a distance of fifteen miles, the following account was given of it in one of the London papers:—

"'The space occupied by the case containing the machinery (which simply stands upon a table, and can be removed at pleasure to any part of the room) is little more than that required for a gentleman's hat-box. The telegraph is worked by merely pressing small brass keys, (similar to those of a keyed bugle,) which, acting by means of galvanic power upon various hands placed upon a dial plate at the other end of the telegraphic line, as far as now opened, point not only to each letter of the alphabet, (as each key may be struck or pressed,) but the numerals are indicated by the same means, as well as the various points, from a comma to a colon, with notes of interrogation and interjection. There is likewise a cross (+) upon the dial, which indicates that where this key is struck, a mistake has been committed in some part of the sentence telegraphed, and that an erasure is intended. To a question—such, for instance, as the following: "How many passengers started from Drayton by the ten o'clock train?"—the answer could be transmitted from the terminus to Drayton and back in less than two minutes. This was proved on Saturday. This mode of communication is only completed as far as West Drayton station, which is about 13½ miles from Paddington. There are wires (as may be imagined) communicating with each end, thus far completed, passing through a hollow iron tube, not more than an inch and a half in diameter, which is fixed about six inches above the ground parallel with the railway, and about two or three feet distant from it. It is the intention of the Great Western Railway Company to carry the tube along the line as fast as the completion of the rails takes place, and ultimately throughout the whole distance to Bristol. The machinery, and the mode of working it, are so exceedingly simple, that a child who could read would, after an hour or two's instruction, be enabled efficiently to transmit and receive information.'

"It being thus ascertained, by practical working, that the electric telegraph can perform all that its designers have proposed, it only remains that it should be spread in different directions over the country, or at the least laid in communication from London along the great lines of thoroughfare.

"The method of working the apparatus will be readily understood. At each extremity of the line of rope—for it would work both ways—there would be an office for receiving and communicating intelligence, at a price conformable to the extent of the message. Being despatched from one end, the communication would be instantaneously received at the other by an officiating clerk, and forthwith made known by a note to the party concerned. Thus intelligence of the rise and fall of stocks, foreign news, orders for goods, or any other species of communication of an urgent nature, might with the utmost facility, and at a trifling cost, be transmitted to any imaginable distance."

Still more lately the galvanic principle has been applied to the regulation of clocks, with a view to preserve a uniformity of motion in all the clocks in a town, or in a public office, to which wires may be led. The manner in which this is accomplished is now (or was lately) exhibited at the Polytechnic Institution in London.

ELECTRO-MAGNETISM.

Before noticing this electric quality, it seems necessary to give a short explanation of magnetism, or the properties of the magnet. Anciently, there was found in Magnesia, in Asia, a certain kind of iron ore, in which the remarkable property was discovered of attracting other kinds of iron or steel; this ore afterwards received the name of *loadstone*, but from Magnesia, the place in which it was originally found, we derive the terms *magnet* and *magnetism*. Latterly, loadstone ore has been discovered in Siberia, Sweden, Piedmont, the kingdom of Naples, and various places in North America. This magnetic iron ore, which is of an excellent quality for making steel, is of a dark colour, and generally occurs crystallized in the form of regular octahedrons; its attractive quality is strengthened by exposure to the air. It has likewise been found that meteoric stones, which are composed of iron and nickel, possess a strong magnetic virtue resembling the loadstone of the earth.

Although the ancients were acquainted with the attractive property of the loadstone, it was left for the moderns to discover that the property could be communicated to the iron which the magnetic stone attracted. Since this important discovery was made, artificial magnets, composed of bars or slips of iron, have been easily constructed; and these possess all the attractive virtues of the loadstone itself. Besides iron, a few other metals are susceptible of being attracted, such as pure cobalt and nickel; but the power is weak and of no avail in the arts.

Independently of attracting iron, magnets possess the extraordinary property of *polarity*. When a small magnetic bar is poised at the centre, so as to be free to move in any direction, one end points towards the north pole of the earth and another towards the south. It is true, there are variations in the direction at different parts of the globe, but with these slight exceptions, the magnetic needle, as it is called, offers one point to the north and another to the south. Hence the application of the compass to navigation. (See the Article Ocean.) From what will be immediately mentioned, no room is left for doubting that the magnetic virtue is referable to electricity. When two magnets are brought near together, the north pole of the one repels the north pole of the other, and the same with the two south poles; but poles of opposite names attract each other. These phenomena are evidently analogous to the demonstrations of positive and negative electricity.

Artificial but permanent magnets are usually made in nearly the form of a horse-shoe, by which the two poles are brought near each other, and are connected at the extremities by a small piece of soft iron called the keeper, which serves to increase the strength of the magnet when not in use. A magnet of this form is represented in Fig. 8. M is the magnet, furnished with a ring R at the top, by which it may be suspended. K is the keeper, into which a hook is fixed supporting weights beneath, so as to exhibit the strength of the magnetic influence.

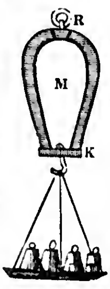


Fig. 8.

In 1819, Professor Oersted of Copenhagen established a most interesting relation between magnetism and voltaic electricity, thus laying the foundation of electro-magnetism. He discovered that when a wire conducting electricity is placed parallel to a magnetic needle properly suspended, the needle will deviate from its original or natural direction. This deviation follows a regular law.

1. If the needle is *above* the conducting wire, and the positive electricity goes from right to left, the *north* end of the needle will be moved *from* the observer. 2. If the needle is *below* the wire, and the positive electricity passes as before, the *north* end of the needle will be moved *towards* the observer. 3. If the needle is in the same horizontal plane with the wire, and is between the observer and the wire, the *north* end of it will be *elevated*. 4. If the needle is similarly placed on the opposite side, the *north* end of it will be *depressed*. In these two experiments the needle must be very near the wire. From these simple facts, Mr. Oersted concludes that the magnetical action of the electrical current has a circular motion round the wire which conducts it.

The metallic wire to be made use of in this experiment, should be two or three feet in length, to allow of its being bent in various directions. It is called the *conjunctive wire*. Ampère and Davy discovered two very important facts soon after Oersted had made his experiments public—namely that the conjunctive wire itself becomes a magnet, and that magnetic properties might be communicated to a steel needle, not previously possessing them, by placing it in the electric current; and the degree of magnetic power thus communicated, Davy showed was always proportional to the quantity of electricity transmitted through it. When the conjunctive wires of two distinct galvanic batteries are made to approach each other, they exhibit magnetic attractions and repulsions. Two wires of copper, silver, or any other metal, connecting the extremities of two galvanic troughs, being placed parallel to each other, and suspended so as to move freely, immediately attract and repel each other, according as the directions of the currents of electricity flowing through them are the same or different. Upon this experiment is founded the most plausible theory of magnetism, namely, that it arises from the attractions and repulsions of currents of electricity, constantly circulating round every magnet. This is conceived to explain the reason why the magnetic needle places itself at right angles to a wire conducting electricity, namely, that the current passing along the wire may coincide with that circulating round the magnet.

From these and other experiments, it seems clearly proved that electricity and magnetism are identical. A permanent magnet is supposed to be thus constituted:—It is a mass of iron or steel, round the axis of which electric currents are constantly circulating, and these currents attract all other electric currents flowing in the same direction, and repel all others which are moving in an opposite direction. The electric currents flow round every magnet in the same direction in reference to its poles. For instance, if we place a magnet with its north pole pointing to the north, in the usual position of the magnetic needle, the current of electricity flows round it from west to east (that is, the direction in which the earth and other planets revolve round the sun), or, on the eastern side of the magnet, it is moving downwards, on the western side upwards, on the upper side from west to east, and on the lower side from east to west. This is found to be a uniform law. To complete the view of this doctrine, it remains only to explain the influence of the earth on the magnet, by which the needle is kept always in one position, nearly coinciding with the meridian. It is conjectured that currents of electricity, analogous to those which circulate round every magnet, are constantly flowing round the globe, as the current of electricity in a galvanic apparatus moves in an unbroken circuit from the negative to the positive pole, and from it, by the connecting wire, round again to the negative pole. The direction of these currents is inferred to be the same as has been stated with regard to artificial magnets; and it is simply by the attractions and repulsions of these terrestrial currents, bringing the currents round the needle to coincide with them, that the latter always points to the north.

By means of a galvanic battery, iron may be temporarily magnetized, that is, endued with an attractive power, so long as the iron is in connection with the seat of power in the trough. When a metallic wire of great length is coiled round the iron, forming what is called a *helix*, the magnetic power of the magnet is correspondingly increased. The wire requires to be previously coated with silk varnished, to prevent the electric current passing from surface to surface of the metal. A magnet of this kind is usually formed in the shape of a horse-shoe, as in the case of the permanent magnet already mentioned. When suspended so as to present the extremities downward, and the galvanic communication is established, the magnetic power is at once excited, and a piece of iron held to the extremities will instantly be attracted and adhere. On breaking the communication with the trough or battery, the magnetic virtue is destroyed, and the piece of iron which was attracted drops. Electro-magnets have thus been made of great power; one having been formed which would sustain a weight of 2063 pounds, or nearly a ton. There is, however, no assignable limits to the power of the apparatus.

Electro-magnets, like those formed permanently, possess opposite poles, one attracting and another repelling. From this property the attempt has been made to give rotation to a wheel, consisting of cross bars of iron; one pole attracting a bar and another repelling it, and thus, by a rapid alternation of poles, obliging the wheel to revolve. Another plan has consisted in reiterated attractions, with intervals during which the attraction is destroyed; in other words, the attraction being destroyed, as relates to one bar of the wheel, that bar is liberated and allowed to go on, while the attraction is being exerted on the next bar.

Electro-Magnetic Machines.—The possibility of moving small pieces of mechanism by electro-magnetic action, to which allusion has just been made, has been known for a number of years; but as far as we have heard, the principle was not applied practically till 1837, when it was adapted by Professor Jacobi of St Petersburg, to the propulsion of a small vessel on the Neva. Under the auspices of an imperial commission, the first attempt was made on the 25th of September, 1838. A galley or boat, 28 feet in length and 7½ in breadth, was provided with paddles similar to those of a steam-vessel, and the apparatus was put on board. The action was produced from 320 pairs of plates, arranged along the sides of the boat, and room was left for twelve persons. Owing to imperfections in the arrangements, the attempt to propel the vessel with its burden of apparatus and passengers was less successful than was expected; nevertheless, the professor succeeded in making the boat proceed against the stream, and the speed attained in still water was three English miles per hour. In this and other efforts of Professor Jacobi, his plan consisted in rapidly reversing the poles during the action.

While Jacobi was busy with his experiments in Russia, mechanicians in England and America were pursuing a similar course of investigation. In March, 1837, Mr. Davenport exhibited at New York an electro-magnetic machine of considerable power; and more lately great advances in the art of electro-magnetic motion were made in Germany by Stoehrer of Leipsic, and others, on the principles of Jacobi; and in some instances with remarkable success. According to the accounts given of their experiments, it appears that the power of the electro-magnetic machines is increased in proportion to the squares of the number of the elements of the batteries. We regret to say that this, like all other enunciations on the subject, wants the confirmation of practical men; and up till the period we now write (December, 1841) no trustworthy account has reached us, as respects either the ratio of the magnetic power or the expense at which it can be obtained.

Machines constructed on the principle of alternate attraction and repulsion being liable to several objections, those in which a reiterated series of attractions are employed are more likely to answer the end of practical working. A machine of this kind was contrived by Mr. R. Davidson, of Aberdeen, in 1839, and brought into notice by the following letter from Professor Forbes, of King's College in that city, to Professor Faraday (Oct. 7, 1839), which was published in the *London and Edinburgh Philosophical Journal*:—"Having seen a notice from Mr. Jacobi sent by you to the *London and Edinburgh Philosophical Magazine* regarding the success of his experiments on the production of a moving power by electro-magnetism, I am sure it will give you pleasure to know that a countryman of our own, Mr. Robert Davidson, of this place, has been eminently successful in his labours in the same field of discovery. For, in the first place, he has an arrangement by which, with only two electro-magnets, and less than one square foot of zinc surface (the negative metal being copper), a lathe is driven with such velocity as to be capable of turning small articles. Secondly, he has another arrangement by which, with the same small extent of galvanic power, a small carriage is driven, on which two persons were carried along a very coarse wooden floor of a room. And he has a third arrangement, not yet completed, by which, from the imperfect experiments he has made, he expects to gain very considerable more force from the same extent of galvanic power than from either of the other two.

"The first two of these arrangements were seen in operation by Dr. Fleming, Professor of Natural Philosophy in this University, and myself, some days ago; and there remains no doubt on our minds, that Mr. Davidson's arrangements will, when finished, be found available as a highly useful, efficient, and exceedingly simple moving power. He has been busily employed for the last two years in his attempts to perfect his machines, during all which time I have been acquainted with his progress, and can bear testimony to the great ingenuity he has shown in overcoming the numberless difficulties he has had to encounter. So far as I know, he was the first who employed the electro-magnetic power in producing motion by simply suspending the magnetism without a change of the poles. This he accomplished about two years ago. About the same time, he also constructed galvanic batteries on Professor Daniell's plan, by substituting a particular sort of canvas instead of gut, which substitution answers perfectly, is very durable, and can be made of any form or size. And, lastly, he has ascertained the kind of iron, and the mode of working it into the best state for producing the strongest magnets with certainty.

"The first two machines, seen in operation by Dr. Fleming and myself, are exceedingly simple, without, indeed, the least complexity, and therefore easily manageable, and not liable to derangement. They also take up very little room. As yet, the extent of power of which they are capable has not been at all ascertained, as the size of battery employed is so trifling and the magnets so few; but from what can be judged by what is already done, it seems to be probable that a very great power, in no degree [illegible] inferior to that of steam, but much more manageable, much less expensive, and occupying greatly less space, if the coals be taken into account, may be obtained.

"In short, the inventions of Mr. Davidson seem to be [illegible]sting to railroad proprietors in particular, that it would be much for their interest to take up the subject and be at the expense of making the experiments necessary to bring this power into operation on the great scale, which, indeed, would be very trifling to a company, while it is very serious for an individual by no means rich, and who has already expended so much of his time and money for the mere desire of perfecting machines which he expected would be so beneficial to his country and to mankind. For it deserves to be mentioned, that he has made no secret of his operations, but has shown and explained all that he has done to every one who wished it. His motives have been quite disinterested, and I shall deem it a reproach to our country and countrymen if he be allowed to languish in obscurity, and not have an opportunity afforded him of perfecting his inventions and bringing them into operation, when they promise to be productive of such incalculable advantages."

The following notice of Mr. Davidson's operations afterwards appeared in the *Aberdeen Constitutional* newspaper, November 6, 1840:—

"Mr. Davidson's invaluable invention is now set down, by common consent, as the desideratum that has been wanting to perfect the power of locomotive agency. Several thousands have visited the exhibition, among whom was Professor Hamel, whose opinion was decidedly favourable to the principle. At a meeting of the British Association of Science, held at Glasgow the other week, Professor Jacobi read a paper on the power of electro-magnetism, which seemed to point to some great improvement in the science: but the principle on which Mr. Davidson's machine proceeds is altogether different from that on which Jacobi's experiments were made. Professor Jacobi produces motion by changing the poles of the magnets, Mr. Davidson by cutting off the galvanic current at given points—the power alternating, as the rotation proceeds, from a neutralized magnet to a newly charged one. In both experiments, it has been clearly demonstrated that the power of the magnet is increased by increasing the diameter, and adding to the length of the helix. The power may be also increased by increasing the sizes of the bars. On the principle of changing the poles of the magnet, the advantages of this increase of power could not be made so fully available as on the principle of neutralizing the magnets—there being in the one case a back action, which retards the momentum power, while in the other the rotation is constant, which tends to increase that power. According to the proportions assigned by Jacobi, an almost indefinite amount of power may be obtained by increasing the diameter of the rods, and the quantity of wire or helix; this, too, constitutes an index of that power so simple and practicable, that it may be regulated to a fraction."

In concluding the subject of Electricity, in the various methods in which it is artificially demonstrated, it is necessary to remind the reader that the science, in all its departments, is still in its infancy, and offers great scope for the enterprise of ingenious students.

[WORKS ON ELECTRICITY, GALVANISM, AND ELECTRO-MAGNETISM.

The following works on the subject of Electricity may be mentioned as deserving the reader's notice.

Dr. Priestley's "*Introduction to the Study of Electricity,*" is excellent for the uninitiated; but it is out of print, and the plates being lost, is not likely to be brought again before the public. As a substitute for this, the sixth volume of the "*Scientific Dialogues*" may be fitly used, in which are accumulated all the common and most interesting experiments; which, being repeated, with the directions given for their performance, the young electrician will afterwards find no difficulty in the pursuit of electrical knowledge in all its branches.

"*An Essay on Electricity,*" &c., by George Adams, with improvements by W. Jones, is a valuable compilation of all the material and experiments in this branch of science.

"*A Complete Treatise on Electricity, in Theory and Practice,*" in 3 vols., 8vo, by Tiberius Cavallo, is a very proper work for those who are desirous of an extensive knowledge in every department of electricity. The first volume treats of the laws and theory of electricity, and contains a full detail of the practical branches of the science. In the second, the author describes a number of new experiments, enters rather at large on the subject of medical electricity, which was in much more estimation twenty years ago than it is at present, and treats of the electrical properties of the torpedo, &c. In the third volume will be found, among other interesting subjects, a particular account of what was then deemed *animal electricity*, but now denominated galvanism.

"*The History and Present State of Electricity,*" by Joseph Priestley, LL.D., F.R.S., &c., will always be a stock book, valuable as a work of reference, and highly interesting to those who would wish to trace the progress of the science to that advanced period in which it was when the author wrote.

"*Principles of Electricity, containing divers new Theorems and Experiments,*" &c., by Charles Viscount Mahon. This work was published on the occasion of the dispute which, more than thirty years ago, engaged the attention of electricians, respecting the best mode of securing buildings from the effects of lightning.

"*Practical Electricity and Galvanism,*" by John Cuthbertson, Philosophical Instrument Maker, contains an extensive series of interesting experiments.

"*Elements of Electricity and Electro-Chemistry,*" by Geo. Singer; "*Miscellaneous Experiments and Remarks on Electricity,*" &c., with a description of an electrometer on a new construction, by A. Brook; and "*New Experiments in Electricity,*" wherein the causes of thunder and lightning are explained, &c., also a description of a doubler of electricity, and the most sensible electrometer, &c., by the Rev. A. Bennett, F.R.S., are excellent treatises, and may be consulted with pleasure and improvement by the student in electricity.

The most elegant and scientific, and at the same time elementary account of the phenomena of electricity, explained on the simple theory of Franklin, is that contained in the Supplement to the former edition of the *Encyclopædia Britannica*, under the head Electricity, which was drawn up by the late Professor Robinson.

GALVANISM.

Of the writers on this branch of science there is but little to be said: it is even yet too much in its infancy to have admitted of a regular elementary treatise; but independently of the third volume of Cavallo's Electricity, to which we have before referred, the student should be informed of the following works:

"*Experiments on Animal Electricity, with their Application to Physiology,*" &c., by Eusebius Valli, M.D.

"*Experiments and Observations Relative to the Influence lately discovered by M. Galvani, commonly called Animal Electricity,*" by R. Fowler.

"*An Account of the Late Improvements in Galvanism, with a set of Curious Experiments,*" &c., by John Aldini. These tracts contain many judicious, well conducted, and highly interesting experiments; but they relate wholly to Galvanism, and were all written prior to the discoveries since made by means of Volta's batteries. *Am Ed.*]

METEOROLOGY—THE WEATHER.

Meteorology is the science of the Weather, and treats of the phenomena which occur in the atmosphere, their causes and effects. Men in all ages of society have been led, by motives of necessity or comfort, to study the indications of the weather in the different appearances of the skies. The mariner, the shepherd, the husbandman, and the hunter, have the strongest motives to examine closely every varying appearance which may precede more important changes. The result of these observations forms a body of maxims, in which facts are often stated correctly, but mixed with erroneous deductions and superstitious notions, such as the credulity of ignorant people always renders them ready to adopt. Hence the disposition to refer the ordinary changes of the weather to the influence of the moon, and even the stars; and to look for signs of approaching convulsions, even in the moral world, in horrid comets and strange meteors. The progress of science, which tends to separate the casual precursors from the real causes of phenomena, refutes these false reasonings, dissipates the empty terrors to which they give rise, and aims, by more patient, long-continued, and wide-extended observations, to deduce the general rules by which the phenomena of the atmosphere appear to be regulated.*

Meteorology, therefore, taken as a distinct branch of knowledge, rests on no idle conjectures or imaginary fears, but has its foundations in the ascertained truths of physical science. The phenomena to which it refers are accounted for by natural laws disclosed to us in the study of chemistry, electricity, the atmospheric properties, optics, acoustics, heat, and other departments of physics. Of all branches of learning, none, perhaps, is more serviceable in clearing the mind from superstition than that now before us; and, on that account alone, independently of all other considerations, we are anxious that it should be extensively understood among the classes whom we have the pleasure to address. That nothing may be left to doubt, we commence by a recapitulation of the leading facts connected with the atmosphere, from preceding treatises, along with some new matter of information.

THE ATMOSPHERE.

The atmosphere is an invisible aëriform fluid, which wraps the whole earth round to an elevation of about forty-five miles above the highest mountains. This great ocean of air, as we may call it, is far from being of a uniform density throughout its mass. At and near the level of the sea it is most dense, in consequence of the pressure above. As we ascend mountains, or in any other way penetrate upwards, the air becomes gradually less dense; and so thin is it at the height of three miles, as, for instance, on the summit of Mont-Blanc, one of the Alps, that breathing is there performed with some difficulty. Beyond this limited height, the density of the air continues to diminish; and at the elevation of about forty-five miles it is believed to terminate. So dense are the lower in proportion to the higher regions, that one-half of the entire body of air is below a height of three miles, the other half being expanded into a volume of upwards of forty miles.

The extreme height of the atmosphere is not observable from the situation in which we are placed on the earth. Our eye, on being cast upwards, perceives only a vast expanded vault, tinted with a deep but delicate blue colour; and this in common language is called the heavens or the sky. The blueness so apparent to our sense of sight is the action of the rays of light upon the thin fluid of the upper atmosphere, and the brightness is in proportion to the absence of clouds and other watery vapours. In proportion as the spectator rises from the surface of the earth, and has less air above him, and that very rare, the blue tint gradually disappears; and if he could attain a height at which there is no air, say fifty miles above the level of the sea, the sky would appear dark or black. Travellers who have ascended to great heights on lofty mountains, describe the appearance of the sky from these elevated stations as dark or of a blackish hue.

The atmosphere exerts a certain pressure on all objects, the degree of pressure being of course in proportion to the height of the atmosphere at the spot. The part at which the pressure is greatest is at the level of the sea, for there the atmosphere is highest. The pressure at the level is ordinarily computed to be about fifteen pounds on every square inch. At every step upward from the level of the ocean, the burden of the superincumbent mass lightens, and at the height of three miles, one-half of the weight is lost.

The Barometer.—The pressure of fifteen pounds to the square inch at the level of the sea, is found by experiment to be equal to the weight of a column of mercury of thirty inches in height; and the fact of such being the case has suggested the construction of an instrument to measure the atmospheric pressure at different points and in various circumstances. This instrument is called the *barometer*, a compound from two Greek words, signifying weight and measure.

The barometer in common use consists of a narrow glass tube upwards of thirty inches in length, and bent upwards at its lower extremity, as represented in fig. 1. The mercury is introduced into the tube with great care, so that a perfect vacuum exists at the upper extremity. The surface of the mercury in the bent part is open to the action of the atmosphere, and buoys up a small plummet or float F, to which a thread is attached; the thread proceeds upwards to a small pulley G, over which it goes, and terminates in a small ball W. The friction of the thread on the pulley turns a small index H, which points to figures on the surrounding dial. Commonly, the whole apparatus, except the dial-plate, is concealed in an ornamental frame. Barometers of this description are adjusted in such a manner that the smallest rising or falling of the mercury from atmospheric action, affects the index on the dial, and consequently shows the degree of pressure.

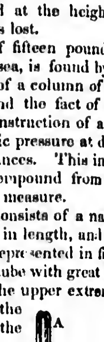


Fig. 1.

In common circumstances, the mercury ranges from twenty-nine to thirty inches. It seldom sinks so low as twenty-eight or rises to thirty-one. When it falls, an indication is given of diminished pressure; and as diminished pressure causes the air to expand, and consequently to be sensibly

* Conversations Lexicon.

cooled, moisture is liable to be precipitated in the form of rain. Hence a fall in the mercury of the barometer is considered a prognostic of rain or wet weather, and a rise the reverse. The dial of the barometer is marked accordingly.

The common rules, however, as to prognosticating the state of the weather from the action of the barometer, are in many cases very illusory, because much depends on the situation in which the barometer is placed. If situated near the sea's level, the pressure on the mercury will appear greater than if on a high ground, and, consequently, no general scale can apply to conditions so very dissimilar. In alluding to the vulgar errors entertained on this subject, Dr. Lardner remarks—"It is observed that changes of weather are indicated, not by the actual height of the mercury, but by its change of height. One of the most general, though not absolutely invariable rules is, that where the mercury is very low, and therefore the atmosphere very light, high winds and storms may be expected. The following rules may generally be relied upon, at least to a certain extent:—1. Generally the rising of the mercury indicates the approach of fair weather; the falling of it shows the approach of foul weather. 2. In sultry weather the fall of the mercury indicates coming thunder; in winter the rise of the mercury indicates frost; in frost its fall indicates thaw, and its rise indicates snow. 3. Whatever change of weather suddenly follows, a change in the barometer may be expected to last but a short time. Thus, if fair weather follow immediately the rise of the mercury, there will be very little of it; and in the same way, if foul weather follow the fall of the mercury, it will last but a short time. 4. If fair weather continue for several days, during which the mercury constantly falls, a long continuance of foul weather will probably ensue; and again, if foul weather last for several days, while the mercury continually rises, a long succession of fair weather will probably succeed. 5. A fluctuating and unsettled state of the mercurial column indicates changeable weather. The domestic barometer would become a much more useful instrument, if, instead of the words usually engraved on the plate, a short list of the best established rules, such as the above, accompanied it, which might be either engraved on the plate or printed on a card. It would be right (concludes this writer) to express the rules only with that degree of probability which observation of past phenomena has justified. There is no rule respecting these effects which will hold good."

The Thermometer.—The atmosphere possesses the capacity of receiving and containing heat from the sun's rays or any other source of warmth, but this capacity is proportionate to the degree of density of the air, and accordingly varies in different situations. It is well known that the air is more warm on low than on high grounds, and this is a peculiarity in its condition arising from the difference of density at the two places. If we take a pound weight of air near the sea's level, and another pound weight at a spot a mile above the sea, we shall find that each pound contains precisely the same quantity of heat; but in the case of that taken near the sea, the air will feel warm, and in the case of the other, the air will feel cool. This seems a contradiction, yet it is a truth. A pound weight of air taken near the sea, is compact in substance, and goes into a comparatively small bulk; but that taken from a high part of the atmosphere is thin, and occupies a much larger space. This explains why the thin air on high grounds is seemingly colder than on low situations. Aloft, the air is as warm as it is below, but there is less of it; the particles are more widely asunder, and this produces the effect of a greater coldness. Properly speaking, the cold in high situations arises from the want of air, rather than from the air itself.

In the warmest regions of the globe, the air is cold at the tops of high mountains, merely because the air is there thin, and incapable of forming a medium for the retention of the sun's rays. In every country there is a point of altitude at which water freezes on all occasions, whether summer or winter. In Europe, this point—called by some the snow line, or point of eternal snow—is from five to six thousand feet above the level of the sea; in the hot regions of Africa and America, it is fourteen thousand feet high. At these points of altitude respectively, snow lies constantly unmelted on the mountain sides and summits. In the warm regions of Hindostan, the atmosphere is as cool and pleasant at a certain height on the Himalaya mountains as it is in the northern part of Europe. The plains of Mexico, under a burning sun, would not be endurable by man, if they were not at such an elevation as to possess an atmosphere so thin as to be incapable of being heated to excess.

Although the heat of the atmosphere thus depends on the density of the fluid, it is proper to state that it is likewise influenced by other circumstances. Certain bodies have the power of heating the atmosphere in a greater degree than would otherwise be the case. For example, in valleys the heat is thrown off from the sides of adjacent hills, from forests of trees, or other objects; and in these situations the air is hotter than if there were no such radiation. If the spot be sheltered from the cooling effect of winds, there is another cause of increase to the temperature.

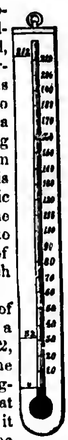


Fig. 2

The degrees of heat and cold in the atmosphere are called its temperature; and for finding this correctly, with reference to a standard, an instrument has been invented, called the *thermometer*, a word signifying heat-measurer. It is a glass tube with a bulb at the bottom, into which mercury or quicksilver is put, with a scale of figures along the tube to mark the rising of the quicksilver. This instrument differs from the barometer, inasmuch as the quicksilver is sealed up close from the air. The atmospheric heat, however, affects the metallic fluid in the bulb, and, according to its warmth, causes it to expand and rise in the tube. The degree of temperature is indicated by the figures to which it ascends.

Our common thermometer (Fahrenheit), of which a representation is given in fig. 2, has a graduation from No. 1, near the bulb, to 212, the degree of heat of boiling water. In the scale of figures, 32 is marked as the freezing-point—that is to say, when the mercury is at the height of 32, *water* freezes; and the more it is below that point, the more intense is the frost: 55 is reckoned moderate heat, and 76 summer heat, in Great Britain: 98 is the heat of the blood in the average of living men.

Different nations adopt different graduations in the scale of thermometers, which is a fertile source of error and confusion in estimating and comparing the statements of temperature made by scientific men in different countries. Wherever the English language prevails, the graduation of a person called Fahrenheit is generally preferred. By the Germans, Reaumur's is used; and the French now adopt what they term a centigrade thermometer. In the French centigrade thermometer, 0 is the freezing-point, and 100 the boiling-point; in Reaumur's thermometer, 0 is the freezing-point, and 80 the boiling-point. Each degree of Reaumur is equal to two and one-fourth of Fahrenheit. It was at one time imagined that the greatest cold could make the fluid in the thermometer fall only 32 degrees below the freezing-point, the place to which it then fell being zero, and therefore the notation has been commenced by Fahren heit at that place. But much greater degrees of cold exist at different parts of our globe in winter, and may be produced artificially, so that the fluid in the stem of the thermometer often descends below that point, and is then said to be at so many degrees below zero.

Water, as above mentioned, boils at 212 degrees, but this is only under the common pressure of the atmosphere near the sea's level. By removing a portion of the pressure either by an air-pump or by ascending a height, the vaporic or boiling point will be reached correspondingly sooner. On this account we might ascertain with tolerable accuracy the height of mountains, by noticing at what degree of heat by the thermometer water boiled. A writer in the *Encyclopædia Britannica*, has given the following instructions on this subject:—

"Boil pure water in an open vessel at the bottom of the elevation, and observe on the thermometer the point at which it boils. Boil it again at the top of the mountain, and observe with the thermometer the point at which it now boils; the difference of temperature, multiplied by 530 feet, will give a close approximation to the height of the upper above the lower station. This will give an approximation; but if greater accufacy be required, it will further be necessary to correct for the difference of the temperature of the air at the two stations, in the following manner:—Add the temperatures of the air at the stations, and subtract sixty-four from their sum; multiply the remainder by one-thousandth part of the height found, and this will be the correction to be added to the height formerly found. The result thus found will still require a slight correction for the figure of the earth and latitude of the place; but this does not amount to more in our latitude than an addition of about two feet in a thousand, which forms a second correction.

"To illustrate the mode of deducing heights from the boiling-point, as we have given it, we take the following example:—Water boils on the top of Ben Nevia at 203·8 degrees, while at the side of the Caledonian Canal it boils at 212 degrees, the temperature being 30 degrees on the summit of the mountain, and 35 degrees below.

In order to determine the height,

	From	212°
	Take	203·8°
There remains,		8·2°
Multiply by		530
		246·0
		410
		4346 first approx.
		4 first correct.
		4350 second approx.
		8·7 second correct.

To	30°
Add	35°
Sum	65°
Subt.	64°
Remain 1° mult. by 4·346.	
Latitude 56° nearly	
Mult.	4·350
by	2
	8·700

Calc. height, 4358·7 third approximation.
4358, true measured height—the difference being less than 1 foot.

"This method, however, is seldom susceptible of so high a degree of accuracy, even with the most carefully conducted experiments."

The Hygrometer.—One of the principal meteorological phenomena of the atmosphere is its capacity for receiving and holding moisture. Evaporation, to a lesser or greater extent, is in constant exercise over the whole earth. The ocean, lakes, rivers, fields, are ever yielding up water to the atmosphere, and plants and animals are also at all times giving forth exhalations. The atmosphere is thus a great receptacle for the moisture of the earth, and its capacity in this respect is increased by an increase of temperature. In a hot day, much more evaporation is produced than in one which is cold, but it is not on that account more perceptible by the senses. The more warm and free the air, so is the moisture less observable in its mass; and it is only when the atmosphere sinks to a certain pitch of cold, that we begin to see the suspended moisture in the form of mists and clouds. Thus, in a hot day, we do not see the breath issuing from our mouth, it being conducted away in an ethereal state, but in a cold damp day in winter, we see it proceeding in puffs at every expiration.

The state of the atmosphere as respects its moistness, is called its *hygrometric condition*, from the hygrometer, an instrument for measuring the degree of dryness or moistness of the air. There are various kinds of hygrometers, depending on the principle of the shrinking and expanding of bodies in relation to the degree of humidity with which they are affected. Fibrous vegetable substances, such as ropes, contract by imbibing moisture, while, on the contrary, hairs and catgut (strings of violins), contract by drought. Hair has been found to be the most delicate in hygrometrical motions. The celebrated Saussure, a French philosopher, accomplished the construction of a hygrometer from a single long hair, previously cleaned in a soda ley. Various philosophical toys, as ornaments for mantelpieces, have also been constructed to indicate the dryness or moistness of the atmosphere, all on the similar principle of contraction and expansion of a hair, piece of catgut, or part of the beard of the wild-oat. One of the most useful instruments of this class is a small object resembling a watch in external appearance, designed to prove the dampness or dryness of beds: a movable hand on the dial-plate points out very speedily the hygrometrical condition of the bed-clothes on which the instrument is laid.

Hygrometers of the kind just mentioned, however ingenious, fail as instruments of science or comparison, chiefly from the circumstance of their liability to lose their contractile and expansive energy, as well as the difficulty of making many of them possessing similar powers. To supply the required instrument of comparison, Professor Daniel contrived a very elegant hygrometer, which is now universally in use. It consists of a glass tube, bent nearly in the form of ∩, supported on a stand, with a ball at each extremity, and containing only some ether. Within one of the depending limbs a thermometer is placed. The instrument operates on a little ether being dropped on one of the balls; evaporation immediately takes place, heat is abstracted, and the ball containing the thermometer is so cooled, that a dew perceptibly gathers on its surface. The degree of temperature at which the dew is seen to collect, marks the exact hygrometric condition of the atmosphere. The principle is precisely that on which a bottle of cold liquor, on being brought into a warm apartment, collects dew on its surface. If no dew appears on a bottle in such circumstances, the atmosphere of the room is certainly very dry.

CLOUDS.

The capacity of the atmosphere for moisture, even in the most favourable circumstances, is limited. The air cannot be loaded with water, in any form, beyond a certain point. Meteorologists mention, that if saturated with vapour even to its utmost extent, the whole would not form more than from six to seven inches of rain; in other words, not more than six or seven inches of water can be maintained in solution throughout the forty-five miles of atmosphere above, at any one time. The capacity for retaining moisture is greatest in the lower strata of the atmosphere, or where it is most dense and warm. At great elevations, such as eight or ten miles, the air is too thin to hold water in solution; and in all ordinary circumstances, the vapours of the earth do not ascend above four or five miles from its surface at the sea's level. Above these heights, whatever be the state of the weather beneath, all is clear and comparatively dry. In very many cases, clouds do not reach the mo derate height of three miles; and the field of their evolutions in temperate climes is more frequently not above a mile or a mile and a half high.

Clouds, it will be perceived, are in reality dependent on temperature, and temperature is often dependent on winds. In a warm and dry summer day, evaporation proceeds with great activity, and, in a manner invisible to the eye, the moisture rises to the higher regions of the air. If the sun be powerful, the moisture may thus ascend several miles, and be dispersed like a gas, leaving no cloud to indicate its existence. All, therefore, appears clear, serene and beautiful. Currents of cold air may now be supposed to intrude themselves on the scene—the gas-like vapour is condensed—and clouds consequently make their appearance. A similar occurrence will take place by the weakening of the sun's rays, and withdrawal of heat at the approach of night, when clouds, as is well known, are always most numerous.

Clouds are commonly formed by the ascending of the invisible vapour into the cold regions of the air, where they take shapes conformable to the degree of temperature and action of varying currents. These currents and other circumstances affecting them are so constantly changing, that seldom for a single minute do they remain of one form, but shift into all sorts of postures, rise, fleet away to a distance, congregate, sink, disperse, and vanish. While the aggregation of clouds is caused by their coming in contact with cold currents of air, their evanishing is attributable to their being acted on by the currents or strata of air warmer than those in which they have previously been sustained. The dispersal and the evanishment of clouds may occasionally be seen to advantage in the neighbourhood of ranges of hills terminating abruptly. The clouds resting on the hill-tops are seen to begin to move towards the precipitous declivity, in consequence of the springing up of a breeze in that direction; and when they arrive at the precipice, they seem to tumble over and vanish in the fall. Dr. Arnott speaks of the beauty of this phenomenon at Table Mountain, at the Cape of Good Hope; and we have observed it occurring at the termination of the range of Pentland Hills near Edinburgh. The explanation of the phenomenon is simple: the cloud, on rolling from the summit of the hill, falls into an atmosphere of a higher temperature, and its particles being diminished into the gaseous form, disappear. When, on the contrary, a cloud is seen to ascend a hill, it enters a region of cold, and being condensed, it is precipitated as a shower of rain. From these oft-observed facts, the old saying has been derived—

> "When the clouds go up the hill,
> They'll send down water to turn a mill."

Luke Howard, in his Essay on clouds, distributes them into four essentially different formations. These formations are—1. *Cirrus*, consisting of thready fibres diverging in all directions, or curled up at one end; 2. *Cumulus*, or roundish bank of cloud, increasing from a horizontal base upwards: 3. *Stratus*, layers vastly extended, connected, and horizontal: 4. *Nimbus*, the heavy black cloud dissolving in rain. There are subdivisions in this classification, as *cirro-cumulus*, *cirro-stratus*, &c.

By the same meteorologist, the clouds are generally assigned to three atmospherical regions—the upper, the middle, and the lower one, to which a fourth, the lowest, may be added. In the upper region, the atmosphere is in such a state, that it can receive and sustain only light and thin vapours; and to this district belongs the *cirrus*, a representation of which is given in fig. 3. Of all the various forms of cloud it has the least density, but the greatest height and variety of shape and direction. It is the first indication of serene and settled weather, and first shows itself in a few fibres, spreading through the

Fig. 3.—The Cirrus.

atmosphere. These fibres by degrees increase in length, and new fibres attach themselves to the sides. The duration of the cirrus is uncertain—from a few minutes to several hours. It lasts longer, if it appears alone and at a great height; a shorter time, if it forms in the neighbourhood of other clouds. From its usually curling appearance, the cirrus is called in England the *mare's tail* cloud.

The *cumulus* is a cloud of a much more massive character. It is vapour in the most compact form, and usually moves with the stream of air nearest to the earth. This region can receive much humidity, but not in perfect solution. The humidity becomes collected, and shows itself in masses rising conically and resting on a region of air capable of giving it support. The annexed engraving, fig. 4, represents the more usual forms of cu-

Fig. 4.—Various forms of Cumulus.

mulus, whether in separate or congregated masses. The appearance, increase, and evanishing of cumulus, in fine weather, are often periodical, and correspondent to the degree of heat. Generally, it forms a few hours after sunrise, attains its highest degree in the hottest hours of the afternoon, and decreases and vanishes at sunset. Great masses of cumulus, during high winds, in the quarter of the heavens towards which the wind blows, indicate approaching calm and rain. If the cumulus does not disappear, but rises, a thunder-storm is to be expected during the night. If the upper region, with its drying power, predominates, the upper parts of the cumulus become cirrus. But if the lower region predominates (into which the densest vapours are attracted and dissolved into drops), the basis of the cumulus sinks, and the cloud becomes stratus, which is of moderate density, and its lower surface rests generally upon the earth or the water.

The *cirro-cumulus*, of which a representation is given in fig. 5, consists of a collection of small white clouds,

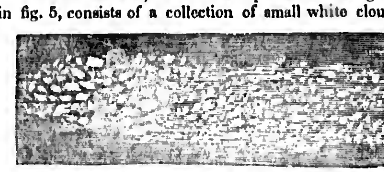


Fig. 5.—Cirro-Cumulus.

of a roundish form, which give to the sky the appearance called dappled, and are in summer considered a prognostic of settled weather, or at least of an increase of temperature. Occasionally the cirro-cumulus may be observed to change into another variety of clouds—the cirro-stratus.

The *cirro-stratus*, which we represent in its common forms in fig. 6, exists in a high region of the air, and is often the cirrus in an altered shape. It is generally in the form of long horizontal streaks, which are ever shifting their figure and position. Sometimes it is a long row of

Fig. 6.—Various forms of Cirro-stratus.

slanting streaks, and at other times an apparently drawn out and translucent cumulus. In the latter form, when shone upon, at the close of day, it is not unlike a long feathery streak of fire.

The *stratus* is the proper evening cloud, and is in reality the vapour which creeps along the ground or mounts into the lowest region of the air at sunset, after a fine summer day. All mists and fogs are of this species of cloud, which in its lightest state does not wet leaves or any objects with which it comes in contact. In calm evenings, the stratus may be seen ascending from the valleys to the higher grounds, and there, as shown in fig.

Fig. 7.—The Stratus.

7, it extends itself in masses like a fleecy mantle. It generally arrives at its point of greatest density about midnight, or between that time and daylight, and disappears at sunrise by the gradual elevation of temperature in the atmosphere. Sometimes it remains quiet and accumulates in layers, till the atmosphere is incapable of sustaining its weight, when it assumes the condition of the heavy and dark *nimbus*, and falls in a shower of rain. We have placed a representation of the nimbus, yielding its tribute of rain, as a frontispiece to the present article.

The various circumstances which concur to precipitate moisture in the atmosphere into the visible form of clouds, are summed up as follows by an intelligent meteorologist, Mr. Graham Hutchinson, in his Treatise on Meteorological Phenomena (Glasgow, 1835):—1. "When a diminution of the atmospheric temperature, unaccompanied by atmospheric rarefaction or transportation, takes place. 2. When a diminution of the atmospheric temperature, arising from atmospheric rarefaction, takes place. 3. When a diminution of the atmospheric temperature, arising from the transportation of air from a warm to a cold climate by the agency of winds, takes place. 4. When an intermixture, and consequent reduction to a mean temperature, of different portions of air, of previously different temperatures, takes place. If any one, or any combination of these circumstances happens to occur, when the atmosphere is previously saturated with humidity; or supposing the atmosphere previously somewhat under-saturated, if they take place to such an extent as to produce over-saturation, a precipitation of moisture, into the visible form of cloud or mist, is the necessary consequence."

Clouds of the cumulus form are frequently seen to rest or hover over the tops of mountains, and it has therefore been supposed that hills attract clouds. Undoubtedly, from electric causes, clouds are occasionally attracted by mountain-tops, where they discharge their contents in a thunder-storm; but, in common circumstances, attraction not the cause of cumulus on hills. The ordinary cause is a low temperature of the atmosphere at these altitudes—a temperature lower than that of the region of air at the same height away from the hills. The mode of cloud-formation on mountain ranges seems to be this: the warmer air of the valleys or of the sea, loaded with invisible particles of moisture, is blown in the direction of the hills, and being compelled to ascend, the particles become visible when they attain the summit. But the wind does not rest there: the particles are blown away beyond, and perhaps vanish in a warmer region of air but new particles are constantly coming up to supply their place; and thus a shifting appearance is given to the masses of clouds which we observe hovering on the tops of the hills. "Mountains of themselves," observes Mr. Hutchinson, "that is to say, without wind, can form no clouds; and winds of themselves, that is to say, without the aid of atmospheric rarefaction which accompanies their exaltation while passing over mountains, are, in this respect, equally inefficient. In short, mountains in all climates may be regarded as passive instruments in the formation of clouds only during windy weather. And whenever their height is such that the temperature of the lower atmospheric strata, while surmounting them, becomes so much reduced as to cause over-saturation, the formation of clouds must take place. Hence, the higher the mountains, the more certain they are, during windy weather, to cause the formation of clouds; and the nearer the hygrometric condition of the aërial strata, before beginning to ascend the mountain, is to the point of saturation, the less height will suffice for that purpose. Accidental coldness on the tops of mountains, beyond what results from their height, sometimes adds to their efficacy in causing the formation of clouds. Such may be occasioned by snow-falls during the cold season remaining unmelted, or only partially melted (as frequently happens on the northern exposure of mountains in the northern hemisphere), till long after the returning heat of spring and summer has rendered the falling of snow, at corresponding altitudes, extremely improbable."

Haze—Mist—Fog.—Mists or fogs, as has been noticed above, are a variety of clouds, and are scientifically described by the term *stratus*. A haze is that species of vapour in which the watery particles are only partially or imperfectly condensed, so as to produce an indefinite obscuration, which generally may be observed in the evening, when the temperature of the air becomes diminished by the decline of the sun towards the horizon. When viewed from a distance, the surface of the earth always appears enveloped in a haze of greater or lesser density; and although, when sailing on an open expanse of ocean, the atmosphere may appear very clear, yet, on being viewed from a high mountain, the water will appear obscured by a haze, which will be found to extend many feet above its surface. When the watery vapour in the surrounding air becomes more condensed, with a defined outline in the form of a cloud, either resting on the surface of the earth or a few feet above it, then it is termed a mist; and when the whole atmosphere around appears equally obscured, then we give it the name of a fog, which, however, is not to be confounded with that moist and obscured state of the air which often accompanies our easterly and westerly winds.

Mists, as well as fogs, consist of thin vesicles of water containing air. How these vesicles are formed, is not well understood; but the general opinion is, that mists and fogs arise from air of unequal temperatures, holding moisture in solution, mingling together. Accordingly, the mixture of the evening sea-breeze with the air above the land, often produces dense mists; for the air above the sea is warmer than that above the land, and when they intermix, a condensation of aqueous vapour into mist or fog takes place. Besides this, the contraction of the air, from its becoming colder after sunset, often produces a condensation of the watery particles floating in it. In addition to which, there can be no doubt that a certain quantity of vapour rises up, or evaporates, from the earth itself, which we may suppose to have been within a short period moistened by rain, and this, having become elevated to some distance above the ground, in like manner becomes condensed. During the night, therefore, the air above the surface of the earth is thus generally rendered hazy, and light mist are observed hanging in gauzy folds along the sides and around the summits of hills and mountains; hence Lord Byron, in noticing the approach of morning, gives us this beautiful passage:—

> "Night wanes; the vapours round the mountains curl'd
> Melt into morn, and light awakes the world."

Fogs are often, especially in large towns, remarkably dense; indeed, so much so as to occasion serious accidents from their interference with distinct vision. This frequently happens in London, and in other large cities, and arises from smoke, vapours, dust, &c., being stagnated in the thick fog. On certain calm winter days it may be observed, that the smoke, on leaving the chimneys, descends towards the ground, and downward currents often set through flues at the bottom of which there is no fire. Fogs seldom rise high in the atmosphere; hence Dr. Darwin, in giving an account of one which overspread a tract of ground through which he had occasion to ride, states, that on every rising of the ground he was quite above its level, though in descending again it was so thick that he could scarcely see a yard beyond his horse's head. In the northern regions, fogs are extremely dense, owing, doubtless, to the difference between the temperature of the air which sweeps over the immense tracts of ice extending through those desolate regions, and that of the air which passes over the warmer surface of the ocean. It is one of the greatest annoyances which the whalers and navigators in those dangerous seas have to encounter.

Colour of the Clouds, &c.—Clouds being composed of pure watery particles, cannot intrinsically possess the colour of any foreign body; nevertheless, by the peculiar action of the rays of light on different parts of their mass, they frequently assume a variety of tints, particularly red and orange, at and shortly after sunset. The sun and moon likewise, when shining through a dense vapoury medium, assume a deep red tinge. Superstition would ascribe these phenomena to supernatural causes; but, in truth, all is but a simple effect of the refrangibility of the rays of light. The white rays are decomposed in shining through the globules of vapour, and they shine as if coming from a prismatic spectrum. In our article OPTICS, as has been explained, each of the seven rays of which the white light is composed, has a different degree of refrangibility, and it is on this account that a variety of colours exist in nature. "Had it been otherwise—had the objects of the material world," says Sir David Brewster, "been illuminated with white light, all the particles of which possessed the same degree of refrangibility, and were equally acted upon by the bodies on which they fall, all nature would have shone with a leaden hue, and all the combinations of external objects, and all the features of the human countenance, would have exhibited no other variety than that which they possess in a pencil-sketch or china-ink drawing. But he who has exhibited such matchless skill in the organization of material bodies, and such exquisite taste in the forms upon which they are modelled, has superadded that ethereal beauty which enhances their more permanent qualities, and presented them to us in the ever-varying colours of the spectrum."*

In cold climates the sky has generally a dull blue or gray tinge, even in fine weather, a circumstance arising from the prevalence of moisture in the air, which forms a kind of gauze, through which our eye is unable to penetrate. In more warm and genial climes, such as that of Italy, the colour of the sky is a bright blue, and in hot weather slightly purplish. This brilliance arises from the comparative absence of vapoury particles; yet that vapour does exist in the clearest azure sky is indisputable, for it is by refraction of light that the colour appears. If moisture were entirely absent, there would be no refrangibility, and consequently no blue colour. The sky, as formerly mentioned, would be black. The reason assigned for the prevalence of a blue colour in the sky is, that the blue rays are reflected more copiously than any of the others.

DEW.

Dew is a result of an alteration of temperature after sunset. No sooner does the sun begin to decline towards the horizon, than its rays fall more slantingly on the earth, whereby their intensity is diminished, and a change of temperature immediately ensues; for the air soon feels chilly and damp, and the grass beneath our footsteps becomes moistened with a genial and refreshing dew.

It has been elsewhere explained, that all bodies receive a certain quantity of heat, which in particular circumstances they again emit; in doing which they necessarily become colder than they previously were, unless they receive in exchange another quantity of heat sufficient to compensate for the loss they have sustained. In this case, their temperature will remain stationary; but if they part with more than returns to them, their temperature necessarily must fall. When, then, the object so cooled is encompassed by a warm and moist medium, it condenses, by its cold contact, vapour on its surface, and thereby becomes moistened. Hence the origin of dew; for no sooner does the sun sink towards the horizon, than the blades of grass which clothe the surface of the earth give out the heat which they have been receiving during the day; the consequence of which is, that their temperature falls so much below that of the surrounding air, that they condense on their surfaces part of the moisture which immediately surrounds them. The temperature of the body, as indicated by the thermometer, at which this deposition takes place, is called the "dew point," which, for the formation of dew, must always be below the temperature of the surrounding atmosphere; indeed, the quantity of dew formed will always be in proportion to the [illegible] of the grass and to the quantity of moisture sus[illegible] the air. Besides this, after the sun has set, th[illegible] which the earth has imbibed during the day, [illegible] still rests below the grassy surface, rises up or [illegible] —in doing which, it rises up through [illegible] blades of grass, the cold contact of wh[illegible] denses it. Dew, therefore, on calm [illegible] more abundant shortly after rain than durin[illegible] son of dry weather. During westerly or south[illegible] which are generally impregnated with moisture, it [illegible] formed more copiously than during easterly and northerly winds. Besides the quantity of moisture existing in the air, the greater or lesser copiousness of the dew formed, depends, as we have premised, on the coldness of the objects on which it is about to be condensed. If the night be calm and clear, the grassy blades emit their heat freely, and it is dispersed through the atmosphere without any equivalent return, whereby the temperature of the grass soon sinks sufficiently low to condense the surrounding vapour; but if, instead of this, the night be cloudy, then the clouds reflect, like mirrors, the rays of heat back again to the grassy blades, and prevent this diminution, so that less dew is then deposited. If, in addition to the sky being overcast with clouds, the weather be windy, no dew will be formed; for the temperature of the grass is then prevented sinking by the

* Life of Sir Isaac Newton, p. 78

agitation of the air, by which a warmer current is continually brought to succeed the colder current by which it is surrounded. Hence, if, during the night, the weather, from having been calm and serene, become windy and cloudy, not only will dew cease to form, but that which has been already deposited will disappear, or diminish considerably. Every kind of covering or shelter which extends above any object, will interrupt the radiation or escape of its heat; for which reason gardeners, to prevent plants being chilled, cover them over, on the approach of evening, with a layer of straw or matting.

For reasons similar to those now advanced, the grass which is situated beneath the boughs of large and spreading trees, becomes only sparingly moistened with dew; for the shelter above interrupts the progress of radiation from the substances underneath, and so preserves their temperature. Accordingly, it is an established axiom, that whatever diminishes the view of the sky, as seen from the exposed body, will occasion the quantity of dew to be less than would have been deposited if the exposure to the sky had been complete. Dew is formed, therefore, more sparingly and irregularly in cities than in the country, where the most open grassy plains are always the most abundantly bedewed. In England it begins to appear in shady places as soon as the heat of the atmosphere has declined; but though the grass on clear still evenings often becomes moist several hours before sunset, dew is seldom present in such quantities as to exhibit visible drops until the sun reaches the horizon; nor does it become copious until some time after sunset. It continues to form also in shaded places some time after sunrise; and it is remarkable, that more dew forms a little before, and in shaded places a little after sunrise, than at any other period. It has also been observed, that more dew is formed between midnight and sunrise than between sunset and midnight—a circumstance which is owing to the cold of the atmosphere being greater in the latter than in the former part of the night. As the quantity of dew deposited thus depends so much on the degree of coldness which the body about to be bedewed attains, its quantity must be materially modified by the greater or the lesser facility with which substances part with their heat. Grass, being a filamentous substance, parts more readily with its heat than garden mould or gravel; wherefore dew is more plentifully deposited on meadow grounds than on ploughed lands. Thus, cultivated soils are refreshed with abundance of dew, while barren rocks and sandy deserts do not receive this congenial moisture. Indeed, every shrub and herb, every leaf and blade of grass, possesses, according to its kind, a different power of radiation, so that each condenses as much dew as is necessary for its own individual and peculiar exigencies. Thus, not even a single dew-drop seems to have been formed by the rude hand of chance, but is adjusted by the balance of infinite wisdom to accomplish a definite and benevolent end.

THE WINDS.

A change in the temperature, a diminution of the vapour, or any other cause that may occasion a portion of the surrounding atmosphere to contract or expand, will give rise to the aërial currents denominated winds, which, indeed, bear a strong analogy to the currents which occur in the ocean. When the air by which we are surrounded becomes heated, it expands, and becomes specifically lighter, in consequence of which it mounts upwards; and the colder and denser air which surrounds the mass thus rarefied, rushes in to supply its place. When the door of a heated apartment is thrown open, a current of air is thereby immediately produced; the warm air from the apartment passing out, and the cold air from the passage rushing in. So, also, in those buildings where the manufacture of glass is carried on, the heat of the furnace in the centre being intense, a violent current of air may be observed to force its way in through the doors or crevices on the opposite sides of the house. On applying these principles to account for the origin of the wind, we find that, when the rays from the sun, by their reflection from the earth's surface, have heated or rarefied a portion of the surrounding air, the air so rarefied ascends into the higher regions of the atmosphere and the colder air by which it was surrounded moves forward in a sensible current to fill the vacuity. When, also, a condensation of vapour in the atmosphere suddenly takes place, giving rise to clouds which speedily dissolve in rain, the temperature of the surrounding air is sensibly altered, and the colder rushing in upon the warmer, gives rise to a sudden gust of wind. For this reason, a cold heavy shower passing overhead, with a hasty fall of snow or hail, is often attended with a violent and sudden gust of wind, such as sailors call "a squall," which ceases when the cloud disappears, but is renewed when another cloud, sweeping along in the same direction, brings with it a fresh blast.

The general nature of the winds in this and in other countries depends very much on the character of the region whence they may have swept; and, accordingly, it is necessary to remember that the globe is divided into five zones or belts—the torrid, which is exposed to the direct rays of the sun; the two temperate zones, which, meeting the rays of the sun obliquely, enjoy a moderate degree of heat; and the two frigid zones, which, deprived of the heat of the sun for a great part of the year, and during the other part receiving his rays still more obliquely, are regions of ice and snow which, it would appear, are destined ever to remain uninhabitable solitudes. Generally, in the British islands, a westerly wind is moist, because it comes from the Atlantic, where a great quantity of vapours arise. When mingled with that of the south, which comes from the torrid zone, it is rendered particularly warm. The east wind is the driest, because it comes from the continent of Asia, where there are few seas. The north wind, however, is the coldest, because it sweeps from the immense tracts of ice and snow in the frigid zone. The north-easterly winds, therefore, being so dry and cold, are in this country proverbially the most chilly and bitter.

While the south-west is the most predominant wind in Europe, the north-east winds in spring may be regarded as periodical in the climate of Britain; it is to be remembered, however, that the succession of the seasons of the year, with their characteristic changes of temperature, depend principally on the relative position of the earth to the sun. The more vertically or directly the sun's rays reach the surface of the earth, descending in a more concentrated manner, the greater is the degree of heat which they produce; but the more obliquely they fall, being thereby more scattered, and consequently falling with less power, the smaller is the degree of heat they impart. Accordingly, in the winter season, the sun's ray's reach the surface of the globe in our latitude more obliquely than they do in the summer season; consequently, that season is characterized by the coldness which then prevails; therefore, the winds, powerful as their agency certainly is, exercise only a subsidiary influence in modifying the temperature of the seasons. Besides this, the physical aspect of a country, its mountains and table lands, its chains of hills and its valleys, its rocky elevations and its level plains, its protected or exposed coasts, all influence very materially the direction of the wind, which must, as it sweeps along, coincide with the elevations and depressions of the country over which it passes. Hence it has been shown by physicians, that the climate in certain districts of England, owing to the protection of surrounding elevations, rivals in salubrity, even in the most trying seasons, many of the most favourite and fashionable resorts for invalids in the south of France.

Besides the division of the winds founded on their direction from the cardinal points—as into north, north-east; south, south-east; west, south-west; east, &c.—they are divided by meteorologists into four classes, namely, regular, irregular, periodical, and hot winds; the causes of which, with the phenomena by which they are attended, will now be considered.

Regular Winds—Trade-Winds.—In order that we may distinctly understand the cause and nature of the trade-winds, it is necessary to bear in mind that the earth, in the centre of its circumference, at an equal distance from the poles, is divided by a line called the equator into two hemispheres—the northern and southern. Across the equator, cutting it obliquely, there passes another great circle called the ecliptic, which describes the path the sun traverses. It extends 23½ degrees north and 23½ degrees south of the equator, which is the utmost limit the sun traverses; for, when arrived at either of these boundaries, he again seems to return towards the equator. It must be very evident that the region of the earth included within a circle drawn 23½ degrees north and 23½ south of the equator—which will comprehend the greatest portion of Africa, a considerable part of Asia and America, and many large, fertile, and populous islands in the East and West Indies—will receive constantly the solar rays in a direction so little oblique, that the most intolerable heat might there be anticipated. It was therefore called the torrid zone; and the limits at which the sun stops, and appears to retrace his course, have received the name of tropics, or circles of return. This being premised, and it being also remembered that the earth revolves daily, "her silent course advancing," round the sun from west to east, the cause of the trade-winds will be readily understood. The rays of the sun, in its apparent motion from east to west, obviously rarefy, by the heat they impart, the air beneath, and the air so rarefied rises into the higher regions of the atmosphere. While this takes place, the colder air from the adjoining temperate zones rushes in to supply its place. But it is from the polar regions, north and south, that these colder currents originally come; and did the earth remain at rest, such would be their obvious direction. Instead of this, however, north of the equator the direction of the trade-winds is from the north-east; south of the equator, from the south-east; the cause of which is thus explained:—The velocity with which the earth revolves, is inconsiderable, if appreciable, at the poles, but increases as we advance, and is at its maximum at the equator; the winds, in sweeping from the poles, do not acquire a corresponding velocity with the motion of the earth, as they advance towards the equator; therefore, moving more slowly than the earth, they are left behind, striking bodies with the excess of the earth's velocity; so that, to the observer who imagines himself at rest, the air appears to move in a direction contrary to the rotation of the earth, namely, from east to west. While the trade-wind thus blows upon the surface of the earth, there is no doubt that an opposite current, probably that of the rarefied air which has ascended, flows in the contrary direction, at a great elevation in the atmosphere.

The external limits of the trade-winds are 30 degrees north and 30 degrees south of the equator; but each limit diminishes as the sun advances to the opposite tropic. The larger the expanse of ocean over which they sweep, the more steadily do they blow; accordingly, they are more steady in the Pacific than in the Atlantic, and in the South than in the North Atlantic Ocean. Within the region of the constant trade-winds, rain seldom occurs, but it falls abundantly in the adjoining latitudes. The reason is, that rain is produced by the sudden mixture of air of different temperatures charged with moisture; but the constant circulation and intermixture of the air from the upper strata of the atmosphere, or ground current, maintains so equal a temperature in these latitudes, as not to occasion the condensation of vapour which is necessary for the production of rain. Besides which, it is plausibly enough alleged by Daniel, that the aqueous vapour constantly flows off in the current of the equatorial wind into the adjoining temperate zones. Within the limits of the trade-winds, contrary to what might have been anticipated from the latitude, the atmosphere is peculiarly cool and refreshing.

The agency of the winds in clearing the atmosphere from noxious effluvia, and keeping it from stagnating, is so apparent, that it scarcely requires to be noticed. In the case of the regular winds to and from the equator, an interchange of atmosphere is effected, beneficial to both torrid and temperate zones. On this interesting point in natural science, the following observations are made by Liebig in his work on Organic Chemistry (1840).—"The proper, constant, and inexhaustible sources of oxygen gas are the tropics and warm climates, where a sky seldom clouded permits the glowing rays of the sun to shine upon an immeasurably luxuriant vegetation. The temperate and cold zones, where artificial warmth must replace deficient heat of the sun, produce, on the contrary, carbonic acid in superabundance, which is expended in the nutrition of the tropical plants. The same stream of air which moves by the revolution of the earth from the equator to the poles, brings to us, in its passage from the equator, the oxygen generated there, and carries away the carbonic acid formed during our winter. The experiments of De Saussure have proved that the upper strata of the air contain more carbonic acid than the lower, which are in contact with plants; and that the quantity is greater by night than by day, when it undergoes decomposition. Plants thus improve the air, by the removal of carbonic acid, and by the renewal of oxygen, which is immediately applied to the use of man and animals. The horizontal currents of the atmosphere bring with them as much as they carry away; and the interchange of air between the upper and lower strata, which their difference of temperature causes, is extremely trifling when compared with the horizontal movements of the winds. Vegetable culture heightens the healthy state of a country, and a previously healthy country would be rendered quite inhabitable by the cessation of all cultivation." How grand the theory in these passages respecting the influence of winds on vegetation! Those streams of air, which superstition would ascribe to demons, are among the most beneficent means arranged to preserve atmospheric salubrity, and afford materials for man's subsistence.

The Monsoon.—In India, a very remarkable periodical or half-yearly wind prevails, which is called the Monsoon, from a Malay word *moussin*, which signifies season. It blows one half the year from the south-west to the north-east, and the other half from north-east to south-west. The former is accompanied by rain and tempest, and constitutes in India the "rainy season;" the latter, although in this respect admitting of some modifications, constitutes the "dry season" of the year. The south-west monsoon, in the southern parts of India, commences about the beginning of June; but in proceeding northwards, it does not commence until later. It is ushered in by vast masses of clouds, which arise from the Indian Ocean; and as they advance towards the north-east, gather and thicken as they approach the land. In a few days afterwards, the sky assumes a more troubled aspect towards the evening, and it is in the night that the monsoon generally sets in. It begins with violent blasts of wind, which are succeeded by floods of rain, during which the lightning flashes without intermission; at first illuminating the sky, showing the clouds near the horizon; then discovering the distant hills, and leaving them again shrouded in darkness; then, in an instant, reappearing in vivid and successive flashes, which exhibit even the nearest objects in all the clearness and distinctness of noon-day light. The thunder, in the mean time, continues in loud peals, and when it ceases, the rain pours in large volumes. This lasts for several days; the sky then clears, the air becomes soft and pure, the rivers are full and tranquil, and the whole face of the earth, as if by enchantment, appears clothed with thick and luxuriant verdure. The rain, after this, falls at intervals for about a month; then it increases in violence, and attains its height in the month of July, when it descends thickly and heavily *en masse* from the heavens. Then this monsoon, in August, somewhat diminishes; in September it abates, or is entirely suspended until the end of the month, when it again re-appears; and departs, as it came, amidst thunder and lightning, and all the turmoil of tempest.

Such is the south-west monsoon, as it appears in the greater part of India; but it is liable to considerable variations, caused by the influence of the sea and the mountainous regions along which it may sweep. Near the sea, the rain falls more plentifully; because, from the more abundant evaporation, the air is there more charged with moisture. The mountains also affect its course, by interrupting and diverting the progress of the winds and the clouds they bear. Thus, the wind which brings the rain to the north-eastern part of the Indian continent, originally blows from the south-west over the Bay of Bengal, until it reaches the Himalaya Mountains, and those which join them from the south; these check its current, and compel it to follow their range towards the north-west; but when it has continued so far towards the north-west as to meet that chain of mountains called the Hindoo Coosh, then it is by them turned off towards the west, and sweeps along until interrupted by the range of the Solimaun, which prevents its proceeding farther in that direction, or compels it to part with the clouds with which it was laden. If the reader will for a moment trace on the map the course here described, he will at once perceive the influence these mountains must have in modifying the direction and general character of the monsoon.

Hitherto we have principally noticed the south-west monsoon, which constitutes the "rainy season" in India; to this succeeds the north-east monsoon, which, with the exception of the eastern side of the Coromandel coast—to which it brings the periodical rains that begin about the middle of October, and end generally in the middle of December—is attended with dry weather throughout the peninsula. After setting in, during the month of September, with considerable variations in its commencement, the north-east monsoon establishes a milder though not less absolute dominion, which lasts until the end of February or the beginning of March. From that period to the month of June, the winds are irregular, and the heat very great all over the peninsula. In respect to the cause of the monsoons, they are, on the authority of the celebrated philosopher Halley, to be explained on the same principles as the trade-winds; the action of the sun's rays inducing a rarefaction of the air, and consequent rushing in of a colder current from the sea and land; and the physical aspect of the country, its elevations or plains, modifying the reflection and influence of the solar rays: which causes, taken conjointly, sufficiently account for the periodical occurrence and local peculiarities of the monsoon.

Sea and Land Breezes.—The sea and land breezes, occurring in warm climates, may also be classified under the head of periodical winds; they occur in the following manner:—During the day, the wind blows for a certain number of hours from the sea to the land; but when evening arrives, it changes its direction, and blows as many hours from the land to the sea. In this country the sea-breeze sets in about seven or eight in the morning, and is strongest at noon, but continues very sensible until three o'clock, when the surface of the sea will be observed to exhibit ripples of a deep blue colour. After this, at six in the evening, the land-breeze commences. The sea now assumes a greenish hue; and this breeze continues until eight the next morning. The cause of this alternation may be readily explained. During the day, the air over the surface of the earth is more heated by the rays of the sun than that over the surface of the sea; because the earth, from its greater density, comparative state of rest, and numerous elevations, reflects the sun's rays sooner, and with more power then they are reflected from the sea, which, from its state of constant motion and transparency, imbibes the warmth very intimately, though more slowly. Accordingly, when the sun, having arisen above the horizon, has, by the reflection of its rays, thus imparted a sufficient degree of warmth to rarefy the body of air over the land, the air so rarefied ascends into the higher regions of the atmosphere, while that over the surface of the sea, being scarcely at all rarefied, rushes in to supply its place. Hence, a sea-breeze, or current of air from the sea to the land, at this time prevails; but when the sun again begins to sink below the horizon, the body of air over the surface of the land becomes rapidly cold, and the earth itself, by radiation, parts very quickly with the warmth it had absorbed. Then the land air, being below the temperature of the sea air, rushes in to supply its place, and thus during the night, a land-breeze, or a current of air from the land to the sea, is produced. When the sea-breeze first sets in, it commences very near the shore, and gradually extends itself farther out to sea, and, as the day advances, becomes more or less hot. Hence, the sails of ships have been observed quite becalmed six or eight miles out at sea, while at the same time a fresh sea-breeze has been blowing upon the shore. The cause of this is obvious: for it is natural to suppose that the mass of air nearest the land will be the first to rush in, for the purpose of supplying the place of the air which is rarefied immediately above it. On this account the effect of the sea-breeze is said not to be perceptible at a distance of more than five or six leagues from the shore, and for the most part becomes fainter in proportion to its distance from the land. The distance, on the other hand, to which the land-breeze extends in blowing across the sea, depends on the more or less exposed aspect of the coast from which it proceeds.

Hot Winds—The Simoom.—Hot winds of a very dreadful character occur, in Arabia, Egypt, Syria, and adjacent countries, the moving air having acquired a prodigious degree of heat and aridity in passing over the hot desert continents. One of the most appalling of these winds has been called by the Arabs the *simoom*, from a word meaning poison; and it is also known by the name of the *kamsin*, which signifies fifty days. When the simoom begins to blow in Arabia, the atmosphere assumes an alarming aspect. The sky, at other times so clear, becomes dark and heavy; the sun loses its splendour, and appears of a violet colour. The air is not cloudy, but thick from the subtle dust with which it is loaded. Sometimes the sky appears yellow from the refraction of light on the minute pieces of quartz which are floating in the air. Sometimes it has a peculiar and frightful blue colour; which variety of this wind comes from those districts where the soil is composed of a great deal of blue-coloured marl and limestone. At first, the wind is light and rapid, and not remarkably hot; its temperature, however, soon increases, until it ranges at upwards of 128 degrees Fahrenheit. The danger, however, is most imminent when it blows in sudden squalls, as then the rapidity of the wind increases the heat to such a degree as to be altogether intolerable. "When this wind occurs," says Volney, "all animated bodies discover it by the change it produces in them. The lungs, which a too rarefied air no longer expands, are contracted and become painful. Respiration is short and difficult, the skin parched and dry, and the body consumed by an internal heat. In vain is recourse had to large draughts of water; nothing can restore respiration: in vain is coolness sought for; all bodies in which it is usual to find it deceive the hand that touches them. Marble, iron, water—notwithstanding the sun no longer appears—are hot. The streets are deserted, and the dead silence of night reigns everywhere. The inhabitants of towns and villages shut themselves up in their houses, and those of the desert in their tents, or in wells dug in the earth, where they wait the termination of this destructive heat." All travellers bear testimony to the destructive effects of this wind; and it is stated that camels are so conscious of their danger from its influence, that they instinctively bury their nostrils in the sand, and keep them there until the squall is over.

The Sirocco—the Solano.—The sirocco is the name given to the hot wind which occasionally blows in Sicily, and which is supposed to derive its origin from the excessively heated deserts of Africa. The solano is a term applied to a modification of this wind which is met with in Spain and Portugal. The heat of the sirocco wind is described to be excessive. Brydone observes, that, when he experienced its first blast, he felt as if his face had been exposed to the burning steam from the mouth of an oven. When this wind occurs, the inhabitants of every town close their doors and windows against the admission of the external air, and sprinkle their apartments with water. Not a person ventures into the open air. It lasts from six or seven to thirty-six or forty hours. During this period the air is thick and heavy, and the sun does not appear. The thermometer, from 70 or 72 degrees, suddenly rises to 110 or 112 degrees, or even higher. When this sirocco wind, which always blows from the south, shifts, the north wind, which is called the *tramontane*, succeeds, and the country is again relieved from this distressing visitation. The most remarkable effect of the sirocco is the extreme depression of animal spirits which it produces. It gives a degree of lassitude both to the body and mind, which renders both alike unfit for performing their functions in an efficient manner. "The natives themselves," says Brydone, "do not suffer less than strangers; and all nature seems to languish during this abominable wind."

Velocity of the Wind.—The velocity of the wind is from an imperceptible movement to 100 miles in an hour. When it moves at the rate of 1 mile per hour, it is said to be hardly perceptible; at 2 or 3 miles, just perceptible; at 10 to 15 miles, pleasant or brisk; at 20 miles, bracing; at 20 to 25 miles, very brisk; at 30 to 35 miles, high; at 35 to 45 miles, very high; at 50 miles, storm or tempest; at 60 miles, great storm; at 80 miles, hurricane; at 100 miles, hurricane, tearing up trees, and throwing down houses, &c.

The Anemometer.—Many years ago, an instrument called the *anemometer* was contrived, for the purpose of measuring the force of the wind; and latterly an apparatus with the same name has been invented, to measure not only the force, but to indicate the direction of the wind at every minute of the day. From an exterior vane, a connection is established to a pointed index in the form of a pencil, which, according as the vane moves, travels on a sheet of paper spread on a table in a room beneath, and marks the paper in certain waving lines as it proceeds. The pencil being influenced by the movements of a clock, and the paper being squared into divisions for every hour in the day, a most effectual record is produced. Anemometers of this kind are now established at all the principal observatories.

RAIN.

It has been explained in the preceding paragraphs, that the waters of the earth yield up a certain quantity of moisture into the air, which, being condensed, assumes the form of clouds of greater or lesser density and magnitude, floating at a variable distance above us in the regions of the atmosphere. It has also been shown that clouds consist of an assemblage of small vesicles, or globules of moisture, which, on being affected by a diminution of temperature, lose their suspensory property, and gathering into larger globules, they drop to the ground in the form of water drops or a shower of rain. The fall of rain, therefore, is the result of so simple and obvious a cause as to require no lengthened explanation; and the only circumstances demanding our attention are the lesser or greater size of the drops, the closer or more distant arrangement of the showers, and the quantity which falls in reference to peculiar localities and different regions of the globe.

Within the tropics, and also in Great Britain, when the air has been charged with electricity, as often happens during the dry summer or autumnal months, the rain-drops are very large, but during the wet and chilly season which attends the fall of the year, they are often very small, and, as it is technically termed, *drizzling*. It is a remarkable fact, and worthy of our notice, that drops of rain have always been found larger in the lower regions of the atmosphere. Thus, Dr. Walker observed, in going down a high mountain, that the drops gradually increased in size as he descended. At a little way below the summit of the mountain, the precipitation appeared only a gentle mist; but this gradually became denser as he descended, until, on reaching the valley, it increased to a heavy rain. In the year 1776, Dr. Heberden proved this curious fact. He placed one instrument for measuring the quantity of rain which falls, called the *rain-gauge*, on the square part of the roof of Westminster Abbey; another on the top of a neighbouring house considerably lower than the first; and another on the ground in the adjoining garden. The rain collected on each was as follows:—Top of Westminster Abbey, 12 inches; top of the house, 18 inches; and on the ground, 22 inches: so that much more rain was collected in the lower than in the upper rain-gauge. It has been observed, that this difference may in some measure be owing to the action of the wind, which might drift the rain from the higher and more exposed vessel; but let the greatest pains be taken to avoid this difficulty—which may be done by placing all the vessels in positions equally exposed to the wind—still the fact will hold good, that the quantity of rain increases as we descend in the atmosphere.

It has been conjectured that the increased size of the drops, as we descend mountains into valleys, depends on their uniting together as they fall. But the truth seems to be, that the increased quantity of moisture precipitated is owing to the continued evaporation going on at the earth's surface. When the sun has withdrawn his rays, or is overcast by a dense cloud in the higher regions of the heavens, and when the air is loaded with excess of vapour, should an additional quantity arise from the earth's surface, it must be obstructed in its ascent, and, meeting with a colder current, be condensed, and converted into rain. In traversing a mountainous country during a storm, we have had occasion to observe this fact; for often the rain by which we have been wet through has seemed not so much to descend from above, as to be formed immediately around us. The garments about the knees of the pedestrian will, under such circumstances, be wet through, while his shoulders remain comparatively dry. Hence, marshy and maritime situations which emit much vapour are observed to be remarkably rainy. Mountainous regions are generally visited also with much rain, in consequence of the condensation of clouds on the summits of the hills. When the hills are in the neighbourhood of the ocean, their tendency to excite rain is greatly increased; and in proportion as we leave hills so situated, and pass into inland and more level districts, the less rain will be found to fall.

Winds, however, exert the chief influence over the atmospheric condition which produces rain. Thus, if winds blow from instead of to a hilly country, the clouds will be carried elsewhere, and be precipitated in lower regions at a distance. But, if these low-lying regions be warm, the clouds will be radiated, and their particles, in a refined state, will be carried onwards by the winds, till they come over a cold, high-lying country, where they will drop in heavy showers. In this manner the vapours from the Mediterranean are carried over Egypt, and do not collapse into rain till intercepted by the higher regions of Abyssinia. In consequence of certain winds blowing within the tropics, most countries near the equator have their *rainy seasons*—periods during which much greater quantities of rain fall than we are accustomed to in temperate climes. The rains in India, which are often so desolating in their effects, as already noticed, generally occur during the shifting of the monsoons, and also during what is termed the south-west monsoon.

In that part of Peru called Valles, which lies on the north and south side of Lima, and is bounded on the east by the Andes, and on the west by the Pacific Ocean, it never rains at all; but during winter, the earth is covered with a fog so thick and dense as to intercept the rays of the sun. These fogs supply sufficient moisture to render the most arid and barren soil fertile, and to convert the disagreeable dust in the streets of Lima into mud. The reason why it never rains in this country, is, that the wind always blows from the south, that is, from a colder to a warmer region of the world.

Speculations on the chance falling of rain in such countries as Britain are exceedingly hazardous, in consequence of the variability of the winds, and the conditions of the atmosphere at points far beyond our knowledge. With respect to the likelihood of rain, we can attain only a few general principles, all beyond which is doubt and difficulty. For example, if the weather be steady and dry, the winds, if not distracted by any foreign circumstance, will continue blowing and carrying away the evaporated moisture to distant regions, thus averting rain; but if, in the meanwhile, the temperature suddenly falls, or the winds shift, clouds immediately make their appearance, and showers of rain are the consequence. Yet there are exceptions to these general rules, as we will immediately mention.

In all countries, particular winds are noted for being accompanied either by wet or by dry weather: thus, the south and the south-west winds bring much moisture into Britain, while those from the north and north-east are cold, dry, and penetrating; hence the old proverb—

> "When the wind's in the south,
> It's in the rain's mouth."

Not only does this arise from the immense surface of ocean over which these winds sweep south of the equator, the evaporation from which must be prodigious, but from these southerly winds being of a higher temperature, whereby they hold a greater quantity of vapour in suspension or solution, the condensation of which must be proportionally greater on arriving in this colder climate. Accordingly, it has been observed that the wind will turn from the north to the south quietly and without rain, but, on returning from the south to the north, will blow hard and bring much rain. Again, if it begin to rain from the south, with a high wind, for two or three hours, and the wind falls, but the rain continues, it is likely to rain for twelve hours or more, and does usually rain until a strong north wind clears the air. For the same reason, winds from the west and south-west are considered to bring with them wet weather; hence the old saying—

> "A rainbow in the morning is the shepherd's warning;
> But a rainbow at night is the shepherd's delight."

In the morning, the sun rising in the east shines directly upon the rain falling in the west, and thereby warning the watchful shepherd of the approach of wet weather with this humid wind; but at night, when the sun sinks in the west, its rays fall on the rain in the east, and the shepherd then sees the storm departing; hence this is one of the many popular sayings founded on observation of nature.

Men of science have made very careful inquiries to ascertain the quantity of rain which falls in certain places during a given time, and the instrument devised for that purpose is the *rain-gauge*. Its construction is very simple, consisting merely of a circular or square vessel, to which is affixed a pipe, funnel-shaped, for conducting the rain into it, where its quantity is estimated by a scale marking the number of square inches which enter. The annual quantity of rain is greatest in tropical countries, and diminishes as we approach the poles; a circumstance explicable by the greater evaporative qualities of the atmosphere in warm than in cold countries. The following table illustrates the progressive diminution of rain as we reach higher latitudes:—

	North Latitude.				Inches of Rain.
Uleaberg. - -	65 degrees,	30 minutes.			13·5
Petersburg, - -	59	—	56	—	17·5
Edinburgh, - -	55	—	58	—	24·5
London, -	51	—	31	—	22·2
Paris, - -	48	—	50	—	19·9
Rome, - - -	41	—	54	—	39·0
Calcutta, - -	22	—	25	—	81·0
Vera Cruz, -	19	—	5	—	83·8
Bombay, - -	18	--	57	—	82·0

The mean quantity falling annually in England is reckoned to be 32 inches, or, according to Dalton, 31·3; but this is unequally distributed. At Keswick, in Cumberland, the depth, on an average of seven years, was found to be 67 inches; and at Plymouth, in Devonshire, 46 inches. In the western parts of Scotland, the depth is from 30 to 35 inches, which is from 6 to 10 inches more than that on the east coast.

Although the quantity of rain which falls in tropical countries is usually greater than what is precipitated in colder regions, it is dispersed over less time, and chiefly falls in heavy showers during a limited season of the year. In our temperate climates, therefore, we have more rainy and drizzling days throughout the year than are experienced in warm countries; and it is this which gives the character of moistness and personal discomfort to our climate.

The seasons of the year, while they contribute, by their variety, to our pleasure and happiness, are characterized by such weather as is best adapted to the necessities of the vegetable and animal creation; wherefore the proportions of rain vary in different months of the year. In summer we have not so many rainy days as in winter; but the showers are then heavier, the streams of rain closer together, and the quantity which falls is greater than during any other season. Dr. Dalton has ascertained that the first six months of the year may be regarded as dry, and the last six as wet months. Another ingenious author has inferred, from long observation, that in spring it rains oftener in the evening than in the morning, but that towards the end of summer, oftener in the morning than in the evening, and storms at this time are apt to occur a little after sunrise.

The reason that in winter less rain falls, though we have more rainy days than in summer, is, that the temperature of the air is less variable in winter, and the condensation of moisture not so forcible; therefore, the rain continues falling in small drizzling drops, which, accompanied or followed by chilly north-east winds gives rise to colds and coughs, and many distressing maladies. It is also to be observed, that, while a clouded and damp atmosphere favours the increase of vegetable foliage, it is not so favourable to its fructification. In such seasons, while the blades of grass grow broader, the nutritious principle which they should contain is not well developed; so that animals feeding on this poorer grass are obliged to take a larger portion to satisfy their appetites. Cattle and sheep which feed on such pasturage, may be observed to be almost continually eating; whereas, in moderately dry seasons, when the occasional rains have been heavier, every blade of grass grows more healthily, its nutritious principle is better evolved, and less sufficing, the same animals may be seen lying down and ruminating in the shade. In the progression of the seasons, rain falls at all times during the twenty-four hours; but it has been ascertained that much less falls by day than by night.

Rain has occasionally been known to fall of a peculiar colour or substance; but this, like other atmospheric phenomena, admits of an explanation on natural grounds. In the year 1810, a shower of red rain fell in Hungary. It lasted a quarter of an hour, and the water was like blood. This was ascertained to be owing to the rain-water being loaded with the red pollen of certain kinds of trees from a neighbouring forest. Red rain, however, is more frequently caused by an incorporation with the atmosphere of a minute fungous vegetation or of animalcules, both too small to be seen by the naked eye. Viscid or a kind of *glutinous rain* has likewise fallen. In the Transactions of the Royal Society of London, an account is given of a shower of viscid rain which happened in Ireland. On examination, it was found to be owing to the presence of extraneous matter, partly vegetable and partly animal. In 1828, a substance was shown to the French Academy, which fell in the plains of Persia. It was edible, and afforded nourishment to cattle and many other animals. This nutritious matter was found to be a vegetable production—the *Lichen esculentis* of botanists—which had been transported thither by the wind.

We are not, in these various instances, to forget the powerful agency of the wind, which often has been proved to carry to a prodigious distance, sand and dust, and the ashes and scoriæ which have been thrown up during the eruption of volcanoes. Not very many years ago, during a strong gale, herrings and other fish were carried from the Firth of Forth to Lochleven, a distance of upwards of ten miles.

Signs of Rain.—We conclude our observations on rain by enumerating a few of those prognostications of approaching rain, which, admitting of explanation, are most interesting. When the moon is of a pure silvery colour, good weather is indicated; but when it has a brown or chestnut-coloured tint, rain may be expected. This is owing to the effect of the vapour in the atmosphere in refracting the moon's light. For the same reason, when stars are surrounded by coloured halos, the approach of rain is indicated.

When mountain ranges or distant objects appear nearer to us than usual—when sounds are heard more clearly from a distance—when the odour of plants is more than usually powerful, rain may be prognosticated. The first of these signs arises from the effect of an excess of moisture in reflecting and refracting the rays of light—the two last from sounds as well as odours being conveyed better through a damp than through a dry air. The low flight of swallows indicates approaching rain. The cause of this is, that they pursue flies, which delight in warm air; and these flies, escaping from the excess of moisture above, descend nearer to the surface of the earth, and are there pursued by these birds.

Ducks, geese, and other waterfowls, before the approach of rain, may be seen to throw water with their bills over their backs, and dive frequently; the cause of which is, that, although so much in the water, they do not like being wet to the skin; to avoid which, when warned by the peculiar sensation preceding rain, they close their plumage together, by throwing a sudden weight of water on their bodies, in the direction of the growth of their feathers.*

Before the fall of rain, cattle may sometimes be observed stretching out their necks, and snuffing in the air with distended nostrils, which, doubtless, is occasioned by the odours of plants being more powerful than usual, when the air is saturated with an excess of moisture.

Man in strong and robust health does not feel his constitution affected by that change in the state of the atmosphere which precedes rain; but persons who are in delicate health are often much affected. Pain of the head, toothache, irritability of temper, pains in old sores which have healed, the aching of corns, and excessive nervousness, are all, in certain habits of body, signs of approaching wet weather.

Dogs closely confined in a room become drowsy and stupid before rain; the same, in a less degree, is observed in cats; horses neigh much; cattle low; the fallow-deer becomes restless; and many other animals, from the uneasiness they feel owing to the altered condition, prognosticate the approach of rain. Insects, being very sensible of every change in the state of the atmosphere, are good weather-guides; hence, fine weather may be predicted when many spiders' webs are seen in the open air; also when bees are found far beyond their hives. On the contrary, when spiders remain hidden, and bees do not range abroad as usual, rain may be expected. Many flowers and plants are excellent prognosticators of the weather. When the flower of the chickweed expands freely, and remains open, no rain will fall for many hours; but when it closes, showery weather or continued rain may be expected. The trefoil, the convolvulus, and many other plants, contract their leaves before the approach of rain.

FROST—SNOW.

When the temperature of the atmosphere falls to a certain degree of cold (indicated by 32 degrees in our thermometers), which it does principally from the weakness of the sun's rays in winter, the phenomenon of frost or freezing ensues. Freezing is a process of congelation, or properly, crystallization, produced by the withdrawal or absence of heat, and by which water assumes the form of ice.

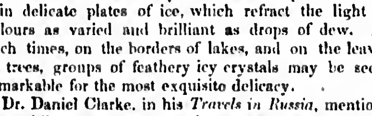
When the temperature of the atmosphere arrives at that low pitch which effects freezing, the watery particles which are upheld in the clouds are frozen in their descent, and coalescing, reach the earth in the form of flakes of snow; and these accumulating on the ground, constitute the appropriate characteristic of the winter season. An intensely cold current of air, mixing with the vapour suspended in a warmer current, occasions, as in the case of hail, this precipitation. Snow, however, is formed in the lower regions of the atmosphere, or might, if commencing in small nucleus, in higher regions, be converted in its descent into hail. That snow is formed in this manner, there can be no doubt; for a very cold stream of air, admitted into a room in which the contained air is warmer, and loaded with watery particles, will occasion its formation. In the huts of the people in the desolate arctic regions, snow is often so formed; they stop the chink, yet still the walls are often covered with a thick icy crust; and whenever a cold current from the external air is ad-

* Luke Howard's Climate of London, notes to vol. i.

mitted, snowy flakes are precipitated. Dr. Robertson states, that, in a crowded assembly-room at St. Petersburg, a stream of cold air was accidently admitted into the room by a gentleman breaking a pane of glass, on which the vapour in the air was immediately congealed, and fell in the form of snow-flakes. In Siberia, Pallas, Chappe, and others, have seen it formed under similar circumstances; and by the narrative of the Dutchman who wintered in Nova Zembla, we are informed that a shower of snow fell, from the vapour of expiration, every time there was any communication with the external air. The peculiarities of snow consist in its extreme lightness, and also in its being purely white. Its lightness is occasioned by the excess of its surface exceeding so much in comparison the matter it contains, and its whiteness is owing to the minute particles into which it is divided; hence, when ice is pounded, it is equally white. When snow, however, accumulates in large quantities, its weight becomes very considerable. Snow occurs in all regions of the globe at a certain height above the level of the sea, but falls more abundantly on plains as we proceed from the equator to the poles. In the arctic regions, snow falls nine days out of ten during the months of April, May, and June, and often a depth of two or three inches is deposited in an hour. In these regions, the thickest precipitations are observed to precede the occurrence of storms.

The forms of snow-flakes present an almost endless variety; they are often very regular and beautiful, and reflect with exceeding splendour the rays of the sun. When they are very large, they are said to indicate the approach of thunder. After a copious fall of snow, when the temperature is too low to produce any moisture, its level surface may often be seen sprinkled with thin delicate plates of ice, which refract the light in colours as varied and brilliant as drops of dew. At such times, on the borders of lakes, and on the leaves of trees, groups of feathery icy crystals may be seen, remarkable for the most exquisite delicacy.

Dr. Daniel Clarke, in his *Travels in Russia*, mentions that, while at St. Petersburg, he observed flakes of snow falling in regular and beautiful forms. "The season," he says, "began to change before we left Petersburg. The cold became daily less intense; and the inhabitants were busied in moving from the Neva large blocks of ice into their cellars. A most interesting and remarkable phenomenon took place the day before our departure: the thermometer of Celsius stood at that time only 5 degrees below the freezing-point, and there was no wind. Snow, in the most regular and beautiful crystals, fell gently on our clothes and on the sledge, as we were driving in the streets. All of them possessed exactly the same figure and the same dimension. Every particle consisted of a wheel or star, with six equal rays, bounded by circumferences of equal diameters: they had all of them the same number of rays branching from a common centre. The size of each of these little stars was equal to the circle presented by dividing a pea into two equal parts. This appearance continued during three hours; in which time no other snow fell, and there was sufficient leisure to examine them with the strictest attention, and to make the representation given in the first figure.



"As water, in its crystallization, seems to consist of radii diverging from a common centre, by the usual appearances on the surface of ice it might be possible to obtain the theory, and to ascertain the laws, from which this stellar structure results. An equiangular and equilateral plane hexagon is divisible into three equal and similar rhombs; and if the engraved figure A be attentively observed it will appear that each linear ray of the star is a diagonal (see fig. B) joining the acute angles of a rhomb, whose sides are the loci of the extreme points of the lines of ramification from these diagonals. The rhomb may therefore be the primitive form of water crystallized. This seems the more manifest, because, if equal and similar rhombs be applied between all the rays of the star A, in the spaces 1, 2, 3, 4, 5, and 6, an equilateral and equiangular hexagon will be the result, as represented by the dotted line in fig. C." The same star-like shape of snow flakes has been seen in Britain. According to a notice in an Edinburgh newspaper, the phenomenon occurred in Lanarkshire in the winter of 1838.

Snow is occasionally seen of a brown colour, which arises from its being impregnated with earthy substances, brought from the mountains by those streams of water which are derived from the thawing of ice or snow. Much oftener has snow been observed of a red colour, which appears generally to have arisen from its intermixture with some vegetable substance. Captain Scoresby informs us, that, in the arctic regions, the redness of the snow may occasionally be attributed to the little auk (*Alca alle*), which feeds on shrimps, and accumulates in immense numbers.

Snow, which in Britain falls generally most copiously during the months of December, January, and February, seldom occurs so early as October, and is generally, after remaining some time on the ground, dissipated by an increase of temperature, arising from the direct action of the sun's rays or the fall of rain. Occasionally, however, it disappears without any apparent thaw, or so much dissipates as to leave deep furrows on the snowy plain. This arises from the snow itself being evaporated, which will occur even below the freezing-point. "On the night of the 10th of February," says Luke Howard, "I exposed 100 grains of light snow, spread on a dish (which had previously the temperature of the air) of six inches in diameter. In the first hour after dark it lost five grains; in the third it acquired a grain, the wind having changed, and the temperature, which had been falling from 25°, inclining to rise again. In the course of the night the loss was about 60 grains." This very ingenious author adds, that this evaporation from snow probably supplies the water for the formation of those thin mists which appear during intense frost. The air then becomes partially loaded with particles of ice, or of water at so low a temperature as to be ready to become solid the moment they find support. Hence, too, may arise the rime-frost, which is found to accumulate on the windward side of the twigs and branches of shrubs and trees. Snow seldom remains long, in temperate latitudes, on plains or in valleys, but on the tops of high mountains it occasionally appears throughout the year. The cause of its continuance on these exalted spots, is the thinness of the atmospheric air, which is incapable of holding sufficient heat from the sun's rays to melt the general mass.

Sleet is only a modification of snow. When aqueous globules freeze in the higher regions of the atmosphere, they aggregate together, and form flakes of snow; and when these have partly thawed, and have again become frozen, they constitute sleet, which is thus caused by the variable temperature of the atmosphere. Sleet falls at all seasons, and sometimes changes into rain and sometimes into snow. It occasionally falls, indeed, very heavily, gathering and freezing additional moisture in its descent.

Hail is described by meteorologists as frozen drops of rain, the freezing having taken place while the smaller vesicles of water were assuming the heavier properties of the rain-drop. A cold current of air, blowing suddenly in the direction of a rain-cloud, is understood to is the immediate cause of most hail-showers. Hail-stones vary much in shape; they are generally oval or round, but sometimes thin, flat, irregularly globular, angular, pyramidal, occasionally irregular, having a central point whence proceed numerous icy spiculæ, like rays in all directions; and, also, although more rarely, they have appeared as six-sided prisms. Hail-stones vary in size from that of a small seed to that of a boy's marble, the smaller generally falling in the more northerly climates, the larger in the south of Europe. In different parts of France and Britain, very large hailstones have occasionally fallen, and done serious damage.

It is calculated that a single drop of water, the diameter of which is only the one-thousandth part of an inch, will, in descending through the air, acquire a velocity of nine or ten feet every second; wherefore it is less surprising that hailstones of such magnitude and weight should occasionally prove destructive, not only to delicate plants but even to animals. The large size of hailstones is attributed to an accumulation during the progress of their descent. It is probable that the largest commences its formation with a small nucleus, which receives continual accessions from vapoury particles which it freezes and attaches to itself as it proceeds. Accordingly, hailstones are found to be smaller on the tops of mountains than in the neighbouring plains or valleys; because, not falling so far, they do not augment their size by the addition of successive layers of congealed watery vapour.

Hoar-frost, which appears like a beautiful powdery crystallization on trees and herbage, is only frozen dew. The conversion of dew into hoar-frost is another wise arrangement in nature, by which plants are protected from the severity of a freezing cold atmosphere.

THUNDER AND LIGHTNING—STORMS.

Independently of the storms of regular occurrence in warm climates, such as monsoons and simooms, there occur sudden and violent atmospheric agitations, both at sea and land, the causes of which are various, though generally depending on rapid transitions of temperature and electrical influence. Two kinds of storms, in particular, are dependent on electrical action in the atmosphere and clouds—the common thunder-storms of temperate climates, and those of a very violent nature occurring in the form of hurricanes in tropical regions.

Thunder-storms.—Storms of thunder and lightning are simply a case of electrical discharges from one cloud to another, and are a means adopted by nature to restore electrical equilibrium in the atmosphere, and at the same time clear the air from unwholesome vapours or properties. The explanation of thunder-storms given by Professor Thomson, in his Outlines of the Science of Heat and Electricity, being the best we have seen, we shall lay it before the reader:—"Air and all gases are non-conductors; but vapour and clouds, which are composed of it, are conductors. Clouds consist of a kind of bladders of vapour, charged each with the same kind of electricity. It is this electric charge which prevents the vesicles from uniting together, and falling down in the form of rain. Even the vesicular form which the vapour assumes is probably owing to the particles being charged with electricity. The mutual repulsion of the electric particles may be considered as sufficient (since they are prevented from leaving the vesicle by the action of the surrounding air and of the surrounding vesicles) to give the vapour the vesicular form. In what way these clouds come to be charged with electricity, it is not easy to say. But, as electricity is evolved during the act of evaporation, the probability is, that clouds are always charged with electricity, and that they owe their existence, or at least their form, to that fluid. It is very probable that when two currents of dry air are moving different ways, the friction of the two surfaces may evolve electricity. Should these currents be of different temperatures, a portion of the vapour which they always contain will be deposited; the electricity evolved will be taken up by that vapour, and will cause it to assume the vesicular state, constituting a cloud. Thus we can see, in general, how clouds come to be formed, and how they contain electricity. This electricity may be either vitreous or resinous, according to circumstances. And it is conceivable that, by long-continued opposite currents of air, the charge accumulated in a cloud may be considerable. Now, when two clouds, charged, the one with vitreous and the other with resinous electricity, happen to approach within a certain distance, the thickness of the coating of electricity increases on the two sides of the clouds which are nearest each other. This accumulation of thickness soon becomes so great as to overcome the pressure of the atmosphere, and a discharge takes place, which occasions the flash of lightning.

"The noise accompanying the discharge constitutes the thunder-clap, the long continuance of which partly depends on the reverberations from neighbouring objects. It is, therefore, loudest and largest, and most tremendous in hilly countries. These electrical discharges obviously dissipate the electricity; the cloud condenses into water, and occasions the sudden and heavy rain which always terminates a thunder-storm. The previous motions of the clouds, which act like electrometers, indicate the electrical state of different parts of the atmosphere. Thunder, then, only takes place when the different strata of air are in different electrical states. The clouds interposed between these strata are also electrical, and owe their vesicular nature to that electricity. They are also conductors. Hence they interpose themselves between strata in different states, and arrange themselves in such a manner as to occasion the mutual discharge of the strata in opposite states. The equilibrium is restored; the clouds, deprived of their electricity, collapse into rain; and the thunder terminates. In thunder-storms, the discharges usually take place between two strata of air, very seldom between the air and the earth. But that they are sometimes also between clouds and the earth cannot be doubted. These discharges sometimes take place without any noise. In that case, the flashes are very bright but they are single flashes, passing visibly from one cloud to another, and confined usually to a single quarter of the heavens. When they are accompanied by the noise which we call *thunder*, a number of simultaneous flashes of different colours, and constituting an interrupted zigzag line, may generally be observed stretching to an extent of several miles. These seem to be occasioned by a number of successive or almost simultaneous discharges from one cloud to another, these intermediate clouds serving as intermediate conductors, or stepping-stones, for the electrical fluid. It is these simultaneous discharges which occasion the rattling noise which we call *thunder*. Though they are all made at the same time, yet, as their distances are different, they only reach our ear in succession, and thus occasion the lengthened rumbling noise, so different from the snap which accompanies the discharge of a Leyden jar.

"If the electricity were confined to the clouds, a single discharge, or a single flash of lightning, would restore the equilibrium. The cloud would collapse, and discharge itself in rain, and the serenity of the heavens would be restored; but this is seldom the case. I have witnessed the most vivid discharges of lightning from one cloud to another, which enlightened the whole horizon, continue for several hours, and amounting to a very considerable number, not fewer certainly than fifty, and terminating at last in a violent thunder-storm. We see that these discharges, though the quantity of electricity must have been immense, did not restore the equilibrium. It is obvious from this, that not only the clouds, but the strata of air themselves, must have been strongly charged with electricity. The clouds, being conductors, served the purpose of discharging the electricity with which they were loaded, when they came within the striking distance. But the electric stratum of air with which the cloud was in contact, being a non-conductor, would not lose its electricity by the discharge of the cloud. It would immediately supply the cloud with which it was in contact with a new charge. And this repeated charging and discharging process would continue to go on till the different strata of excited air were brought to their natural state."

After these explanations, it is only necessary to say, that however awful the noise which thunder usually makes, it is in no shape dangerous. The real danger is from the lightning, which has a tendency to strike high pinnacles of buildings or spires of churches; but if these high places be furnished with metal rods to conduct the lightning to the ground, no injury is likely to occur. Lightning, either silent or accompanied by thunder, is of much rarer occurrence in the British islands than on the continent of Europe.

Law of Storms.—Considerable attention has been bestowed by various men of science on what are supposed to be the regulating principles of storms; for it cannot be doubted that, however irregular their occurrence and apparent action, they are subject to certain fixed laws, and these it is important to discover. As yet, the law of storms has assumed no very distinct or generally recognised form, almost every student of atmospheric phenomena having his own theory on the subject. The question upon which the chief difference exists, is, whether storms blow in direct lines or in circles. The probability is that storms of wind are greatly influenced by the configuration of the localities over which they blow, as well as by the opposition they may meet with in their course: for example, a violent gale of wind, coming in direct force against a lofty mountain, will probably be transformed into a whirlwind; and a similar result will follow the opposing contact of two fierce winds.

At a meeting of the British Association at Newcastle in 1838, Lieut. Colonel Reid, of the Royal Engineers, laid before that body his views respecting the laws of storms, which have met with general acceptation. From extensive observations on foreign stations and at sea, he was of opinion, with Mr. Redfield and Colonel Capper, two persons who had previously investigated the subject, that hurricanes are great whirlwinds, and that these whirlwinds were progressive. "The general phenomena of these storms," he observed, "will be understood, if the storm, as a great whirlwind, be represented by a circle whose centre is made to progress along a curve, or part of a curve, which is in most cases of a form approaching the parabolic, the circles expanding as they advance from the point at which the storm begins to be felt—the rotatory motion, in the northern hemisphere, being in the contrary direction to that on which the hands of a watch goes round; while, in the southern hemisphere, the rotation is in the same direction as that in which the hands of a watch revolve. He pointed out how his views were illustrated by the disastrous storm of 1809, experienced by the East India fleet, under the convoy of the Culloden line-of-battle ship, and the Terpsichore frigate, and four British men of war, which left the Cape of Good Hope about the same time, intending to cruise about the Mauritius. Some of these vessels scudded and ran in the storm for days; some, by lying to, got almost immediately out of it; while others, by taking a wrong direction, went into the heart of it, foundered, and were never heard of more; others, by sailing right across the calm space, met the same storm in different parts of its progress, and the wind blowing in opposite directions, and considered and spoke of it as two storms which they encountered; while others, by cruising about within the bend of the curve out beyond the circle of the great whirl, escaped the storm altogether, which had been for days raging on all sides of them. This led him to draw the very important practical conclusion as to how a ship should act when she encountered a gale, so as to escape from it. By watching the mode of veering of the wind the portion of a storm into which a ship is falling may be ascertained; if the ship be then so manœuvred as that the wind shall veer aft instead of ahead, and the vessel is made to come up instead of being allowed to break off, she will run out of the storm altogether; but if the contrary course be taken, either through chance or ignorance, she goes right into the whirl, and runs a great risk of being suddenly taken aback, but most assuredly will meet the opposite wind in passing out through the whirl. To accomplish her object, he showed, by a diagram, that it was necessary the ship should be laid on opposite tacks, on opposite sides of a storm, as may be understood by drawing a number of concentric circles to represent the whirl of the hurricane, and then different lines across these, to represent the course of ships entering into or going through the storm.

Mr. Espy, an American gentleman, who laid a number of facts on the subject before the British Association in 1840, arrives at the same conclusion as Redfield, Capper, and Reid; but adds, that the whirlwinds blow progressively towards a common centre. This blowing inwards to a centre, Mr. Espy conceives to be the consequence of the sudden and powerful ascent of a column of air at that centre, from the atmosphere being there more heated than elsewhere.

If any careful observer of atmospheric phenomena, on the ocean, possess facts which tend to throw any light on this exceedingly important branch of science, it is his duty to make them known for the general benefit of mankind.

UNUSUAL METEORIC PHENOMENA.

Among the meteoric phenomena which are of less frequent occurrence than those already noticed, may be included rainbows, figures in the air, luminous meteors, ignis fatui, the aurora borealis, halos, parhelia, and aërolites. Having in the article OPTICS explained the cause of rainbows to be simply the refraction of light through the drops of a shower of rain (or through the spray of a cataract), nothing more need be said on the subject here. With respect to the appearance of figures in the air, such as representations of landscapes, men, and animals, ships at sea, and so on, it has likewise been shown, in the article OPTICS, that they are a natural consequence of peculiar refractive powers of the atmosphere at the time of the occurrence. The Mirage of the desert, the Fata Morgana of the Venetians, the Brocken of the Hartz Mountains in Germany, and the armies seen in the air, according to Scottish superstition, all belong to this class of meteoric phenomena.

Luminous Meteors.—These are of various kinds. One of the most familiar is the Will o' the wisp or *ignis fatuus* (the fire of fools), which appears at night on marshy grounds or places of sepulture. The appearance is that of a small flickering light, straggling in an irregular manner at the height of one or two feet from the ground, and sometimes standing for a few moments over a particular spot. When approached or pursued, the lights are agitated by the motion of the air, and seem to elude investigation. The cause of this species of meteor is well known to men of science; the light being nothing more than phosphuretted hydrogen gas, arising from decomposing substances in the ground, spontaneously lighted. The meteors commonly called *falling stars*, which shoot from the upper region of the atmosphere, are ascribed to a similar origin: they are masses of matter inflated with phosphuretted hydrogen gas, which, being spontaneously ignited, shout in a downward direction to the earth. The greatest height whence they come is not above two or three miles, and seldom so much. Electricity, it may be supposed, is also concerned in this class of meteors.

Aurora Borealis.—In extreme northern and southern latitudes, and generally in the coldest season of the year, the sky appears luminous with streams of soft light, called the aurora borealis or the northern lights. This beautiful phenomenon is comparatively seldom seen as far south as the centre of England, but is frequently observed in Scotland, where it is popularly known by the name of *streamers*. In the latter country it appears a little after sunset, and uniformly arises in the north, inclining generally a little to the west; and it occurs more frequently about the time of the equinoxes than at any other season of the year. Its manner of arising, and the general characters it assumes, vary extremely; indeed, so much so as almost to preclude any accurate description. Sometimes, an hour or two after dark, it seems to illumine the northern region of the sky with no more than a gentle and subdued twilight, which gives a soft relief to the surrounding darkness. Sometimes detached masses of light suddenly appear in different parts of the sky, from which silvery and tremulous beams shoot with dazzling and evanescent splendour. Not unfrequently, indeed, from one single spot of light the beams vividly and rapidly extend. Sometimes the phenomenon is first discernible in delicate streaks or threads of light, which enlarge and shift with inconceivable rapidity, until a tremulous arch is formed, which completely spans the azure vault. Very often one general or principal arch is observed, with smaller ones at unequal distances, which frequently move laterally towards each other, and suddenly unite into one broad brilliant mass. Often, from the horizon, in the north, one limb or segment in the arch springs up into the heavens, and sometimes several of these arise at distances from each other. The varying splendour of the coruscations, and the rapid and playful movements which they display, as they sweep across the heavens, excite alike the wonder and admiration of the spectator.

The height of the aurora has been variously computed to be from 100 to 700 miles above the surface of the earth, and consequently far beyond the sphere of our atmosphere. All the conjectures hazarded with respect to the nature and cause of the aurora have been unsatisfactory: the most feasible conclusion is, that the phenomenon is a demonstration of electric fluid in its passage from the polar to the equatorial regions. Well-digested facts are still required to form an exact and satisfactory theory on the subject.

Halos—Parhelia.—In the colder regions of the globe, and sometimes in temperate climes during cold weather, what are called halos and parhelia, or mock-suns and mock-moons, are sometimes seen. A halo usually consists of two concentric circles of coloured or refracted light, such as that of a rainbow, the one forming an angle of about 23½ degrees, the other an angle of about 47 degrees, with the sun or moon. In different parts of these circles, and chiefly in opposite points at a similar altitude with the sun, bright spots of unrefracted light are seen, which have received the names of mock-suns and mock-moons, according as the light is received from the sun or from the moon during the appearance of the halo. From these bright spots diverging horns of light are occasionally observable. It is generally agreed that a halo is produced by the sun or moon's light being refracted by frozen vapour in the atmosphere. The cause of the parhelia, or bright sun-like spot, is more difficult of definition. Some suppose it to be caused by the frozen vapour being arranged in such a manner at particular points, as allows the light of the sun or moon to be transmitted in a concentrated instead of a refracted form.

Aërolites.—These are fiery meteors, which, in various forms and sizes, are seen to shoot from the heavens, and, falling to the earth, are found to consist of certain kinds of stones. The chronicles of almost every age and country record the fall of these bodies, which sometimes arrive on the surface of our planet individually, and at other times in what must be called a stream or shower. The celebrated Gassendi informs us, that, on the 29th November, 1637, about ten o'clock, A. M., while the sky was perfectly serene and transparent, he saw a flaming stone, apparently about four feet diameter, fall on Mount Vaison, in Provence. This stone was encircled with a zone of various colours, like a rainbow, and accompanied in its fall with a noise resembling the discharge of artillery. It was of a dark metallic colour, extremely hard, and 59 lbs. in weight. In June, 1668, two stones, one of which weighed 300, and the other 200 lbs., fell near Verona. The event took place during the night, and when the weather was perfectly serene and mild. They appeared to be all on fire, descending in a sloping direction, and with a tremendous noise. The phenomenon was witnessed by a great number of people, who, when the sounds had ceased, and their courage was sufficiently re-established, ventured to approach these celestial deposits, and found that they had formed a ditch, such had been the force with which they had descended. One of the largest meteoric stones which have ever fallen, is now exhibited in a room in the British Museum; it is several feet in diameter, of great weight, shaped like a spheroid, and brown in exterior appearance.

All meteoric stones that have been examined, present a similar structure and appearance. The chemical analysis of one which fell in France in 1810, may be taken as a sample of the whole:—Silica, 38·4; alumina, 3·6; lime, 4·2; magnesia, 13·6; iron, 25·8; nickel, 6; manganese, 0·6; sulphur, 5; chrome, 1·5; total, 98.7. The velocity with which the stones are shot through the atmosphere renders them red hot, and some time elapses after their fall before they cool and can be handled.

With respect to the origin of aërolites, there are four theories, each having its supporters. According to Laplace, Poisson, Dr. Hutton, and others, they are stones projected from volcanoes in the moon; it being demonstrated that an initial velocity of 6000 feet per second would be sufficient to drive them beyond the moon's attraction, and to bring them within the greater attraction of the earth. Another set of philosopher's allege they are projected from volcanoes on the earth, which is exceedingly improbable. Playfair and others say it is not unlikely that the stones are formed in the atmosphere, by an aggregation of particles of matter, the result of gaseous vapours; this chemical theory is also very unsatisfactory. The fourth and most probable theory is, that the stones are *asteroids*, or diminutive planets, drawn to the earth's surface when our globe, in its annual revolution, arrives at points near which these bodies are performing circuits round the sun. A series of remarkable phenomena, of recent occurrence, serve to support this theory. On the morning of the 12th, 13th, or 14th of November, every year since 1833, there have occurred, at different parts of both Europe and America, showers of meteoric bodies, of a most brilliant appearance; and it has thence been conjectured that the earth, in its revolution round the sun, had fallen in with these bodies in the same or nearly the same part of its orbit. If such be the true hypothesis, it follows that these meteors are travellers in space, performing circuits like the planets, and have most likely been projected from the sun in the same manner as the earth and other planetary bodies are believed to have been hurled from that luminary. Showers of fiery meteors, sometimes only gaseous, and at other times solid, are, however, found to occur annually in August, December, and other periods of the year. In September, 1841, a shower of many millions of meteoric stones, the greater number of which were not larger than small hailstones, occurred in Hungary, their chief ingredients being oxydate of iron, oxyde of iron, and oxyhydrate of iron, with flint, lime, and clay earth.

THE WEATHER.

From the preceding account of the various phenomena of the atmosphere, it must be evident that prognostications respecting the weather must be extremely uncertain, if not, for the most part, quite illusory. According to an ancient prejudice, it has been supposed that the moon, on entering its different quarters, exercises an influence over the weather; but this is ascertained by men of science to be without foundation in truth. The moon affects the tides of the ocean, but in no other known manner has it any influence over the ordinary phenomena of our planet.

It has been seen that the winds are the grand disturbers of the weather, and that to them we may proximately ascribe the occurrence of clear skies, fogs, clouds, rain, &c. As the winds originate from circumstances frequently far beyond our horizon, and cannot consequently be foreseen, every prognostic of either fine or bad weather is liable to complete derangement. The chance floating of an iceberg from the northern polar regions to a temperate latitude in the Atlantic, has been known to shed such a cold over Britain as to destroy the best hopes of summer. To utter prophecies of the coming weather, in a country exposed to such contingencies, appears ridiculous. It has long been a favourite belief with certain classes of persons, that the weather goes in cycles—that, after a limited number of years, the same succession of weather in the different seasons of the year recurs, and is repeated periodically. A period or cycle of nine, eighteen, thirty-six, and fifty-four years, has been variously fixed upon. In Scotland, nineteen years has been more generally believed to form a cycle, and on that account, leases of farms are commonly made out for that period, in order to give the agriculturist the benefit of an entire round of weather. To suit and support these theories, which rest on no solid foundation, almanacs have been put forth, pretending to foretell the weather of the coming year; but, unless when favoured by accidental resemblences between the weather and the prediction, all such oracular prophecies have been disproved by facts. As far as the records of meteorological phenomena for a long series of years warrant a conclusion, the following principles respecting the weather may be considered settled:—1. The weather of each year stands by itself; 2. The weather differs annually, and is different in different places according to circumstances; 3. The weather in the interior of continents is so regular in its seasonal variations, that it may be foretold with considerable certainty; 4. The weather of the British islands is so irregular, from unforeseen causes, that predictions as to its condition are only warrantable in very general terms, at any season of the year, 5. That agricultural improvement, such as draining of moist grounds, improves climate, and tends to equalize temperature; and, 6. That the asperities of cold in our winters, and extreme heats of our summers, have been modified from this cause; while, though in some respects uncomfortable, our climate is improved in its salubrious properties, and by allowing out-of-door exercises and employment for a greater number of days throughout the year than that of most other countries, is highly conducive to health, longevity, and social advancement.

[RECENT DISCOVERIES IN METEOROLOGY.

The science of Meteorology has attracted more attention of late than in former times. Among the most successful inquirers is Mr. Espy, of Philadelphia, whose ingenious theories on the subject are founded on a course of observations and experiments continued regularly for some thirty years. His predictions respecting changes in the weather, and the precision with which he has pointed out the locality of storms raging at the moment at great distances from his own residence, have excited astonishment. These, however, are founded on scientific principles which he has developed in his theory of storms.

The facts and laws which he has discovered are generally recognised as having considerable practical value.

Other inquirers both in America and Europe are still earnestly endeavouring to advance the science and to reduce their discoveries to such practical results as may be useful to the agriculturist and the mariner.—*Am. Ed.*]

PHRENOLOGY.

It has of late been customary for the conductors of popular cyclopædias to admit articles on Phrenology; but in most if not all the instances in which this has been done, the articles were the composition of persons who denied that phrenology was a true system of mental philosophy, and whose aim rather was to show its want of sound foundation than simply to present a view of its doctrines. In every one of these instances, it was afterwards successfully shown by phrenological writers, that their science had been misrepresented, and its doctrines challenged on unfair grounds; so that the articles in question might as well not have been written, in so far as the instruction of candid inquirers was concerned. We have resolved to eschew this practical absurdity, by presenting a view of phrenology by one who believes it to be the true system of mind. This we conceive to be a course the more necessary, that phrenology, overlooking altogether its organological basis, presents a far more intelligible view of the faculties of the human mind, and the phenomena of their working, than any of the metaphysical systems. It is eminently, we think, the system of mental philosophy for the unlearned man, because it is much less abstract than any other. In perusing the account which it gives of the mind and its parts, ordinary people feel, for the first time in their attempts at psychological investigation, that they have ground whereon to rest the soles of their feet. Thus, supposing the observations made with regard to the connection of certain manifestations of thought and feeling with certain parts of the brain to be untrue, there is still a distinct value in phrenology, as an extensively available means of studying mind. We deem it right, at the same time, to mention that phrenology appears to us as beforehand likely to be true, in as far as it assigns a natural basis to mind; while we are equally sensible that its leading doctrines have acquired a title to a very respectful attention, from the support given to them by a vast amount of careful observation, and the strikingly enlightened and philanthropic aims for which many of its supporters have become remarkable. With these introductory remarks, we leave our readers to form their own opinions respecting the science, as far as they are enabled to do so by a treatise necessarily brief, and which, therefore, admits of but a slender exhibition of evidence.—*Ed.*

Phrenology is a Greek compound, signifying a discourse on the mind. The system which exclusively passes by this name, was founded by Dr. Francis Joseph Gall, a German physician, born in 1757. Dr. Gall was led, when a school-boy, to surmise a connection of particular mental faculties with particular parts of the brain, in consequence of observing a marked prominence in the eyes of a companion who always overmatched him in committing words to memory. Finding the same conformation in others noted for the same talent, he reflected that it was possible that other talents might be accompanied by external marks, and that dispositions might also be so indicated. He devoted himself to observing marked features of character; and on examining the heads, was struck with differences in their forms, there being prominences and hollows in some not found in others, with corresponding variations of character in the individuals. After most extensive and accurate observation, he first lectured on the subject in Vienna in 1796. There his lectures were suppressed by a jealous and ignorant despotism; upon which he abandoned Germany and settled in Paris, where he practised as a physician, and studied and extended his "doctrine," as he always called it, till his death in 1828. His great work, with its illustrative engravings, is one of the most extensive and beautiful examples of inductive evidence of which any science can boast. Many phrenologists, who had previously read the works of the British writers only, have expressed their astonishment, when they came to read Gall's work, at the immense fabric he had reared, and how little, in the way of proofs of the organs discovered by him, he left to be done. Dr. Gall never took any particular step for making phrenology known in our island. With the exception of a light and trivial article in the *Edinburgh Review* in 1803, and another in the *Edinburgh Medical and Surgical Journal* in 1806, the science was not heard of in Britain till introduced by Dr. Spurzheim in 1815. He was a native of Treves on the Moselle, born in 1776, the pupil and, from 1804, the associate of Dr. Gall. Besides making many valuable discoveries in the anatomy and physiology of the brain, and ascertaining several organs in addition to those discovered by Dr. Gall, Dr. Spurzheim had the distinction of systematizing the discoveries of both into a harmonious and beautiful mental and moral philosophy. Dr. Spurzheim died at Boston in the United States in 1832. Since then, the recognised head of the phrenological school has been Mr. George Combe, of Edinburgh, author of many able and popular works on the science, and its most distinguished and successful teacher, by his public prelections both in Britain and America. The applications of phrenology to insanity, health, and infant treatment, have been at the same time admirably made by Dr. Andrew Combe, Mr. George Combe's distinguished brother; and to the treatment and reformation of criminals, and the new or character-forming education, by Mr. George Combe himself and Mr. James Simpson of Edinburgh. Many writers of more recent date have followed in the track of these authors, for, indeed, no other is now followed with practical effect on the subjects enumerated; but to phrenology the sound views now current on these subjects can in a great measure be traced.

THE PRINCIPLES OF PHRENOLOGY.

1. The *brain* is the organ by and through which *mind* in this life is manifested. This truth is now disputed scarcely anywhere. It was a great though wide-spread error, before the discovery of phrenology, that we can recognise mind and body as two distinct entities or existences: under the influence of that error, they were treated of separately by two several orders of philosophers—the metaphysicians and the anatomists. In vain to the metaphysician was it obvious, that we have no knowledge of mind but through the medium of a bodily apparatus, with which it grows and decays; he continued to treat of mind as a spirit unconnected with body. The anatomical investigator reasoned quite as unphilosophically, when he assumed that mind was nothing but matter, the higher qualities of which were to think and feel. The phrenologist avoids both these unproved assumptions. He does not pretend to know, much less to assume, the *essence* or nature of either mind or matter. Whether they are one or distinct is known only to the God who made them; and whatever they are, they must, therefore, be the best possibly adapted to their end and design. This is his answer to the unproved and unwarranted assumptions of spiritualism on the one hand, and materialism on the other; while he confines himself to the observation of the laws

IMAGE EVALUATION TEST TARGET (MT-3)

6"

which regulate mental phenomena, in their invariable connection with bodily organization; and to the *brain*, as most obviously so connected, he has seen reason to address his chief attention. To all sane manifestations of mind, brain in healthy action is necessary. In sleep, fainting, and compression of the brain, mind is suspended. In perfect sleep, the brain reposes, and mind ceases to be manifested. Were it an immaterial spirit, acting independently of the brain, the repose of the material brain could not suspend the spirit's working. In fainting, the blood ceases for the time to supply the brain, and consciousness and motion are suspended. Pressure on the brain instantly suspends consciousness. Mr. Combe, in his "System of Phrenology" (4th edition, p. 14,) describes several most interesting and instructive experiments on compression, as made by Richerand, Cooper, Chapman, Cline, and others. In several individuals, when the brain was partially exposed by accidents, these gentlemen applied pressure to the exposed part, when speech and consciousness suddenly stopped, to return when the pressure was removed. Pinel* clearly traces to a *bodily* cause the diseased manifestation of mind called insanity, by the following cases:—"A man engaged in a mechanical employment, and afterwards confined in the Bicêtre, experiences, at irregular intervals, fits of madness, characterized by the following symptoms:—At first there is a sensation of heat in the abdominal viscera, with intense thirst, and a strong constipation; the heat gradually extends to the breast, neck, and face, producing a flush of the complexion; on reaching the temples, it is still greater, and is accompanied by very strong and frequent pulsations in the temporal arteries, which seem as if about to burst; finally, the nervous affection arrives *at the brain*." What then follows? All the effects hitherto described are purely corporeal. Pinel proceeds—"The patient is *then* seized with an irresistible propensity to shed blood; and if there be a sharp instrument within reach, he is apt to sacrifice to his fury the first person who presents himself." How powerfully this case connects mind and brain, and what a strong light it sheds upon that really bodily, that is, cerebral, disease called insanity! Pinel cites another case of total change of character, from mild to furious, in an insane person, when redness of face, heat in the head, and thirst, occurred. The brain, when exposed, has been seen *in action*, during emotion, conversation, dreams, &c. Sir Ashley Cooper refers to the case of a young man who had lost a portion of skull above the eyebrow. "I distinctly saw the pulsation of the brain," says Sir Ashley; "it was regular and slow; but at this time he was agitated by some opposition to his wishes, and directly the blood was sent with increased force to the brain, and the pulsations became frequent and violent. If, therefore, you omit to keep the mind free from agitation, your other means (in the treatment of injuries of the brain) will be unavailing."† Blumenbach saw a portion of exposed brain to sink in sleep, and swell when the patient awoke.‡ Dr. Pierquin, and a writer in the *Medico-Chirurgical Review*, adduce other instances of the brain swelling out in waking hours, and still more in mental agitations. In these, such as pain, fear, anger, the dressings were disturbed, and the brain throbbed tumultuously. The cause is obvious: increased activity of brain, as of muscle, is accompanied by increased flow of blood to the part. Dr. Pierquin cites a case which is extremely instructive. His subject was a female, twenty-six years of age, who had lost a large portion of the skull and dura mater, so that a corresponding portion of the brain was laid bare. When she was in a *dreamless* sleep, her brain was motionless, and lay inside the cranium; when her sleep was *imperfect*, her brain moved and protruded; in *vivid dreams*, the protrusion was considerable; and when awake, and particularly when engaged in conversation or mental action, it was still greater, and remained so while conversation lasted.*

* Sur l'Aliénation Mentale, p. 157.
† Lectures on Surgery, vol. i. p. 270.
‡ Elliotson's Blumenbach, 4th edition, p. 283.

Common feeling refers the mind to, or localizes it in, the head; and common phrases are in accordance with this conviction. We have *long-headed*, *shallow-pated*, *crack-brained*, *well furnished with brain*, &c.; as expressions in every one's mouth.

From the above facts, phrenologists assume:—1st, As there is no vision or hearing without their respective organs, the eye and ear, so there is no thinking or feeling without their respective organs in the brain; 2d, Every mental affection must correspond with a certain state of the organ, and *vice versa*; 3d, The perfection of the mind will have relation to the perfection of its organs. The study of the cerebral organs, therefore, is the study of the mind, in the only condition in which we can cognise it. Hence all previous study of the mind, without reference to cerebral organization, has, philosophically speaking, gone for nothing, if we except the shrewd but unsystematic guesses of superior sagacity;† and phrenology presents the first practical mental philosophy known to man.

The brain being the general organ of the mind, we come next to inquire whether it is *all* necessary to every act of feeling or thinking; or whether it is divided into parts, each part being the instrument or organ of a particular mental act. 1st. It is a law of organization that different functions are never performed by the same organ. The stomach, liver, heart, eyes, ears, have each a separate duty. Different nerves are necessary to motion, feeling, and resistance, and there is no example of confusion among them. Analogy, therefore, is in favour of the conclusion that there are distinct organs for observing, reflecting, and feeling kindness, resentment, self-love, &c. 2d. The mental powers do not all come at once, as they would, were the brain one indivisible organ. They appear successively, and the brain undergoes a corresponding change. 3d. Genius varies in different individuals; one has a *turn*, as it is called, for one thing, and another for something different. 4th. Dreaming is explained by the doctrine of distinct organs which can act or rest alone. Its disjointed images and feelings could never occur if the brain acted as a whole. Undivided, it must either all sleep or all wake; so that there could be no such thing as dreaming. 5th. Partial insanity, or madness on one point, with sanity on every other, proves the distinction

* More lately than all these examples, Mr. Combe has recorded one of his own observing in America, which goes not only to prove action of the brain corresponding to activity of mind generally, but action of ascertained organs when their corresponding mental manifestations were called forth. The subject was a girl of eight years of age, who four years before, from a fall out of a window, lost the portion of skull which covers the organs of Self-Esteem and Love of Approbation. The integuments and hair are the only protection her brain has in that region, and its movements can be felt by the hand, like a leech through a silk handkerchief. Mr. Coombe placing his hand on the part, led the conversation so as to pique the child's self-esteem, when the motion was distinctly felt. When she was requested to do some arithmetical lesson, to set in action her intellect, the brain at Self-Esteem ceased to move. She was praised for her success, when the organ of the Love of Approbativeness, hitherto quiescent, sensibly moved; again the child's attention was directed to something distinct from herself, and once more the organ of Self-Esteem and Love of Approbation reposed. Mr. Combe repeated his trials several times with the same results.—*Notes on the United States.*

† An opinion, not much different, was expressed by the last of the Scottish metaphysical school, towards the end of his life. We allude to Mr. Dugald Stewart, who denies as true, but indirectly confirms, the following confession of M. de Bonald:—"Diversity of doctrine has increased from age to age with the number of masters, and with the progress of knowledge: and Europe, which at present possesses libraries filled with philosophical works, and which reckons up almost as many philosophers as writers, poor in the midst of so much riches, and uncertain, with the aid of all its guides, which road it should follow—Europe, the centre and focus of all the lights of the world, HAS YET ITS PHILOSOPHY ONLY IN EXPECTATION."

of organs, and their separate action. 6th. Partial injuries of the brain, affecting the mental manifestations of the injured parts, but leaving the other faculties sound, prove distinctiveness of organs. 7th. There could be no such state of mind as the familiar one where our feelings contend, and antagonize and balance each other, if the brain were one organ.

These are grounds for presuming that the brain is not unique, but a cluster of organs, or at least that it is capable of acting in parts, as well as in whole. For this conclusion, the phrenologists have found satisfactory proofs in repeated observations, showing that particular manifestations of mind are proportioned, in intensity and frequency of recurrence, to the size or expansion of particular parts of the brain, and are thus to be presumed to depend on those parts. Every step they have taken in this investigation has been guided by the strictest rules of the inductive philosophy, each of their inferences being grounded on an overwhelming number of cases leading to one uniform conclusion. It is therefore considered by them as a settled point, that the brain consists of a congeries of organs. It is a necessary result of the same investigations, and one of the most important doctrines of phrenology, that the power of each organ, in other words, its degree of mental manifestation, is in direct proportion to its *size*. This is a law everywhere seen affecting organic nature;* a large muscle, the conditions of health, quality, and outward circumstances, being the same, has more power than a small one. The same is true of a nerve. Dogs have very large nerves for smelling, eagles for seeing, &c. A child's brain is smaller, and its mental power weaker, than those of an adult. A very small brain in an adult is the invariable cause of idiocy. Dr. Gall observed that a head not measuring more in horizontal circumference than fourteen inches, is always idiotic. A large head *may* be idiotic from cerebral disease, but a very small head, from defect of size alone, is always idiotic. We present a contrast. Fig. 1

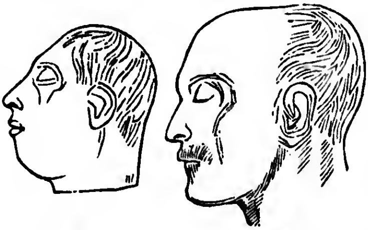


Fig. 1. Fig. 2.

is the head of an idiot of 20 years of age; fig. 2 is the head of the celebrated Hindoo reformer, Rammohun Roy, which was of great size, and, as is well known, manifested great power. It will in the sequel be shown that the Hindoo type of head is small, and the mental power correspondent; hence the exception, in both particulars, of Rammohun Roy's head, tells the more strongly for the doctrine. Men of great force of character, such as Napoleon, Franklin, Burns, had brains of unusually large size.

Powerful energetic nations exceed weaker ones in size of head, and invariably, when brought into collision with them, overcome them. The Gothic or Teutonic head is larger than the Celtic, which last race first occupied Europe, but was driven by the Gothic into the mountainous regions, where it was not worth the pains to follow it. The average European head is to the average Hindoo as the head of a man to that of a boy; and hence the conquest and subjection of a hundred millions of the latter by thirty thousand of the former. Figs. 9 and 10, to be found in a subsequent column, contrast a European with a Cingalese head. Indeed, the doctrine of size of brain accompanying power of character, is now generally admitted by the opponents of phrenology.

The general law, then, being that size of organ is accompanied by power of manifestation, we proceed to inquire, secondly, if there are any circumstances, and what these are, which modify this law. It will be found that *quality* of brain is a modifying circumstance, also *health* of brain, and *exercise* of brain.

1. Phrenologists conjectured that different brains differ in quality, but were long without any indications of these differences. The doctrine of the *Temperaments* has thrown considerable, though not perfect light on this point, and for this we are indebted to Dr. Thomas, of Paris. There are four temperaments, accompanied with different degrees of power and activity, in other words, quality of brain. These are the *bilious*, the *nervous*, the *sanguine*, and the *lymphatic*. These temperaments were observed and distinguished long before the discovery of phrenology, though to little purpose. They figure in the fanciful philosophy of Burton, and similar writers of former times, and much nonsense is written connected with them. Phrenology has adopted them, and made them intelligible and useful. They are supposed to depend upon the constitution of particular bodily systems. The muscular and fibrous systems being predominantly active, seem to give rise to the bilious temperament. The name is equivocal, and therefore not well applied; the other three are more appropriate. The brain and nerves predominating in activity, give the nervous; the lungs, heart, and blood-vessels, the sanguine; while the glands and assimilating organs present the lymphatic temperament. The predominance of these several bodily systems is indicated by certain sufficiently obvious external signs, whence our power of recognising them. The nervous temperament is marked by silky thin hair, thin skin, small thin muscles, quick muscular motion, paleness, and often delicate health. The whole nervous system, brain included, is active, and the mental manifestations vivacious. It is the temperament of genius and refinement. The bilious has black, hard, and wiry hair, dark or black eyes, dark skin, moderate fulness, but much firmness of flesh, with a harsh outline of countenance and person. The bilious temperament gives much energy of brain and mental manifestation, and the countenance is marked and decided; this is the temperament for enduring much mental as well as bodily labour. The sanguine temperament has well-defined forms, moderate plumpness and firmness of flesh, light or red hair, blue eyes, and fair and often ruddy countenance. It is accompanied with great activity of the blood-vessels, an animated countenance, and a love of out-door exercises. With a mixture of the bilious—for in most individuals the temperaments are mixed, often all four occurring in one person—it would give the soldier's temperament. The brain is active. The lymphatic temperament is indicated by a round form, as in the fat and corpulent, soft flesh, full cellular tissue, fair hair, and pale skin. The vital action is languid, the circulation weak and slow. The brain also is slow and feeble in its action, and the mental manifestations correspond.*

It must be kept in mind that the temperaments are only useful in comparing different brains; and this well illustrates what is meant by the condition of *cæteris paribus*, or other things being equal, a phrase much used in phrenology. If two brains, in every way similarly organized in size, differ in manifestation of power and activity, we must look to the temperaments of the individuals; and if we find one nervous and the other lymphatic, we

* See Essay by Dr. Andrew Combe, Phrenological Journal, vol. iv., p. 161.

* For a fuller description of the temperaments, see the article Account of the Human Body.

have a key at once to the difficulty. In the same brain all the organs, being influenced by the same temperament, must be subject to precisely the same modification. Various *causes* of the temperaments have been propounded, but none satisfactory; the *effects* more concern us, and these are now tolerably well recognised. In Mr. Combe's *System* (4th edition, page 43) there are coloured portraits of the temperaments, which convey a very satisfactory idea of them. We would recommend to our readers to see these, as we are precluded by our method of printing from introducing coloured engravings. The temperaments and their mixtures, for they are rarely if ever found unmixed, should be observed in living subjects.

2. The brain must be in a *sound healthy condition*, to manifest itself properly in the mental faculties. In judging of character, the phrenologist must inquire into this circumstance, as the external development does not reveal it.

3. Exercise—or whether or not, and how, the brain has been exercised—is another condition to be inquired into before judging of two individuals similarly organized. The brain which has been the more, and more judiciously, exercised, will manifest the greater degree of activity and power. The law of exercise is of universal application to animals, if not to organization in general. A muscle or nerve is strengthened by exercise; and a tree or plant by the motion given it by the wind. Over-exercise injures the brain. It is only another mode of inquiring into the circumstance of exercise of brain, when a phrenologist asks what opportunities of education an individual has enjoyed, and to what kind of society he has been accustomed. To this information he is entitled in judging of character, for the head alone will not reveal it.

If size of organ implies vigour of function, it is of great moment in what region of the brain the organs are largest —whether in the animal, moral, or intellectual. On this preponderance depends the character. Two brains may be exactly alike in size, generally, yet the characters may be perfect contrasts to each other. If the organs predominate in the moral region, the leading manifestations will probably be of a virtuous character; if in the intellectual, talent will be the probable consequence; if in the animal, there will be tendencies accordingly. There is nearly as much brain in fig. 4 as in fig. 3; yet fig. 3 is the head of Melancthon, the most virtuous and

Fig. 3.

Fig. 4.

talented of the reformers; while fig. 4 is the atrocious criminal Hare, who murdered by wholesale for gain. The superiority of fig. 3 in intellect is obvious by one glance at the high and full forehead, compared with "the forehead villanous low," as Shakspeare would have called it, of fig. 4. The horizontal line in fig. 4 shows the shallowness of moral brain. A line drawn from the same points in fig. 3 would show a much greater depth; while the mass of brain behind the ear in fig. 4, compared with fig. 3, shows the preponderance of animal brain in the former. Hare's head is an average specimen of the criminal type, of which there are hundreds in the phrenological museums, all of one unfortunate family likeness; while Melancthon's head may be taken as a type of high virtue and intelligence.*

THE PRIMITIVE FACULTIES OF MIND, AS CONNECTED WITH THEIR ORGANS IN THE BRAIN.

Mind, which was considered by the metaphysicians as a single thing or essence, was said by them to be capable of being in different *states*, in each of which states it made one of its various manifestations, as memory, judgment, anger, &c. In no particular does the phrenological hypothesis differ more from the metaphysical than in this. The phrenological doctrine is, that the brain, the organ of the mind, is divided into various faculties, each of which has its own mode of acting. It is held—

First. That by accurate observation of human actions, it is possible to discriminate the dispositions and intellectual power of man, such as love, anger, benevolence, observation, reflection, &c.

Secondly. That the true form of the brain† can be ascertained from the external form of the head; the brain, though the softer substance, being what rules the shape of the skull, just as a shell takes its form from the animal within.‡

Thirdly. The organs or parts into which the brain is divided, all of which organs are possessed by every individual except in the case of idiocy, appear on the brain's surface in folds or convolutions, somewhat like the bowels or viscera of an animal, but have a well-ascertained fibrous connection through the whole substance of the brain with one point at its base, called the *medulla oblongata*, which unites the brain to the spinal cord. The organs have thus each a conical form from the medulla oblongata to the surface; the whole being not inaptly compared to the stalks and flower of a cauliflower.

Fourthly. The brain is divided into two equal parts called *hemispheres*; on each side of the fosse or division between these hemispheres the same organ occurs; all the organs are therefore double, in analogy with the eyes, ears, &c. But when the term *organ* is used, both organs are meant. The organs which are situated close to the middle line drawn vertically on the head, though close to each other, are nevertheless double; for example, Individuality, Benevolence, Firmness, &c.

Fifthly. Besides the brain-proper, there is a smaller brain, attached to the hinder part of the base of the brain, called the *cerebellum*.

Sixthly. The brain, including the cerebellum, is divided into the *anterior*, *middle*, and *posterior lobes*. The cerebellum forms part of the posterior lobe. The anterior lobe contains all the intellectual faculties; the posterior and lower range of the middle lobe are the regions of the animal propensities; while the moral sentiments are found, with a sort of local pre-eminence, to have their organs developed on the top or coronal surface of the head.

* In these contrasted heads, the distinction may appear to be favoured by the way in which they are placed. We can assure our readers that the heads, however placed, fully make out the contrast here insisted on.

† A profile view of the naked brain, with the connected nerves and vessels, is given in the article entitled "Account of the Human Body."

‡ The skull being formed of two plates, a partial separation, generally in the forehead over the nose, often takes place, called the *frontal sinus*. This has given rise to much controversy, and more importance has been given it by opponents than it deserves. Its consequences, which do not affect the general truths of the science, are treated of in most of the phrenological works. We may add, that every student of phrenology should understand the anatomy of the brain, although such knowledge is not indispensable. We cannot enter on the subject of the brain here, but recommend Dr. Spurzheim's work on the brain, and a brief and clear exposition of its anatomy in Mr. Combe's *System*, 4th edition, p. 80.

The gradation in size of the organs is thus denoted:—

Very Small.	Moderate.	Rather Large.
Small.	Rather Full.	Large.
Rather Small.	Full.	Very Large.

It has been found convenient to express these degrees in numbers, thus:—

1.	8. (Rather Small.)	15
2. (Idiocy.)	9.	16. (Rather Large.)
3.	10. (Moderate.)	17.
4. (Very Small.)	11.	18. (Large.)
5.	12. (Rather Full.)	19.
6. (Small.)	13.	20. (Very Large.)
7.	14. (Full.)	21.

The intermediate numbers, 3, 5, 7, &c., denote something between the two denominations, and have been found useful.

In practice, the general size of the head is measured, in several directions, with calliper compasses. Twenty males, from 25 to 50 years of age, measured, from the occipital spine (the bony knot over the hollow of the neck) to the point over the nose between the eyebrows, on an average, $7\frac{1}{2}$ inches; some of them being as high as $8\frac{3}{8}$, and others as low as $6\frac{1}{2}$. From the occipital spine to the hollow of the ear, the average was $4\frac{3}{8}$, some being as high as 5, others as low as $3\frac{1}{2}$. From the hollow of the ear to the point between the eyebrows, as above, average nearly 5; some being $5\frac{1}{2}$, others $4\frac{1}{2}$. From the same hollow of the ear to the top of the head, about an inch behind the centre (the organ of Firmness), the average was $5\frac{9}{10}$; some being $6\frac{1}{2}$, others $5\frac{1}{2}$. Across the head, from a little below the tops of the ears (from Destructiveness to Destructiveness), the average was $5\frac{8}{10}$; some being $6\frac{1}{2}$, others $5\frac{1}{2}$. The averages are in these twenty individuals higher than those of the natives of Britain generally, some of them being large, and none small.

It ought never to be lost sight of, that, in estimating character from development, it is not legitimate to go out of the same head, and compare any organ with the same organ in another head. This will never ascertain the effect of a particular organ in the head where it exists; and for the plainest reason, that character is another word for the most powerful organs, as modified by their neighbours in the same head. A virtuous person may have the organ of Destructiveness absolutely larger than a person remarkable for a violent disposition; but it will be found that there are moral faculties to control, or that there has been education to modify, in the one person, and not in the other. The relative size of the organs in the same head has been compared to the relative size of the fingers in the same hand. We do not think of comparing any one finger with the same finger in other hands. But, in studying phrenology, different heads may be compared, in order to observe where particular organs are absolutely large, and where they are absolutely small. The learner should first attend to *extreme* cases of size, as the most easily observed.

We have said, the larger the brain, and of course the head, the more the power. The old adage, "Big head, little *wit*," is often true, but not always. It is true when, with a large brain, there is a lymphatic temperament, or when some damaging or deranging circumstance has taken place, to deprive the brain of its natural power, or when the largeness is not in the intellectual region. It is to be remarked, however, that even large animal brains have great *animal* power, in spite of their *intellectual* deficiency. A moderate-sized head, of which the brain is chiefly in the anterior or intellectual region, will have much more wit or cleverness than the other. Its power will be intellectual. The adage, which originated ages before these discoveries were made, must now, like many other adages, suffer modification.

Phrenologists further distinguish between *power* and *activity* in the organs of the brain. Power, in whatever degree possessed, is *capability* of feeling, perceiving, or thinking; while activity is the *exercise of power*, or the putting into action the organ with more or less intensity. An individual, for example, may possess great power of rage and destruction, and yet it may remain quiet, and the individual be perfectly calm. His large Destructiveness, however, will be more prone to start into activity than a smaller would. Activity is measured by the rapidity with which the faculties act. Clever brilliant men have active but moderate-sized brains, and do not make the impression, or command the homage, of larger, and of course more powerful, heads.

The powers of mind, as manifested by the organs, are called *faculties*. A faculty may be defined to be a particular power of thinking or feeling. A faculty has seven characteristics, in order to our concluding it primitive and distinct in the mind, namely, 1. When it exists in one kind of animal and not in another; 2. When it varies in the two sexes of the same species; 3. When it is not in proportion to the other faculties of the same individual; 4. When it appears earlier or later in life than the other faculties; 5. When it may act or repose singly; 6. When it is propagated from parent to child; and, 7. When it may singly preserve health, or singly manifest disease.

DIVISION OR CLASSIFICATION OF THE FACULTIES.

The faculties have been divided by Gall and Spurzheim into two great orders—FEELING and INTELLECT, or AFFECTIVE and INTELLECTUAL FACULTIES. The Feelings are divided into two genera—the *Propensities* and the *Sentiments*. By a propensity is meant an internal impulse, which incites to a certain action, and no more; by a sentiment, a feeling which, although it has inclination, has also an emotion superadded.

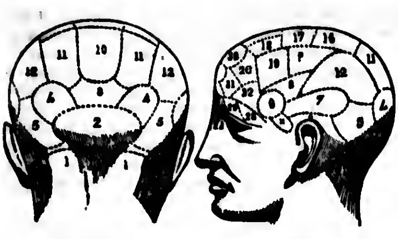
The second order of faculties, the Intellectual, also suffers division into the *Perceptive* or *Knowing*, and the *Reflective Faculties*. The Perceptive Faculties are again divided into three genera—1st, the *External Senses* and *Voluntary Motion*; 2d, the *Internal powers which perceive existence*, or make man and animals acquainted with external objects and their physical qualities; and, 3d, the powers which perceive *the relations* of external objects. The fourth genus comprises the *Reflective Faculties*, which act on all the other powers; in other words, compare, discriminate, and judge.

We owe to Dr. Spurzheim the names of most of the faculties as yet in use; and they have only been ridiculed, on account of their novelty, by those who did not perceive their logical accuracy.* In all the propensities, we find the termination *ive* to denote the quality of producing—as Destruct*ive*. To this is added the syllable *ness*, to denote the abstract state. Instead of *ive*, the termination *ous* is found in the name of a sentiment, with *ness* added—as Caut*ious*-ness, Conscienti*ous*-ness—to express the abstract quality. The names of the intellectual faculties require no explanation. The arrangement of the faculties generally adopted in the present state of the science, is that of Dr. Spurzheim in the third edition of his *Phrenology*, 1825—an arrangement to which he was led by the anatomy of the brain.

In the case of many of the organs, the proof from observation is so strong, that these are said to be *established*, while others are only *probable*; a very few are no more than *conjectural*.

The following is a representation of a bust of the human head in four points of view—front, side, back, and top—with the organs marked by numbers; and there follows a table of the names of the organs synoptically given, before we proceed to describe each faculty as related to its organ. The reader is requested to remember the number of each organ:—

* Dr. Gall created a prejudice against the science by naming certain faculties from their abuse, as the organs of *theft* and *murder*, &c. This was corrected by Dr. Spurzheim.



AFFECTIVE.

I.—Propensities.	II.—Sentiments.
1. Amativeness.	10. Self-Esteem.
2. Philoprogenitiveness.	11. Love of Approbation.
3. Inhabitiveness and Concentrativeness.	12. Cautiousness.
4. Adhesiveness.	13. Benevolence.
5. Combativeness.	14. Veneration.
6. Destructiveness.	15. Firmness.
[Alimentiveness.]	16. Conscientiousness.
[Love of Life.]	17. Hope.
7. Secretiveness.	18. Wonder.
8. Acquisitiveness.	19. Ideality.
9. Constructiveness.	20. Wit, or Ludicrousness.
	21. Imitation.

INTELLECTUAL.

I.—Perceptive.	
22. Individuality.	29. Order.
23. Form.	30. Eventuality.
24. Size.	31. Time.
25. Weight.	32. Tune.
26. Colouring	33. Language.
27. Locality.	II.—Reflective.
28 Number	34. Comparison.
	35. Causality.

ORDER FIRST.—FEELINGS.

GENUS I.—PROPENSITIES.

The propensities are common to man and the lower animals; they neither perceive nor reason, but only feel.

No. 1.—Amativeness.

This organ (No. 1 on the marked bust) is situated immediately over the nape of the neck, and fills up the space between the ears behind, or rather between the mastoid processes, or projecting bones behind the ears. It generally forms a projection in that part, and gives a thickness to the neck when it is large, and a spareness when small. The cerebellum, or little brain, is or at least contains the organ of this propensity. The nerves of sight and hearing can be traced into contact with the cerebellum, which probably accounts for blindness and deafness being often among the frightful consequences of abusing the propensity. In a popular work like this, it would not be proper to go into the details of this function. These are to be met with in the more scientific phrenological books, especially Mr. Combe's translation of Dr. Gall's proofs of the function of the cerebellum. Among other evidences of the function of the cerebellum, it may be stated that the organ scarcely exists in infancy. It was Dr. Spurzheim's opinion, that the fact that the cerebellum is the organ of the amative propensity, was supported by a more overwhelming mass of evidence than any other truth known to him. Many of the enemies of phrenology make the phrenologists a present of this organ, as not to be longer doubted; though, in doing so, they are unawares abandoning their chief tenet, that the brain is not divided into organs. Although Amativeness is the only ascertained function of the cerebellum, it is not impossible, from its size and structure, that it may have others; but no others have yet been discovered.

It is not necessary here to enter fully into the character of this faculty. As the basis of the domestic affections, it is one of great importance, and its regulation has ever been one of the prime objects of moral systems, laws, and institutions. For the evils and calamities, often amounting to national, which it has occasionally led to, in its abuse, we need only refer to history. Dr. Spurzheim held, with regard to this faculty, that, in education, a more candid and explicit mode of treating it might be advantageous; and much could be said in defence of his opinion.

We here present the reader with a head (fig. 5) in which the organ is small, and another (fig. 6) in which it is large. We shall, in the sequel, give a few of the organs as specimens, as we cannot afford space for the whole. This organ is established.

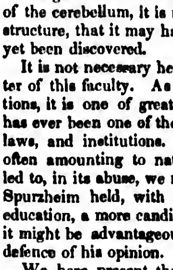


Fig. 5.

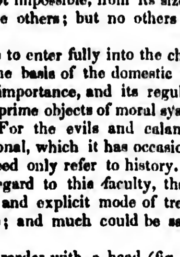


Fig. 6.

No. 2.—Philoprogenitiveness.

This, in man as well as animals, is the feeling of the love of his offspring. It depends on no other faculty, as reason or benevolence; it is primitive; and in the mother, who, for wise reasons, is gifted with it most strongly, its object, the infant, instantly rouses it to a high state of excitement. It is situated in the middle of the back of the head, and when large projects like a portion of an ostrich egg. See fig. 7. It is small in fig. 8.

Fig. 7.

Fig. 8.

It was discovered by Dr. Gall, from its extreme protuberance in monkeys: and we have only to visit a zoological garden to see how that animal cherishes its young. All naturalists are agreed in this as a quality of the monkey species. The organ is one of the easiest to distinguish in the human head. Those who are flat and perpendicular there, instead of being delighted are annoyed by children. It is generally smaller in males than in females, though sometimes found larger; and men so organized delight to carry about and nurse children. The feeling gives a tender sympathy generally with weakness and helplessness; and we find it often returned by the young themselves to the old and feeble. It is essential to a soft kind attendant on the sick, to a nurse or nursery-maid, and to a teacher of youth. It induces women to make pets of small and gentle animals, when tyrant circumstances have kept them single, and denied them offspring of their own. Its feelings are, by a kind Providence, rendered so delightful, that they are extremely apt to be carried the length of excess; and spoiling and pampering children, into vicious selfishness, is the ruinous consequence. The organ is large, and the character corresponds, in the Negroes and Hindoos, who are both good nurses, men as well as women—a fact practically known to our countrymen in the East and West Indies. The most savage races must have the impulse to protect their young, or they would become extinct. The Caribs, the most ferocious race known, are remarkable for a large development of this organ; a fact which may be said to prove, that the care of children is not an impulse of benevolence, as is insisted on by some. The Esquimaux have the organ large; and Captain Parry bears testimony, confirmed by Captain Lyon, to the extraordinary affection of that people for their children. Captain Ross could not, by any bribe, induce any of the parents to part with their children. The organ, like the other cerebral organs, may become diseased; and madness on the subject of children may be found in many asylums. Dr. Andrew Combe attended a woman who had a three days' fit of insane anxiety about her children. On her recovery, she said she had had a *pain in the back of her head*, pointing to this organ; but had forgotten every thing else that had passed. She was altogether unacquainted with phrenology. Under this mental aberration, the most delicate and virtuous female will boast, without the slightest foundation, of being in the family way with twins, nay, with six children at a time. Males have had the same hallucination, and in them the organ was large. This organ is held established.

No. 3.—Inhabitiveness—Concentrativeness.

The organ is situated immediately above the preceding. Two of the most distinguished phrenologists, Spurzheim and Combe, disagreed about the function of this organ—at least about its *whole* function. Dr. Gall did not discover its function at all; and Dr. Spurzheim, observing it large in persons attached to their native place, or any place in which they had long dwelt, called it *Inhabitiveness*. Mr. Combe does not disallow to it this function; and certainly man has such a faculty as attachment to place, often so strong as to render it impossible to move him from a particular spot by the most tempting inducements. The purpose of a faculty which prompts men to *settle* instead of roaming, which latter habit is inconsistent with agriculture, commerce, and civilization, is obvious; *nostalgia*, or home-sickness, is the disease of the feeling. Mr. Combe claims for it, however, a more extended sphere of action than love of place—one, at the same time, with which we have always thought love of place may be reconciled. He has observed the organ large in those who can detain continuously their feelings and ideas in their minds, while the feelings and ideas of others pass away like the images in a mirror, so that they are incapable of taking systematic views of a subject, or *concentrating* their powers to bear on one point. The first class of persons, in conversation, continue the same subject till it is exhausted, and pass gracefully to another connected with it: it is painful to converse with the others whose unconnected thinking gives us the notion of what is vulgarly called *scatter-brains*. Dr. Welsh, and Dr. Hoppe of Copenhagen, unknown to each other, communicated to Mr. Combe their opinion, that the faculty gives the tendency to *dwell in a place, or to dwell on feelings and ideas*, for a length of time, till all, or a majority of the other faculties are satisfied with regard to them. Mr. Combe illustrates a *continued* feeling, by the lengthened pauses in the declamations of Mrs. Siddons and Mr. John Kemble, in which the audience saw the mental state prolonged over the whole interval. We must content ourselves with what we have said, and refer the reader for proofs and arguments, on either side, to the works of Mr. Combe and Dr. Spurzheim. We may, however, observe, that the knowing faculties may be steadily directed by such a power as well as the reflecting. The rope-dancer fixes his eye steadily on the point, else he would lose his balance; and the American-Indian rifleman will lie for many hours behind an object which conceals him, with cocked piece, waiting for the appearance of a hostile head at some selected point, at which he instantly fires with deadly effect. The organ is stated as only probable, till further facts are obtained.

No. 4.—Adhesiveness.

This organ will be observed on the engraving of the marked bust to be situated on each side of No. 3; a little lower down than No. 3, but a little higher up than No. 2, at the middle of the posterior edge of the parietal bone. It was discovered by Dr. Gall, from being found very large, and of the shape as on the bust, in a lady remarkable for the warmth and steadiness of her friendships; and was observed in so great a number of instances to accompany this propensity, and to be flat or hollow in those who never formed attachments, that he came to consider it as demonstrated. It attaches men, and even animals to each other, and is the foundation of that pleasure which we feel, not only in bestowing but receiving friendship. It is the faculty which prompts the embrace and the shake of the hand, and gives the joy of being reunited to friends. Acting in conjunction with Amativeness, it gives constancy and duration to the attachments of the married. Amativeness alone will not be found sufficient for this. Hence the frequent misery of sudden love marriages, as they are called, founded on that single impulse. The feeling attaches many persons to pets, such as birds, dogs, rabbits, horses, and other animals, especially when combined with Philoprogenitiveness. With this combination, the girl lavishes caresses on her doll and on her little companions. Added to Nos. 1, 2, and 3, with which it is in immediate contact and ascertained fibrous connection in the brain, it completes what has been called the domestic group of organs, or the love of spouse, children, home, and the friends of home, as brothers, sisters, cousins, &c. These domestic feelings bind the dwellers under the same roof to each other faster than chains of brass. The finger of God is here, benevolently, effectually, beautifully; for he has made the bonds not irksome but exquisitely delightful. Some of our ballads express Adhesiveness with much beauty. "John Anderson, my jo," and "There's nae luck about the house when our gudeman's awa'," are most touching examples. The feeling is strongest in woman. Her friendships, speaking generally, are more ardent than man's. The faculty is not kindness or benevolence; it is instinctive attachment, often felt by those who are selfish in every thing else—selfish even in their attachments. It is the faculty which prompts man to live in society; and its existence overturns the absurd theory of Rousseau and some others, that man is solitary, and that mutual interest alone bring men to congregate with their fellow-men. There are other faculties, the existence of which implies society as much as the lungs imply atmospheric air, or the eye light: Benevolence, Love of Praise, and Justice, are of the number. It is in this way that a true analysis of the primitive faculties settles, with a word, questions which philosophers agitated for ages without advancing a step. Various animals congregate under the impulse of adhesiveness—sheep, pigeons, deer, &c.; but it should be observed, that pairing for life, or *marriage*, is not found in all, though it is in some of, the congregating animals. M. Vimont thinks there is a distinct organ for the marriage adhesiveness, forming a part of what has been assigned to Philoprogenitiveness, on each side of it. This is yet open for further proof. Mr. Stewart and Dr. Brown both admit this faculty of attachment as primitive in our nature, and describe it nearly as the phrenologists do. Dogs manifest it very strongly. The organ is held to be established.

No. 5.—Combativeness.

The organ of this propensity is situated behind, and a little upwards from, the ear; anatomically, at the posterior-inferior angle of the parietal bone. Compare fig. 9, which is an outline of the skull of General Wurmser, at the organ 5, with fig. 10, that of a Cingalese, at the same

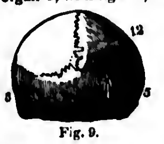


Fig. 9.

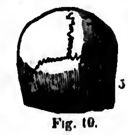


Fig. 10.

organ. No. 12 is the organ of Cautiousness, to be afterwards treated of. In this, the difference is reversed between these two heads. Dr. Gall discovered the organ by a vast number of observations on the heads of individuals whom he observed to be addicted to fighting. Dr. Spurzheim extended its function to *contention* in general, whether physical or moral. In this view Sir George Mackenzie concurs; and Mr. Robert Cox, in an interesting paper in the *Phrenological Journal* (vol. ix. page 147), endeavours to show it to be of the nature of opposition in general, and terms it *oppositiveness*. The condition of the physical world, full of difficulties and dangers, seems in itself to make it necessary that man should possess a faculty giving the impulse to meet boldly, and press vigorously through, such impediments. In the mingled scene, also, which forms the moral world, such an impulse is not less needed. It is easy, therefore, to reconcile with our ideas of divine wisdom and goodness the existence of this vehement quality of our nature, the true intent of which is expressed in the well-known adage of the Mantuan bard—"Ne cede malis, sed contra audentior ito," [*Do not give way to evils, but go the more daringly against them.*] A small endowment of this faculty manifests itself in that over-gentle and indolent character, which is easily aggressed upon, easily repelled by the appearance of difficulty and trouble, and which naturally seeks the shades and eddy-corners of life. Nations so organized—the Hindoos, for example—are easily conquered by others, under whom they naturally sink into a condition more or less of servitude. A large endowment, on the other hand, shows itself in a love of danger for its own sake, a delight in adventurous military life, and a tendency to bluster, controversy, and turmoils of all kinds. Society calls, no doubt, for all the over-average endowments of this faculty which exist, to perform its dangerous and difficult work; and we see such endowments rightly directed in the Leonidases, Wallaces, Tells, and Washingtons of history; in Luther, Knox, and the whole tribe of rational reformers; in the Columbuses, De Gamas, Cooks, and Parrys of nautical adventure, and in such professions as that of the fireman, the common mariner, and the land-clearer of the "far-west." But, being left free to act, and not being certain always to follow the guidance of the moral feelings and intellect, great combativeness often exhibits itself in painful forms—in aggressive war, blustering, bravadoing, outrageous polemics, and a habit of encountering dangers without any useful end in view. The French are much marked as a nation by irrationally directed combativeness. Persons with large combativeness may be readily recognised in private society by their disposition to contradict and wrangle. They challenge the clearest propositions, and take a pleasure in doubting where everybody else is convinced. The generality of boys manifest an active combativeness in their adventurous spirit, and their disposition to fighting, and to the working of all kinds of petty mischief. To control and guide the propensity is one of the most delicate, but also most important, duties of the educator. When combativeness is deranged, we have a violent and noisy, and often a dangerous patient. Intoxication generally affords a great stimulus to it; hence, drunken quarrels and fightings. The organ is established.

No. 6.—Destructiveness.

This organ is situated on both sides of the head, immediately over the external opening of the ear, extending a little forward and backward from it, and rising a trifle above the top or upper flap of the ear. It corresponds to the lower portion of the squamous plate of the temporal bone. When the organ is large, the opening of the ear is depressed. In fig. 11 the organ is large; in fig. 12 it is small. Dr. Gall discovered the organ by comparing

Fig. 11.

Fig. 12.

the skulls of carnivorous with those of graminivorous animals, and afterwards by observing the same prominence in those of several murderers sent him for examination. Dr. Gall, from observing the organ large in murderers, called it the organ of murder, thus describing it from an abuse, a mistake which gave occasion to a great outcry against his doctrines, and not without cause. It is still generally considered as giving the impulse to kill and destroy; but, in man, this propensity is shown to have, under the control of the higher sentiments and intellect, a legitimate sphere of exercise. Those roughnesses and difficulties in the physical world which have been shown to call for the exercise of combativeness, that man may not sink under them, also appear to call for a faculty which may prompt to the destroying or repressing of them, so that the way may be cleared for the future. The annoyances and troubles of the moral world call in like manner for a faculty which may be always endeavouring to put an end to them. There are many animate and inanimate things, and many institutions and social arrangements, which, though useful for a time, become in the end noxious, and require to be destroyed: the organ under notice appears to be that which is commissioned to do this duty. It prompts beasts and birds of prey to keep down the redundant breeds of the lower animals, and enables man to "kill" that he may "eat." It dictates the demolition and clearing away of obstructive objects of all kinds, and prompts Luthers and Mirabeaus to the extermination of bad systems. Anger, resentment, and indignation, in all their shapes, likewise spring from this faculty. St. Paul indicates its legitimate exercise in this class of its manifestations, in the words "Be ye angry and sin not." The penalties imposed in all civilized communities for offences arise from destructiveness, more or less under the guidance of reason and humane feeling. Blame may be described as a comparatively gentle emotion of destructiveness.

A small endowment of this faculty is one of the elements of a "soft" character. Persons so organized seem to want that which gives momentum to human operations, like an axe wanting in back weight. The Hindoos are deficient in Destructiveness as well as Combativeness, hence their remarkable averseness to the shedding of blood, and, in a great measure also, their being constantly the slaves of other and more energetic nations. Those, on the other hand, who have a large endowment of Destructiveness, are generally marked by an energetic, and probably fierce and passionate character. If uncontrolled by moral feelings naturally strong, or cultivated into activity by education, they are apt to be violent and vindictive. Low and untutored natures generally allow free exercise to this feeling, as we may daily see in their brutal swearing at each other, their horrible combats, their cruelty to every helpless creature under their care, and their delight in whatever is merciless and inhumane. The highly-trained gentleman generally masters the tendency to all such manifestations, but often shows the same native quality active in his nature, in polished sarcasm and invectives, in duelling, and in cold and stately alienation from those who have given him offence. The most notable abuses of the faculty is in homicide, a crime which the mind in a temperate state regards with horror. This act is often perpetrated under the influence of infuriate resentment, but is also sometimes committed without the appearance of any such prompting cause. Men have confessed to the committing of murder under impulses which they could not account for, but which they were equally unable to restrain. In these cases, we may surmise that the impulse took its rise in some morbid action of this organ. Frantic inclination to break and smash is also, probably, an effect of this organ in an unduly excited or diseased state. There are instances of rational and excellent men, who, at a particular and by no means advanced stage of intoxication, find themselves unable to refrain from breaking bottles, mirrors, and other articles of value near them.

In a very ingenious and elaborate paper in the Phrenological Journal, Mr. Robert Cox has expounded a law affecting Destructiveness and Benevolence. It is no more than the common observation of mankind, that every pleasure we enjoy tends to soothe and to create a feeling of good will to others; while every annoyance equally tends to ruffle and to produce a feeling of anger. Mr. Cox traces this to a sympathetic action, of which each of our faculties is capable with regard to Benevolence and Destructiveness. Are we undervalued?—our Self-esteem instantly awakens the latter faculty. Are we disappointed of a meal, or even of a favourite dish?—our Alimentiveness is equally alert in rousing this sleeping lion, and a certain exhibition of pettishness is the almost unavoidable consequence. Is a scene of wanton cruelty presented to our gaze?—our Benevolence sounds the alarm to the faculty which may be termed its declared enemy and antagonist, and we are all eagerness to punish the authors of the outrage; and so on. Even Destructiveness itself may be so much pleased by being allowed a free action, that a benevolent feeling may for a brief interval supersede it, and induce a wish to act kindly by its victims. Were this law affecting Destructiveness more generally held in consideration, many angry and violent scenes might be spared, and social life in general would be much sweetened.

The organ of Destructiveness is held to be established.

Alimentiveness, or Appetite for Food.

Some of the recent phrenological works treat, in this part of the order of the faculties, of a faculty of Alimentiveness, and also of another which follows, namely, Love of Life. The first being yet no more than *probable*, and the second only *conjectural*, they have no number allotted to them on the bust.

Alimentiveness is the desire of, or appetite for, food. In this feeling, as such, the stomach is not concerned: its functions are strictly confined to the reception and digestion of our food. But, that the mind is concerned in our desire of food, is proved by many circumstances. This desire often continues after the stomach is overloaded; it often prompts to a fulness and frequency of feeding, which must be in the highest degree inconvenient to the digesting organ. The *nausea* created in the sick by the idea of food—the rush of saliva to the mouth of the gourmand, on hearing a description of rich dishes—must alike be the effect of mental emotions. Appetite may be taken away by other organs of the brain being suddenly and strongly affected; as, for instance, in sudden accesses of joy, fear, or grief. In these cases, we may presume that the nervous influence is abstracted from the organ of Alimentiveness to supply the extra demand of the others. Were desire anywhere but in the brain, there could be no permanent character in individuals, as the glutton, the epicure, the abstemious. The stomach alone could make no such discriminations. Satisfied that appetite is a mental faculty, phrenologists have long been looking for its organ. Dr. Hoppe of Copenhagen was the first to observe, in those who manifested remarkably the gourmand or glutton, a fulness in front of Destructiveness, in the *fossa zygomatica*, between the top of the ear and the temple. Its place is marked by a cross † on the side view of the bust. Many phrenologists have confirmed this by observation. The convolution is developed in the base of the brain farther in than that of Destructiveness; but it is believed that it also shows itself by contact with the cranium at the point now described. A phrenologist once saw it obviously large in the head of a stranger who sat opposite to him in the saloon of a steamship going to London. He resolved to observe the individual's manifestations; whenever he heard the gentleman speaking, it was about excellent dinners and cookery, while his practice was eating and drinking, with short intervals, all his waking hours. The propensity is subject to insane action, one of the strongest proofs of its being a primitive faculty of mind. Voracity and insatiableness, far beyond the stomach's natural capacity, or the natural want, are then often the consequences. A patient in the Infirmary of Edinburgh was permitted, by way of experiment on the capacity of the stomach, to eat for six hours without stopping. He declared in a state of delirium, that nevertheless he was dying with hunger. His delirious cry was "Hunger! hunger! hunger!" He complained of pain in the spot where Dr. Hoppe observed the development of the organs, and nowhere else. Mr. Sydney Smith states, that a patient in the same circumstances was blooded with leeches at the same spot, and thereby relieved. M. Descuret mentions a woman in the Salpetrière, who ate the allowances of fifteen persons, and was always stealing bread and meat; when prevented she had recourse to raw vegetables, plants, and roots, and poisoned herself by devouring ranunculuses. Alimentiveness, from its near neighbourhood to Destructiveness, seems to have a peculiar influence on that faculty, rousing it to great energy when its own enjoyments are endangered or interrupted. It is not horses, dogs, and wild beasts alone, which are dangerous when feeding. The organ of Acquisitiveness is also close to this supposed organ. Mr. Simpson observed the organ of Alimentiveness large in a young man, with very large Acquisitiveness, who had periodical fits of indiscriminate theft; and expecting that Alimentiveness might probably be active at the same time, asked the question, and was answered, that the young man's friends knew when to look after his stealing propensity by being forewarned by his inordinate voracity. The function of this faculty is obvious from its object, namely, food suitable to the palate and digestion, and its end the preservation of the individual. In diseased action it is discriminating, as in the case of the devourer of ranunculuses; but when acting in health, it discriminates the food which is desirable, and rejects other substances. It has been said that animals are easily poisoned; this is true, but it is always by disguising the poison in the food which their alimentive faculty especially selects. The chick just out of the egg-shell picks up crumbs and seeds, but rejects pebbles and sand; and the new-born child, without the power of relieving any other pain, if all the medicines known were placed within its reach, instantly relieves the pain of hunger by applying its lips to the nipple and draining its mother's breast. Stimulating liquors are supposed to please this organ, so as to constitute it the organ of drinking as well as of eating. Hence the prevailing conclusion that drunkenness is a functional, if not an organic, disease; and in America, as well as this country, it has been treated as such. Tobacco and opium are believed to be cravings of this organ; but much observation is called for before phrenologists can speak positively on the subject. No attention has been paid to the proper training of this faculty in education. Its natural activity in the young, their bodies demanding much food, has been too much pampered and indulged, to the great injury of both health and character in after life. Gluttony and drunkenness stimulate the other animal organs, and hence the licentiousness of gluttons and drunkards—hence, too, their crimes. Insanity is one of the ordinary effects of starvation. The organ may now be said to be advanced from *conjectural* to *probable*.

Love of Life.

The self-preservation involved in the love of life is certainly not accounted for by any known organ or combination of organs. Cautiousness is fear of injury; fear of death; but it is not love of life. This feeling is powerfully manifested by some when their life is in no danger, but who look upon the close of life as a very great evil. Others are so indifferent on the subject, as scarcely to care whether they live or die, but for the disagreeable effect the contemplation of death has upon their other faculties—such as leaving children unprovided, &c. Mr. Combe thinks that the organ is situated in the base of the brain, and that its development cannot be ascertained on the skull during life. Dr. Andrew Combe had a patient whose constant theme was her love of life, and her unwillingness to part with it. After her death he saw the brain, and observed an enormous development of one convolution at the base of the middle lobe of the brain, lying towards the middle line, farther in than both Destructiveness and Alimentiveness. The base of the skull presented an uncommonly deep groove, in which the convolution lay. The Scottish phrenologists wait for further observation before coming to any conclusion on this supposed organ. The French phrenologists think they have discovered the organ immediately above the sphenoid bone; but their facts are too few and uncertain to be philosophically founded upon.

No. 7.—Secretiveness.

The order of this faculty will be observed, by its number on the bust, to be situated immediately above that of Destructiveness, at the inferior edge of the parietal bones, or in the middle of the side of the brain. Dr. Gall observed this fulness in one of his companions remarkable for finesse and cunning, and for its sly expression. He observed it in another companion, whose gait and manner were those of a cat watching a mouse. The first companion was honest, and only deceived for sport; the other, however, being deficient in moral restraint, turned out perfidious, and deceived his companions, his tutors, and his parents. One of Gall's patients, who possessed a large endowment of the organ, continued through life to deceive the world as to his real character; but his affairs on his death proved that he had been extensively fraudulent. Dr. Gall cites many other instances of deceitful and cunning characters, all showing the same development. An immense number of observations have confirmed the soundness of Dr. Gall's conclusions with regard to the function of this organ. The legitimate use of the faculty is to exercise that control over the outward manifestation of the other faculties, which is necessary to a prudent reserve. Without it, and of course, in those in whom the organ is small and the manifestation weak, the feelings express themselves too openly. Such individuals "wear their hearts upon their sleeves, for daws to peck at." They are too open and unsuspecting, and often all good taste and propriety are lost sight of by them, in the exposure of their feelings. Society would be insupportable were there no secretiveness. There is an amusing fairy tale called *The Palace of Truth*, designed to show how truly this is the case. We may consider secretiveness as an instinct to conceal the feelings or thoughts, till reason shows it to be prudent to declare them. This control evidently was not left to reason alone, whose judgment would have proved too slow for the end intended. Concealment is given to animals to enable them both to avoid and to prey upon each other. Many animals owe their safety from their destroyers to their cunning; while to others is given that quality to steal upon their prey unperceived; such as the fox, the cat, the tiger, &c. Mr. William Scott, in an essay in the *Phrenological Transactions*, has thrown much light on the functions of this organ. The secretive, he remarks, are always occupied with prying into the thoughts and motives of others, while they are closely veiling their own. The character of Louis XI., as drawn in *Quentin Durward*, is of the "calm and crafty" description; he used to say, that if his cap knew his secrets, he would throw it into the fire. Such are the intriguing politicians of the old, and yet too much of the modern school, who mistake cunning for wisdom.

In abuse, the faculty leads to lying, hypocrisy, and fraud. When acting with Acquisitiveness, it forms the thief, cheat, and swindler. The organ is almost always found large in these persons; and they have been known to say that they have great pleasure in the secretive part of their profession. All *ruses* and stratagems are exercises of secretiveness. The faculty, in combination with the Love of Approbation, occasions much of the hypocritical insincerity of civilized society. It is, according to Mr. Scott's view, the basis of that form of the ludicrous called humour, namely, concealing the mirth which is in one's own breast, and with a grave countenance and manner setting the table in a roar. The actor must possess the organ largely, if for no other purpose than to preserve his gravity while his audience is laughing; but still more to conjure down his natural faculties, that he may assume those of the character he plays. Mr. Scott allots both efforts to Secretiveness; while Mr. Combe, with more truth, limits Secretiveness to the concealment of the actor's own natural feelings, while the positive act of imitating those of his part must be the result of Imitation. Accordingly, in all great actors both Secretiveness and Imitation are large. To such an extent is Secretiveness carried in the practice of *malingering*, as pretending sickness is called in the army and navy, that incredible tortures have been submitted to without a wince. In such cases, Firmness, of course, aids Secretiveness.

We are indebted to Mr. Richard Carmichael of Dublin, for a report of the singular case of Anne Ross.* This girl, to gain the favour and charity of some pious ladies, thrust needles into her arm to produce disease, and went the length of submitting to amputation without revealing the truth. On dissecting of the arm, the needles were found, a circumstance which appeared to distress her much more than the loss of her arm. Mr Combe saw this extraordinary girl in Dublin, and found both Secretiveness and Firmness large in her head. He supposes that the power of enduring torture, without the expression of pain, which is the boast of the North American Indians, is the result of these two faculties, which are found large in all the skulls of that race in the museum of the Phrenological Society of Edinburgh.

* Phrenological Journal, vol. ii. p. 34.

The Hindoos are cunning, and Secretiveness is large in their skulls, in the same collection, and proved to be so by a much more extensive observation in India. The organ is subject to disease, and the cunning insane are difficult to deal with. Disease here leads to the belief in plots and conspiracies formed against the patient, so common with the insane. The manifestation of Secretiveness ought to be watched in education, and regulated, and the maxim impressed, that cunning is not wisdom. The organ is held by phrenologists to be established.

No. 8.—Acquisitiveness.

The organ of this faculty is situated farther forward than, and a little above, Secretiveness, at the anterior-inferior angle of the parietal bone. The existence of a cerebral organ for the desire of property, bearing a proportion in size to the degree of that desire, decides the question of the feeling being a primitive *animal* power, and not, as Hutcheson, Stewart, and Brown have held it, the natural result of calculation, wealth being the means of gratifying all our other inclinations. Man feels as an animal before he reasons. Lord Kames, whom the *regular* metaphysicians of his time considered as admitting too many faculties, takes, by sagacious anticipation —as he did when he recognised a hunting and killing propensity in man, phrenologically Destructiveness— the phrenological view of Acquisitiveness as primitive, and calls it "the hoarding appetite." This theory of it alone explains the miser's desire to accumulate, without ever putting his wealth to the use required by the metaphysicians above named, the purchase of enjoyment, the gratification of the other faculties. Mr. Combe illustrates this blind passion for wealth by alluding to the character of Trapbois in *The Fortunes of Nigel*. The very essence, he says, of this character, which is true to nature, is a desire for wealth, independent of every purpose of application.

Dr. Gall discovered the organ by resorting to what was a common practice with him, collecting a number of persons of the lower orders in his house, and encouraging them to the freest manifestation of their natural and unregulated instincts. He found that some in each group were characterized by the rest as thieves, and these were generally proud to avow their skill in this line. Among his very promiscuous visiters were some that abhorred theft, and others who were indifferent in the matter. He found the thieves with the organ large, those who abhorred theft with it small, and the medium individuals with a medium development. Among the deaf and dumb of an institution which he served as physician, he found some who showed the thieving propensity, with the corresponding organ. Visiting, as he did, houses of correction and prisons, he found the organ always large in thieves; and was unfortunately led to call it the organ of Theft, thus describing not the primitive function or legitimate use of the faculty, but one of its greatest abuses, and raising strange misconceptions with respect to his system of mind.

The faculty of Acquisitiveness could not, and no faculty could, be given to man by his Creator for a mean, grovelling, and immoral use; accordingly, when we consider it aright, we recognise in it the dignity of the greatest utility. In a word, it is the faculty through whose impulse man accumulates *capital*, and nations are rendered rich, great, and powerful. Without the faculty, man would be content to satisfy his daily wants, although even in this he would fail; but the surplus which, under the impulse, of this faculty, he contributes to the store of wealth which accumulates from generation to generation, would not exist. Under proper regulation, then, the faculty is of the greatest value to man; by means of it he "gathers up the fragments, that nothing may be lost." Excessive pursuit of wealth is, however, an abuse of the faculty, and too much the vice of civilization, when it advances, as it has hitherto done, without adequate moral improvement. This abuse withers up every generous purpose, perverts the intellect itself, and is a grand national evil. This country, at its present stage of progress, suffers from this abuse of Acquisitiveness. So, according to Mr. Combe, does America.* When accumulation becomes a passion in the trader, there is no end to it: it is necessary to his happiness, and hence one element of the *ennui* and regret of the retired tradesman or merchant.

The faculty is often diseased, so that those who are insane in this organ, without any temptation arising from their circumstances, which are often above want, and even prosperous, pilfer every thing of value, and often of no value, which comes in their way. Many incorrigible thieves in lower life, on whom the punishments of the law fail to have any effect, are diseased in this organ. Phrenology is daily demonstrating that many supposed criminals are in truth *patients;* and a more enlightened and benevolent system of criminal treatment, from which the element of vengeance shall be excluded, will in time come to deal with them as such. When treating of alimentiveness, we mentioned the case of a young man, the son of a man of fortune, who was subject to fits of *voracity* and *stealing* simultaneously; the following is an account of his case:—"An English gentleman, aged nineteen, and his tutor, a clergyman, requested that the development of the former should be taken, which was done by Mr. Simpson, and afterwards confirmed by four other phrenologists. General size of head, considerable; anterior lobe, large; temperament, two parts sanguine, two nervous, and one lymphatic. Development irregular and unusual. (Here follows an estimate of the organs, of which it is enough to say, that Amativeness, Philoprogenitiveness, and Acquisitiveness, are large, and Self-esteem, Benevolence, and Veneration, very large—the two last unusually so.) He had been rickety, scrofulous, and unable to walk alone until six years. His feelings were always, as his tutor expressed it, 'at high pressure.' Knowing that the impulses were thus strong, Mr. Simpson considered the case as one of a certain degree of derangement. He inferred that all that class of faculties, called the Feelings, would act with a force beyond the control of the individual. The tutor was much struck with the question, 'Does your pupil appropriate articles that do not belong to him?' And the answer was given that he had been forced to quit a great public educational institution for detected *theft*, committed both in shops and houses. Mr. S. then inquired respecting vicious manifestation of another of the propensities, and received, as in the former case, a strikingly affirmative answer. 'Did fits of *voracity* in food ever show themselves?' *Answer*. The three vices acted simultaneously, so that the others had to be watched when the voracity appeared. Mr. S. then observed to the tutor that his pupil was a patient, not a criminal. Yet, wherever he had turned, he had seen hostile society, and even legal vengeance; the walls of the late place of his study were chalked with his disgrace, and prosecution threatened by tradesmen. The present was the first time that his tutor had heard him humanely sheltered as an irresponsible being, visited with *disease* by his Maker's hand. The organization of the young man indicated great kindness of heart, which, his tutor said, was manifested at any expense of personal labour; great tenderness to children; and, what was most to his tutor's content, ardent devotional sentiments and active religious habits. Of course, all who knew the fatal propensity of theft to which the young man was subject, set his religion down to gross and disgusting hypocrisy. Phrenology teaches

* See Notes on the United States.

that such religious feelings, when mere feelings, as they are if undirected by intellect, are impulses quite as real as the acquisitive propensity itself. Flying from prosecution and persecution, without one friendly hand held out to him, save that of his kind-hearted tutor and a few pious persons who prayed over him in vain, the outcast comes at last, at the distance of hundreds of miles from his forbidden home, into contact with the disciples of a new and ignorantly-despised philosophy of man, by whom his case is at once understood and explained, and a means pointed out for his cure." We may add, from our own knowledge, that, at the suggestion of those who had judged of his case, the young man was boarded in the country, with a much larger pecuniary allowance than his relations at first intended for one whom they ignorantly held a disgrace to them; that he gradually recovered his health, was released from his bad habits, and is again of sound mind and correct conduct.

The periodical recurrence of disease in Acquisitiveness is a curious fact. The young man just alluded to was subject to such fits, and many other instances are detailed in the works of the phrenologists. Dr. Gall cites four cases of women, who, in their ordinary state, had no stealing tendency, but manifested it in the most marked, and, to those around them, unaccountable manner, when in a state of pregnancy: the brain at that organ, or its neighbourhood, must have been subjected to some morbid over-excitement during the peculiar condition of the system which pregnancy induces.

A variety of the inferior animals manifest the sense of property, and some of them of accumulation. It is a mistake to say that human laws establish property; a natural propensity does this, and laws become necessary to protect it. The organ is established.

No. 9.—Constructiveness.

The situation of this organ is immediately behind the temples, in the frontal bone, above the spheno-temporal suture. It is sometimes found higher up than its usual position; but a little practice familiarizes the observer with its appearance. The temporal muscle, which varies in thickness, throws some difficulty in the way of ascertaining this organ and also that of Acquisitiveness. This thickness can be felt in the living subject, while the lower jaw is moved, and its thickness may be allowed for; which cannot be done in a plaster cast. The difficulty is removed when the cast is taken, not from the head with the integuments, but from the skull. The faculty of which this organ is the instrument, is the power of mechanically making, constructing, and fashioning, by changing the forms of matter. Many of the inferior animals possess it, as the bee, the beaver, birds, and insects. Some savages have it in such small endowments as never to have built huts or made clothes, or even the simplest instruments for catching fish. Such are the New Hollanders, in whom the organ appears very slightly developed. Drs. Gall and Spurzheim verified this organ by a vast number of instances—in mechanicians, architects, designers, sculptors, and even painters. Indeed, the concomitance is so constant as to be a test of the fitness of individuals to be devoted to those branches of art. It is easily observed, and the student may verify it for himself. In the casts of the heads of the celebrated Brunell, the inventor of the block-machinery and engine work of the Thames tunnel, Sir W. Herschell, the painters Haydon, Wilkie, and Williams, it is remarkably large. In all operatives who excel in their art—engravers, joiners, tailors, &c.—and in children who early manifest a turn for drawing figures, and cutting them out in paper, the organ is large. Naturally the French, and still more the Italians, are more constructive than the English; yet, with the aid of capital, the division of labour, and other favourable circumstances, the English actually are the greatest manufacturing, in other words, constructive, people in the world. Were these advantages transferred to France and Italy, a greater prevalence of the faculty would make it more easy to procure skilful hands. The metaphysicians do not recognise a primitive faculty for Constructiveness, but consider mechanical skill to be the result of reason. This is an error, which the slightest observation contradicts. Were it true, the most sagacious animals would be the most constructive; yet the horse, the dog, the elephant, never construct; while the bee, the beaver, and many birds and insects, perform works, by this instinct, which excite our wonder. Very young children, long before reason could assist them, have manifested proficiency in making models, drawing, cutting with scissors, &c.; and a talent for mechanics, often amounting to a passion, turning, clock-making, lock-making, has been found in judges, statesmen, nobles, and even princes. This talent is often possessed in a high degree by men of very moderate and even inferior reflective powers; while some men of a great intellectual standard have been unable to make a pen. The primitive character of the faculty is proved by the power being often so much increased by insanity, as to appear to be created by it. Idiots are often skilful constructors, witness many of the Cretins of the Alps. Intellect is, however, important to the range, variety, and application of human Constructiveness; while the Constructiveness of the inferior animals is limited to one invariable result.

The use of this faculty is obvious. Physical nature consists of raw material, in scarcely any instance fitted for the convenience and accommodation of man. Constructiveness prompts him to form and fashion; and he continues to do so, advancing—which the inferior animals never do—from building the rude wigwam and making the stone hatchet, up to achieving the palace, the steam-engine, and the cotton-spinning machine. Man was held by Franklin to be the only tool-making animal; unlike the other animals, he constructs tools to apply to further objects of construction. Mr. Richard Edmonson, of Manchester, in an ingenious paper in the *Phrenological Journal* (vol. ix. p. 624), while he admits this organ to be that of the impulse and power to construct, form, and fashion, suggests that, inasmuch as we cannot construct, form, and fashion, without a nice perception of the application of the requisite force, it is therefore the organ of the faculty, which must exist, for the application of force in counteraction of mechanical resistance. He cites many cases in confirmation of this view. If he be correct, the function of the faculty must be much extended, for all animals apply force to antagonize resistance in many ways, without either constructing or fashioning. We shall, in the sequel, be brought back to this subject. The organ of Constructiveness is established.

GENUS II.—SENTIMENTS.

Mr. Combe introduces this branch of the subject thus:—"This genus of faculties embraces certain feelings which correspond to the 'emotions' of the metaphysicians. They differ from intellectual perception in being accompanied with a peculiar vividness, which every one understands, but which it is impossible to express by any verbal definition. They may be excited by the presentment of the external objects naturally related to them, as danger is to fear, or august appearances to reverence, or by the spontaneous activity of the organs. Dr. Spurzheim has named these faculties *Sentiments*, because they produce an emotion or feeling of a certain kind, joined with a propensity to act; but, as shown in the Appendix No. II., the detail of his classification is here by no means accurate. Several of them are common to man and the lower animals; others are peculiar to man. The former, styled the Inferior or Lower Sentiments, shall be first treated of." The argument referred to by Mr. Combe in his appendix, is an abridgment of an ingenious paper by Mr. Robert Cox, in the *Phrenological Journal* (vol. x. p. 154), in which he endeavours to show that, on the one hand, several of the propensities are accompanied by emotions as well as inclinations t act, and, on the other, several of the sentiments have likewise both qualities. We are inclined to go farther even than Mr. Cox, and to submit for the consideration of phrenologists, whether all the faculties, not excepting the intellectual, have not both a propensity to act and an emotion. At present, however, we will not disturb the old arrangement. The reader will judge for himself. Much is yet to be done in the metaphysical department of the subject.

I. SENTIMENTS COMMON TO MAN AND THE LOWER ANIMALS.

No. 10.—Self-Esteem.

The situation of this organ is at the top of the back of the head, at the centre; forming, as it were, the curve or turn between the back and top of the head. Technically, it is a little above the posterior or sagittal angle of the parietal bones. When it is large, the head rises far upward and backward from the ear, in the direction of the organ. It is large in fig. 13 and small in fig. 14. Dr. Gall first observed the organ in the head of a beggar. This man had spent a fortune, and was too proud to labour for his bread. Dr. Gall long hesitated to believe that pride could stoop to begging; but the individual positively averred that his sense of degradation in condescending to labour was much greater than in begging and living in idleness. The organ was noted by Dr. Gall, and found by him large in a great number of proud men. He cites many instances of this concomitance of organ and manifestation. A physician of Vienna, when

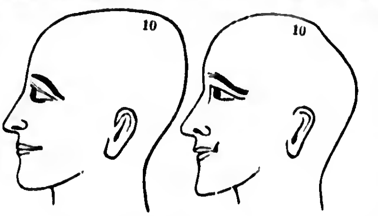


Fig. 13. Fig. 14.

called to consultations, always put himself before even his seniors, and insisted on placing his signature first on all occasions. At Heidelberg, Dr. Gall saw a girl of eighteen, who could not bear a word of familiarity. When she spoke, assurance and presumption were expressed in her features. She carried her head high and a little backwards, and all her movements expressed pride. Although of humble rank, she contrived to associate only with persons of rank superior to her own. Dr. Gall found the organ large in chiefs of brigands, whose pride was a main cause of their bad eminence. The legitimate use of the faculty of Self-Esteem, or Self-Love, is that degree of self-complacency which enhances the pleasures of life, and which gives the individual confidence in his own powers, and leads him to apply them to the best advantage. It is sometimes called proper pride, or self-respect, in which form it aids the moral sentiments in resisting temptations to vice and self-degradation: this is called being *above* doing a criminal, a vicious, or a mean action. Its deficiency renders an individual too humble, and the world take him at his word, and push him aside. In large and uncontrolled endowment, it produces great abuses, and causes much annoyance and often misery to others. It is the quarrelling, insulting, domineering tyrannizing, duelling faculty. In children it is pettishness, forwardness, and self-will, and produces disobedience. In adults, it gives arrogance, superciliousness, and selfishness. In nations, the feeling shows itself in national pride and boasting. It characterizes nearly all, if not all nations, every one concluding itself the most meritorious, if not the greatest people on earth. This produces contempt of other nations, and leads to international jealousies and hatreds, the origin of almost all the wars that have disgraced and desolated the world. It is not long since, in England, the young were trained up to call the French people their "natural enemies!" The Greeks and Romans styled all other nations barbarians, and the Chinese do the same at this day. The vainglorious records and anniversaries of our battles, the exultations because of our martial prowess, our illuminations, and our very *Te Deums*, are all the offspring of Self-Esteem. It occupies the individual so intensely with self, that he is insensible to all interests but his own; every thing is seen by him through the medium of self. The first thought, when a proposal is made, is, "How will this affect *me?*" Love of Approbation is often useful by subjecting the individual to some degree of dependence on the opinion of others, to moderate the intensity, the exclusiveness, of Self-Esteem. Without this counterpoise, the self-esteeming person becomes a self-erected standard of opinions, manners, and morals. It has been observed, that proud men often marry beneath their rank; less, we think, because they do not like to risk the mortification of refusal in their own rank, for they do not think it possible, but that they do not conceive that any thing which they may please to do can be degrading. These are your solemn men, your "Sir Oracles," who, mistaking, as they often do, the mere blind feeling of self-exaltation for talent and genius, speak forth the merest twaddle with a solemn emphasis extremely ludicrous to those who see its nothingness. But every thing that comes from a person of such self-importance *must* be admirable. Accompanying this high appreciation of self, we generally find depreciation of others. This is the basis of sensoriousness and invidiousness. Discussions of character, with vilifying remarks, come from a large Self-Esteem and that want of candour and fairness which is the result of an inferior endowment of Conscientiousness. Envy, which includes hatred, is Self-Esteem rousing Destructiveness; with deficient Benevolence and Conscientiousness, the envious could injure a fortunate individual merely because of his better fortune. It is a modification of invidiousness, although directed against things and not persons, to affect to undervalue every thing one sees—in other words, never seem pleased—in order to reap from this petty exhibition a fancied consequence, extremely gratifying to a large and active Self-Esteem. This character is satirized by Voltaire, who makes Candide naïvely exclaim, "What a great man that Pococuranté must be—nothing can please him." Never let the truth be forgotten, that the abuses of Self-Esteem, and also of Love of Approbation, invariably defeat their own end; they lower, but never exalt, the individual. The feeling magnifies not only self, but all that belongs to self. A vulgar Self-Esteem prompts the individual to dilate upon the excellence of "*my* horse, *my* gun, *my* yacht, *my* house," merely because they are *his*. Mr. Combe states, that an eminent phrenologist sailed passenger with a captain in whose head he saw the organ very large, and Reflection and Conscientiousness deficient. His manifestations were in accordance. His ship, which he thought a very ordinary vessel before it was his, "became the first of Sea-boats" when it became *his*. He himself was the most powerful of captains dictatorially telling his passengers that he would send them before the mast, and speaking always of himself. The phrenologist observing that the organ of Cautiousness was large in a petty tyrant, dexterously used it as a counter-working engine, and in his turn ruled the ruler. A large Self-Esteem renders its possessors what is called *touchy*—impatient of reproof, and irritated by it, however just, as if it were a positive injury. The *cause* of reproof in misconduct of their own, however marked to every one else, goes for nothing with, or rather is never admitted by, themselves. *They* are of course never in the wrong, *that* is impossible; and however they may have by some act injured others, to be even told that they have, is an injury which they deeply resent. They are always themselves in such cases the injured party. A loud and clamorous announcement of this is sometimes resorted to by the secretive and unconscientious, in order to avert the legitimate resentment of the really injured party. Yet as Self-Esteem is almost in every one a strong and also a tender feeling, it ought to be one of our earliest, longest-continued, and most earnestly-pressed exercises, to moderate its manifestations in ourselves, and treat it tenderly in others. The greater part of real politeness, and of its external manner, consists of an effort to reduce, outwardly at least, our own self-estimation and our general selfishness, and pay homage to, or treat delicately, these feelings in others. In low society, the rudeness and coarseness which work the most annoyance, are nothing else but an unregulated contest of the self-esteem of the individuals for temporary ascendency; and to this may be traced the quarrels and blows with which, in that society, even convivial meetings are often disfigured. Yet the refined visiters of the drawing-room, and the brawlers in the pot-house, are the same beings; only the one class restrain, while the other gives free vent to, Self-Esteem, and yet lower propensities. Intoxication, in some individuals, increases the activity of Self-Esteem. This was ludicrously experienced by a person who, when negotiating for the purchase of a horse, thought, by giving liquor to its owner, to find him more easily dealt with in his inebriety. He succeeded only in rendering him utterly impracticable. *His* horse rose above all price, and he resented as an insult the very proposal of the other to buy it. The self-esteeming individual uses the capital *I*, with *me*, *mine*, *myself*, and other correlatives, with great emphasis and abundance, both in discourse and writing. There is a joke against an author of this stamp, that, during the printing of a work of his, the press was stopped till the printer could get a fresh stock of capital I's. Cobbett was an example; his Self-Esteem and Combativeness led him to dogmatize quite as confidently *every time*—and the times were many—that he changed his opinions, as he had done before the change. All patronizers are self-esteeming and benevolent men. You will know them by such modes of address as "My good sir"—"My good fellow"—"Mark *my* words"—"That's *my* maxim," &c. Mr. Scott contributed an amusing paper to the *Phrenological Journal* (vol. i. p. 378), of great value, in which he shows the effects of Self-Esteem in combination with various other faculties. A *small* endowment of this faculty is exceedingly rare. A large endowment leads to a wish for selfish and exclusive pleasure. This feeling will be observed in children who value some indulgence the more that their brothers and sisters are not to share in it. Proper training would prevent this paltry and most unamiable manifestation; and likewise lead perhaps to less of that modification of selfishness seen in adults in the ambition of possessing *uniques*. Such persons have been known to purchase a duplicate, if they heard of the existence of one, in order to destroy it, and then boast of being the sole possessor of the article in the world. Parks and palaces are kept shut against the public by the same pitiful spirit. Self-Esteem gives love of power and dislike of power in others. Hence the notorious fact, that many violent republicans have become, when vested with power, the greatest tyrants. A due proportion of the feeling, however, is essential to independence in a people. The English have it large.*

Self-Esteem has a marked natural language. When powerful, the head is carried high, and reclining backwards, an attitude well known to stage kings and lords. The manner is cold, haughty, and repulsive; and two self-esteeming persons meeting, repel each other like the similar poles of magnets. Dr. Reid and Mr. Stewart acknowledge this sentiment, under the name of the Desire of Power. Dr. Thomas Brown calls it Pride. It is evident that these are narrow and partial views of the feeling—one or two only of its manifestations; phrenology alone has brought out all its phases. The organ and feeling are apparently possessed by some of the inferior animals, such as the turkey-cock, pea-cock, horse, &c. Lord Kames observed that the "master-ox" must have the lead, else he will not work. A cow of a herd refused to enter the cowhouse, if the others went in first; when this happened, they were turned out, and she then walked in and occupied her stall.

Self-Esteem is found insane perhaps more than any other faculty, and then shows itself in extravagant notions of self-importance. Such maniacs are kings, emperors, and even the Supreme Being. Pinel mentions many such patients: one man under his care believed himself to be the Prophet Mahomet, and moved about with the most dignified majesty. When cannons fired, he believed it was on his own account. In the great Hospital of St. George's Fields, there were at one and the same time several *George the Fourths*. The organ is generally larger in men than in women; and more men are insane from pride than women.

We cannot conclude our observations on this faculty, without adding that it is usually an element in religious intolerance. Cowper in one of his letters says, "There is no grace which the spirit of *self* can counterfeit with more success than a religious zeal. A man thinks he is fighting for Christ, while he is only fighting for his own notions. He thinks that he is skilfully searching the hearts of others, when he is only gratifying the malignity of his own; and charitably supposes his hearers destitute of all grace, that he may shine the more in his own eyes by comparison. When he has performed this notable task, he wonders that they are not converted: *he* has given it them soundly; and if they do not tremble, and confess that God is in *him* of a truth, he gives them up as reprobates, incorrigible, and lost for ever." This is a mirror for too many. The organ is established.

No. 11.—Love of Approbation.

This organ is situated on each side close to Self-Esteem, and commences about half an inch from the lambdoidal suture. It gives, when large, a marked fullness to the upper part of the back of the head. It cannot be shown in outline like the previous organ of Self-Esteem, which, when large, with Love of Approbation moderate, gives a conical shape to the top of the back of the head. Dr. Gall discovered the organ in an insane woman, who imagined herself Queen of France. He looked for the organ of Self-Esteem, of course, and was much perplexed to find a hollow where its prominence should have been, but, at the same time, a marked rising on both sides of the hollow. *The queen's* manifestations soon explained to him the difficulty. There was no calm, grave, arrogant, imperiousness in her, as in the kings and queens of Self-Esteem. She was restlessly *vain* of her rank; talked of it in the most frivolous and affected way;

* It thus happens that Self-Esteem is the natural defence against the *aggressive* operation of the same faculty in others. A proper endowment of it never acts on the offensive; but it can be roused to repel and spurn all such acts in others. These degrees, therefore, seem to call for a distinction between an *offensive* and *defensive* Self-Esteem. Phrenology alone affords a key to character thus discriminating.

and promised favours and honours to all with whom she conversed. She was a vain, not a proud, queen. From that time, Dr. Gall perceived the difference between Self-Esteem and Love of Approbation. "The *proud* man," says he, "is imbued with a sentiment of his own superior merit, and, from the summit of his grandeur, treats with contempt or indifference all other mortals. The *vain* man attaches the utmost importance to the opinions entertained of him by others, and seeks with eagerness to gain *their* approbation. The *proud* man expects that mankind will come to him and acknowledge his merits; the *vain* man knocks at every door to draw attention towards him, and supplicates for the smallest portion of honour. The *proud* man despises these marks of distinction, which, on the vain, confer the most perfect delight. The *proud* man is disgusted with indiscreet eulogiums; the *vain* man inhales with ecstasy the license of flattery, although profusely offered, and by no very skilful hand."

Dr. Gall named this faculty Vanity, from one of its abuses, as he named Self-Esteem Pride. Dr. Spurzheim elucidated the ultimate functions more satisfactorily. It is the desire of approbation, admiration, praise, and fame. Its legitimate function is regard to reputation and character, and it gives the sentiment of shame. It is an excellent guard upon morals as well as manners. The loss of character, to those largely endowed with this feeling, is worse than death. If the moral sentiment be strong, this sentiment will desire honest fame, and in the line, too, of the prevailing faculties—as poet, painter, orator, warrior, statesman. The love of glory is a passion with many, and has deluged the world with blood in all ages. The decorations, orders, stars, garters, of civilization, and the tattooing, nose-boring, and pluming, of savage life, all spring from Love of Approbation. When the propensities predominate, the vain man will be pleased to be thought the best fighter or greatest drinker among his acquaintance. A due endowment of this faculty is essential to an amiable character. "It gives," says Mr. Combe, "the desire to be agreeable to others; it is the drill-sergeant of society, and admonishes us when we deviate too widely from the line of march of our fellows; it induces us to suppress numberless little manifestations of selfishness, and to restrain many peculiarities of temper and disposition, from the dread of incurring disapprobation by giving offence; it is the butt upon which wit strikes, when, by means of ridicule, it drives us from our follies." What the world will think and say, is uppermost in the mind when Love of Approbation is too strong. A youth in whom it is powerful, cannot do this thing or the other, because everybody will look at him, or wonder at him. The young are extremely sensitive on this point, especially in relation to those of their own age. The admonitions of the parent or teacher are nothing with them, in comparison with the jeering of their companions. Ridicule is intolerable to a large Love of Approbation at any age. Hence the poet's thought, "the world's dread laugh which scarce the stern philosopher can scorn." Combined with Self-Esteem, it creates the impression that the world are all busy thinking of us, instead of themselves; which last is the truth. This excess of the feeling subverts all independence. The opinion of others is the unhappy individual's rule of morals, taste, religion, even philosophy.

As this faculty, and that of Self-Esteem in abuse, are the cause of much evil, both to the individual and others, education ought to moderate their activity. Under the new system this is attended to; but under the old the competition of pride and vanity, in places and school honours, is still the grand stimulus, to the injury of the character of the young for life.*

The faculty, unless kept in subordination by a very large and vigilant Conscientiousness, prompts to all the conventional insincerities and flatteries of society, from the dread that the truth will offend Self-Esteem, and draw down on the teller of it disapprobation. When Secretiveness is large and Conscientiousness small, Love of Approbation is profuse in the unmeaning compliments of society. These compliments many people scorn only when applied to others, but take them more complacently when addressed to themselves; their Self-Esteem supporting them, and persuading them that these compliments *have* a meaning, and value too, when *they* are the objects of them. It is held to be Love of Approbation, which prompts to the equivocation of "not at home," when the person does not wish to admit visiters. "The faculty of Conscientiousness would desire that the plain fact should be stated; but Love of Approbation produces an instinctive feeling that the Self-Esteem of the person calling will be offended, if any engagement can render it inconvenient to see *him*. To save this pang, Love of Approbation and Secretiveness resort to the invention of this little equivoque. The deceit is seen through by all; and, nevertheless, the use of it is more pleasing to persons in whom Love of Approbation and Self-Esteem are very large, than the announcement of the simple truth." Much of the acutest suffering of life consists in nothing else but wounded Love of Approbation, when the feeling is powerful. The rivalries of rank, wealth, and fashion, commence with school boys and girls. The youngest creatures will, unchecked by delicacy, boast of the importance, in these particulars, of *their* parents, and vilify their companions, to the intense suffering of the latter, who have not arrived at sufficient reflection and force of character to disregard such taunts. Successful rivalry wounds the feeling both in the young and in the old; equipage, dress, attendance, when superior in others, these being acquaintances, or who have been equals, are all tormenting distinctions of Love of Approbation. Refusing to acknowledge, or shunning, well-known acquaintances, when the vain happen to be in what they consider higher or more fashionable company, is a very usual abuse to the feeling. This is not only a pitiful weakness, and confession of want of personal merit, but not seldom an act of coldhearted, selfish, ingratitude. With a good endowment of regulating moral feelings and intellect, turned into their right channel by proper character-improving education, this paltry conduct would be of much more rare occurrence. The vain talk of themselves, their affairs, and connections, and much afflict their auditors by so doing. Education would moderate this variety of bad taste. The same weakness leads the vain to be impatient of the appearance of neglect or forgetfulness of themselves in company, and to resort to many artifices to attract attention. Dr. Johnson noticed this small ambition in Goldsmith, who, he said, often began to talk lest his presence should be forgotten. Vain children force themselves into notice in the same way; a teacup has been purposely broken to this end. Extravagances, and even crimes, have been committed for mere notoriety. In these extreme cases the organ is diseased. The incendiaries of the Temple of Ephesus and York-Minster, and the lunatic Oxford, who fired on the queen furnish examples. Shamelessness is the effect of the want of this faculty, often observed in criminals. It is a great defect in character; the individual is beyond the salutary government of the feeling; he cares not for the opinion of others, and laughs equally at their censure or approbation. The educator finds this negation very difficult to deal with, inasmuch as one engine, with which he might otherwise legitimately work, is useless to him. His pupil will not *draw* by Love of Approbation. This defect aids the impudent, who have a purpose to serve. Their importunity is often boundless and untiring. No repulses affect them, no indignities touch them, so long as absolute personal violence is not

* Simpson's Philosophy of Education, second edition, p. 108; and Phrenological Journal, vol. v. p. 613, and x. p. 9.

applied to their intrusions. The *blush* is the natural language of shame—one of the feelings of powerful and sensitive Love of Approbation. The organ is oftener found insane in women than in men, as in women it is more active than in the other sex generally. The patients whose Love of Approbation is diseased, are not solemn, haughty, and irascible, like the monarchs of Self-Esteem. They are generally in a bustle of display, overpowering the listener with details of their merits, their talents, their works, and even their beauty. They are decked out, without regard to taste or sense, in colours, flowers, feathers, ribbons, crosses, and orders; their rooms are decorated with trophies and all sorts of imaginary proofs of their own transcendent merit, worth, fame, and glory. Prompted by Acquisitiveness large, the subject of their boast is the fancied possession of wealth that has no bounds; and if to this combination be added Benevolence, checks on their bankers for immense sums are freely given to strangers who visit them. As Dr. Gall well observed, pride and vanity are never better distinguished than when manifested uncontrolled by the insane.

The organ and faculty are observed in some of the lower animals—dogs, horses, monkeys, and others. It is established.

No. 12.—Cautiousness.

The organ of this faculty is situated about the middle of the parietal bone on both sides. Dr. Gall discovered it by first observing the prominence large in two individuals, who positively harassed him with their doubts, fears, hesitations, and precautions. When he observed this cerebral mark for the peculiarity, he confirmed it by numberless subsequent observations. Dr. Gall's two first subjects of observation were a prelate and a councillor of the regency, in Vienna. The first, through fear of compromising himself, overlaid his discourse with never-ending qualifications and cautions, spoken with great slowness. A conversation with him was interminable; he stopped in his sentences, and cautiously recurred to the point where he began, to be assured that all was right before proceeding farther. He was always mending what he had said. His preparations were careful and cautious in the most insignificant matters, and his examinations and calculations most rigorous. The councillor, again, from his marked irresolution, was nicknamed Cacadubio. Sitting behind both of these individuals, on a public occasion, Dr. Gall had an opportunity of comparing their heads, and observed their agreement in the protuberances since called the organs of Cautiousness. The intellectual powers and dispositions of these two men were different in all other respects; but in Cautiousness and its external development they closely resembled each other. No organ is more easily observed than Cautiousness. It is evident to the eye as well as the hand, and there is none of which the concomitant mental feeling may be predicted with more confidence.

It has been said that *fear* is the fundamental feeling of this faculty. We doubt this. Fear is a disagreeable affection of the faculty, for it *is* one of its feelings; and we are disposed to think that the disagreeable or painful is not the root of any of our faculties. We are not necessarily conscious of the feeling of fear while we are taking the most circumspect precautions for our safety, and it is just when we have taken these precautions that fear is excluded. In our opinion, Cautiousness expresses the feeling better than Fear. The words *foresight* or *circumspection* are too intellectual for it; for it does not foresee or look around; it merely feels blindly, and stimulates the intellect to take the means of insuring safety: its motto is, "Take care." It is an important element in prudence, which places the individual on his guard, and warns him not to be rash in his moral as well as his physical movements. In general, the organ is large in children—a wise and beneficent provision for their protection. Children who are deficient in the organ are in constant mishaps and accidents; twenty keepers will not supply to them the place of the instinctive protection of Cautiousness. Mr. Combe mentions a boy of six years of age, in whom the organ was very small, who took off his clothes to plunge into the deep water of an old quarry, into which the wind had blown his cap. A child with a large Cautiousness is comparatively safe; much more so than any degree of care by others would render him. We have seen the organ so large on both sides as to deform the head, and give, by contrast, to the fore part a great narrowness, especially in children. Mothers are often alarmed with this appearance, seeing that water in the head often shows itself in this region. But there is also a natural and healthy development of the organ when extraordinarily large. The symptoms of a very large endowment will be great timidity, fears, and even imaginary terrors, especially in dreams; but the existence of these would argue that the substance itself of the brain is large, and not merely extended by hydrocephalous affection, in which last case there could be no increase of the power of manifestation in the organ, but the contrary. No feeling is more rapidly and extensively communicated by sympathy than fear; it is well known to run through and infect a whole army; in such cases, it has the name of panic. It is therefore of vital importance, and a chief object of an officer's attention in battle, to prevent even the commencement of a feeling of fear, by checking all outward manifestations of it, and setting an example of coolness and courage to the soldiers under his command. In the history of war, there are instances of panic affecting both the contending armies at the same time, when they have turned their backs upon each other and fled in opposite directions from the field. The organ is often diseased, and then produces causeless dread of evil, despondency, and often suicide. In the heads of suicides the organ is invariably large, and Hope deficient, Destructiveness also being of course large. Persons with the organ diseased will often shrink as if the house were about to fall over them, or a bridge under them. Those who do not distinguish feeling from thinking, imagine that such persons may be reasoned into a dismissal of their fears, on being shown that they are groundless; but if, as is demonstrable, the feeling results from a portion of brain being positively diseased, it would be as rational to attempt to reason a person out of the pain he suffers from a bodily wound or sore. A brief extract from Dr. Andrew Combe's admirable work on Insanity, which has greatly helped to revolutionize the whole science and practice of that interesting field of medicine, will serve the twofold purpose of showing in what manner Cautiousness becomes diseased, and likewise how clearly and intelligibly the phrenologist treats the subject of that disease of brain called insanity. "Among the functional causes of cerebral disease and mental derangement, the over-activity of *Cautiousness*—an organ second in size to none—stands pre-eminent. Under the present selfish system of society, there is perhaps no faculty which is called so often, so powerfully, and so permanently into action; and the natural result is, that none is so frequently the source of nervous disease. In times of public distress, the victims whose health it destroys, whom it deprives of reason, and throws into the cells of an asylum, are incalculably numerous. Timidity, apprehension, fear, despondency, and despair, are the different degrees of intensity of the same feeling of Cautiousness gradually roused to a higher and higher degree, till the health of the cerebral organ at last gives way, and the most sombre melancholy ensues. The wide prevalence of hypochondriacal affections, which embitter existence, by the gloomy depression to which they give rise, and which I have elsewhere shown to have for a common feature a morbidly active Cautiousness, is another and a very convincing proof of the influence of excitement of function in inducing cerebral disease. In the greater number of such cases, it is easy to trace their origin to real or fictitious causes of anxiety about the health of friends, the success or failure of schemes of advancement, the fluctuations of trade, and many other grounds, all directly addressed to the faculty of Cautiousness."

Dr. Combe here mentions two instances, one of which ended in suicide, and proceeds—"The effect of fear, or sudden and violent excitement of Cautiousness, in producing mental derangement, and all sorts of nervous disease, is well known. I have already quoted an instance from Boerhaave, in which a fright from thunder rendered a lady insane, and also of a girl in the Hotel-Dieu in Paris, who was frightened by a soldier with a drawn sword. Pinel received three young women into the hospital; one deranged from seeing a *ghost* clothed in white, by which some young men wished to frighten her; the second, from a tremendous clap of thunder which terrified her; and the third, from horror at finding herself in a house of bad character, into which she had been unconsciously decoyed. In the two first, and partly in the third also, the disease was evidently induced by the organ of Cautiousness roused to an inordinate degree, producing general disordered action in the brain. The story of the parrot which was driven mad by the noise of the great guns during a naval action, and ever afterwards could emit no sound but one imitative of the report of a cannon, is an instance of similar functional excitement."

Practical jokes, intended to frighten, have often fearfully overshot their aim, and produced insanity. A knowledge of this ought to put an end to them. Lord Kames is the only metaphysician who recognised *fear* as a primitive faculty of the mind. Nations are characterized by different degrees of this organ. The German head, including the English and Scotch, has it larger than the Celtic, including the native Irish, and also than the French. It is smaller, too, in the Turkish head than in the European. It is very large in many savages, and in the Hindoos and Cingalese. See fig. 10. It is small in fig. 9. The organ is held established.

Having brought to a close our account of the affective faculties common to man and the inferior animals, we will proceed to an analysis of the SUPERIOR SENTIMENTS PROPER TO MAN.

II.—SUPERIOR SENTIMENTS, PROPER TO MAN.

WE have hitherto considered the faculties which phrenologists describe as common to man and the lower animals; we are now to treat of those superior sentiments which they consider as peculiar to man. The organs of these sentiments lie in the superior region of the brain. That they are all of them entirely wanting in animals, is an opinion which the phrenologists will yet, probably, have to reconsider; but we deem it best, in the mean time, to follow the generally received view. It may only be remarked, that, while the convolutions of the brain which form Veneration, Conscientiousness, and Hope, are not found in animals, traces of the convolutions forming Benevolence and Imitation do appear; and these two last are the powers of this class with which it seems most likely that animals are endowed.

No. 13.—Benevolence.

The organ of this sentiment is situated at the upper part of the frontal bone, immediately before the fontanel, in the middle of the top of the forehead, where it turns to form part of the top of the head, or coronal surface. It is easily distinguished; and when large (see fig. 15) gives a round elevated swell to that region. When the organ is small (fig. 16) the forehead or top-front is low,

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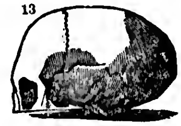

Fig. 15.

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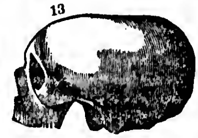

Fig. 16.

flat, and retreating. We cannot blame the unfortunate individual so organized, seeing that he did not make himself; but we are so constituted as instinctively to shrink from him, as deficient in one of the chief ornaments of human nature—the faculty of kindness and brotherly love. Dr. Gall discovered the organ, and at the same time distinguished the faculty as primitive, by observing in what region the heads of several remarkably benevolent, disinterested, and generous persons—whom, after suspecting the existence of the faculty, he placed together—agreed, however much they differed in other particulars. His subsequent observations left no doubt on the matter.

The faculty of Benevolence gives more than compassion for, and a desire to relieve, suffering; it gives a wish that others should be positively happy; prompts to active, laborious, and continued exertions; and, unless Acquisitiveness be very large and powerful, to liberal giving to promote its favourite object. It differs essentially in its charity, "which suffereth long and is kind," "and vaunteth not itself," from that which springs from Love of Approbation. Yet to this last selfish faculty, how often is it necessary to appeal when funds are wanted for benevolent purposes! Hence the *published* lists of subscribers' names; hence, too, the appeals to other selfish faculties by balls, plays, &c., for contributions to relieve suffering, as if it were to be charmed away by dancing and music. The Samaritan's conduct was pure benevolence. Addison portrayed the feeling well in Sir Roger de Coverley. All the phrenological books cite the case of Eustache, a St. Domingo negro, who was so striking an example of this faculty in great power and activity, that he received the *prize of virtue* from the French Institute. The organ in him was so large as to give an uncommon height to the front of his head. The faculty, like sunshine, lights as well as warms the whole of social intercourse. Mr. Combe well expresses this *leavening* influence. "It is a vulgar idea that this faculty cannot be manifested except in bestowing alms or money. It may be exerted in the domestic circle, in a thousand ways productive of advantage, without being accompanied by donation. It is benevolence to those with whom we live, to order our arrangements with a due regard to their comfort and happiness, and not to deny them proper gratifications; it is benevolence to suppress our own humours and tendencies when these would give unnecessary pain to others; to restrain Self-Esteem and Destructiveness in our commands; to be mild and merciful in our censures; to exert our influence and authority to promote the welfare of others: and one of the most benevolent of all exercises is, to visit the poor and vicious when suffering and wretched, even with the view of administering only the pecuniary bounty of others. Benevolence is an essential element in true politeness." Those who have the organ small are not on that account cruel; for cruelty is the result of a positive faculty, Destructiveness; they are merely indifferent to others' suffering, so that their Destructiveness meets with no check. Hare, the murderer, was an example. He required no effort, no drowning influence of liquor, as even the wretched Burke did, to steel him against the cries and struggles of his victims. See his head, fig. 4, contrasted with a benevolent development, fig. 3. Benevolence is the chief ground of an individual's popularity; when added to integrity and talent, it renders a public man justly an idol; it is always the most prominent inscription on his monument. The martial fame of Henry IV., of France, has descended in the mild company of the history of his benevolence; and his memory is yet, after nearly three centuries, dear to the French people. The air that bears his name is the first they call for in their theatres. Unregulated by Conscientiousness and Intellect, Benevolence degenerates into abuse, and becomes profusion and facility. Such an endowment gives indiscriminate alms, without reflecting that it is thereby probably encouraging fraud and crime. When Conscientiousness is weaker than Benevolence, we see the individual generous before he is just—making expensive presents, and leaving his tradesmen unpaid. Benevolence often co-exists with Destructiveness, although this has been ignorantly denied as an inconsistency in nature. How many individuals known to us are at once kind-hearted and hasty and irascible? Shakspeare has often portrayed characters showing both the feelings in extreme endowment. Dr. Currie, in his Life of Burns, says, "By nature kind, brave, sincere, and in a singular degree compassionate, he was, on the other hand, proud, irascible, and vindictive." To explain this seeming incongruity, phrenology steps in and shows that the two classes of manifestations depend on two distinct faculties. The sword of justice is Destructiveness, coming in aid of Conscientiousness and Benevolence. The knife of the surgeon has a benevolent purpose. While Destructiveness arms the soldier, Benevolence provides the surgical staff that follows him to the field. Horses and dogs are known to be mild or vicious by the breadth and roundness, or the narrowness and flatness of the region of their foreheads in the middle, a little way above the eyes. In the inferior animals, Benevolence is little more than passive mildness, and is quite enough distinguishable from the faculty as above described in man, to warrant the general position that Benevolence is peculiar to man. Mr. Combe, however, mentions several examples of benevolence more positive in certain of the lower animals. The Scotch metaphysicians in general admit this faculty as primitive. Hobbes, who traced all our benevolent and just actions to selfish calculation, denies it. Phrenologists account for such a theory by concluding that the organs of Benevolence and Justice must have been small in Hobbes's own brain, so as never to have inspired him with their legitimate feelings. As already mentioned in the section on Destructiveness, Mr. Robert Cox has shown, by a variety of facts and arguments, that when the other faculties are *agreeably* excited, Benevolence, as a feeling, is increased; while Destructiveness is excited by the disagreeable activity of the other faculties. Happiness, therefore, gives generosity and sweetness of temper, while misery gives sourness and irritability. From these principles important practical results are to be deduced. The organ is established.

No. 11.—Veneration.

The organ of this faculty occupies the centre of the coronal region just at the fontanel—the centre of the top of the head. It was discovered by Dr. Gall in the pious and devout; and is very obvious in the bald head of the monk of real sentiment and not of mere interest. The function of the faculty is the sentiment of veneration, or deference in general for superiority, for greatness, and goodness. Its highest object is the Deity. It is remarkable in how many instances the painters of sacred subjects have given large development of this organ in the heads of their apostles and saints—no doubt, because the pious individuals whom they would naturally select as studies for such characters, possessed the organ large. Veneration has no special object: it finds appropriate exercise with regard to *whatever is deemed superior*. One man may venerate what another treats with indifference, because his understanding leads him to consider that particular object as superior, while his neighbour deems it upon his own level, or beneath it. But any man with a large endowment of the organ will have a tendency to consider things as superior: he will be naturally disposed to look up, and not to look down. Self-Esteem is a positive faculty opposite to Veneration. The one prompts to a regard for, and appreciation of, self; the other to a regard for, and appreciation of, others, or something above self. He in whom there is much Veneration, with a moderate or defective Self-Esteem, will always be disposed to think well of what other persons do, and to put himself under their guidance and advice, which he will scrupulously follow, although his own understanding might have suggested better courses. Veneration is the basis of the feeling of loyalty: it is a main element in such political parties as the Jacobites of England and the Carlists of France. We see it irrationally exercised in the savage, with regard to his idols of stone and wood, and, in civilized society, with regard to the mere idea of rank unattended by worth. It is, on the other hand, rationally exercised with regard to persons of real excellence, and those who have been invested with important functions for the benefit of society. It is, indeed, at the root of all subordination, and even of that courtesy which forms so important an element in private life. Without this sentiment to make man look up to man, a people would be like a rope of sand, and society could not exist. The democratic spirit, when not entertained as a dogma in philosophical politics, depends expressly on a preponderance of Self-Esteem over Veneration. There are many so constituted in this respect, that submission to authority of any kind would be to them positively painful. "I am as good as he," is a formula of words in which such a nature finds appropriate expression. The fact may be, that the individual referred to is possessed of infinitely superior endowments, and has a high place in society, which the other wants; but the defective Veneration does not allow of the difference being appreciated.

Veneration, having the Deity for its highest objects, forms an element in the purest and most exalted religious feeling. But while there can be no perfectly pious man without it, we are bound to admit that individuals are often found, passing for very fair religious characters, in whom Veneration is by no means conspicuous. Such show little reverence or care in the handling of divine things, and often address the Deity in their prayers in a style calculated to shock others by its familiarity. Some languages are said to be better adapted for addressing the Deity than others: the Gaelic of the Scotch Highlanders bears this reputation. Such a circumstance would seem to show that the people whose language that is, are nationally characterized by large Veneration.

Phrenologists trace to this faculty a love of antiquities, and a tendency to approve of every thing that is old. They ascribe to it the awe with which many visit ancient temples, cathedrals, and the sepulchres of the illustrious dead. It is said by them to delight in collecting relics, and archaiological objects generally. They describe it as looking back to past times with regret that they *are* past, and as being the basis of the often-exposed fallacy as to the wisdom of our ancestors. There is some reason, however, to conclude that these manifestations, in some degree at least, belong to another organ, for which a site has been assigned in a space heretofore unmarked in the busts, and whose primitive function may be defined as a love of, or regard for the past, as hope is a love of or regard for the future.

So liable is the organ of Veneration to disease, that devotional exaltation is well known to be one of the most common forms of insanity. The religiously insane abound in the asylums. Drs. Gall and Spurzheim adduce many examples, and in all of them the organ of Veneration was found large. Esquirol justly remarks, that, although a particular sermon is often blamed for deranging religiously the mind, yet it has that effect in consequence of a predisposition to the disease, and probably a pre-existence of it in the individual.

No. 15.—Firmness.

The organ of this faculty occupies the top of the head, behind Veneration, in the middle line. It is a faculty of peculiar character. Dr. Gall held that it was neither an inclination nor a power, but a *manière d'être*—a mode of existing or being firm, resolute, and determined. He who is deficient in the faculty, is the sport of circumstances and impressions. Dr. Spurzheim says that Firmness is apt to be mistaken for Will, because those that have the organ large are prone to say, "I will," and "I wont," that being the natural language of determination; but the feeling is quite different from what is properly called the Will. It gives fortitude, constancy, perseverance, and determination; and when too powerful, it produces obstinacy, stubbornness, and infatuation. The organ will be found large in obstinate and intractable children. Firmness has no relation to external objects; its influence is within the mind, and adds a quality of endurance to each or all of the other faculties. For example, it renders Combativeness determined bravery; Conscientiousness, inflexible integrity, and so with others. With Self-Esteem, it renders the individual absolutely impracticable. The want of it is a great defect in character; it is unsteadiness of purpose. Fig. 18 is that of the head of a lady who had several houses taken because she could not *determine* in which she should live: her Conscientiousness (marked 16) will be observed large, and this feeling she manifested by faithfully and punctually paying the rents of them all. The English soldier has more of Firmness than the French, although in courage and spirit they are equal. The battle of Waterloo illustrated the two characters in a remarkable manner. The organ is large in the torture-enduring American Indian. Dr. Gall mentions that he found it large in the head of a highwayman, who firmly resisted the most horrible tortures, and contrived to escape from agony and confession, at once, by suicide. After his death, the parietal bones were found separated just over this organ. Dr. Gall did not conclude from that single case that this separation was the effect of the excessive energy of this portion of the brain, but he recommends the fact as worthy of notice in similar cases. The insanity of the faculty has not been observed; it must naturally be a morbid aggravation of its symptoms. The insane often manifest indomitable obstinacy, in refusing food, &c. The faculty is a difficult feeling to deal with in education. To contend with it, as many parents and teachers do, is to aggravate it. Such procedure resembles an attempt to extract a nail by striking it on the head with a hammer. Firmness is an established organ. In figs. 18 and 20, it is small; in 17 and 19, large.

No. 16.—Conscientiousness.

The organ of this sentiment is situated on each side of the organ of Firmness, between the latter organ and that of Cautiousness. Dr. Spurzheim discovered the organ, and thereby incalculably benefited mental and moral science. Previously, metaphysicians differed in opinion as to the existence of a moral sense—a primitive instinctive feeling of truth and justice. Hobbes and Mandeville held justice to be a mere selfish calculation. Even Paley considered it as influenced by the hope of eternal reward, and therefore no better than a selfish calculation. Adam Smith placed the standard of moral approbation in sympathy, Hume in utility,

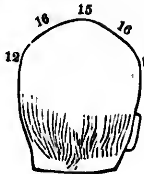

Fig. 17.

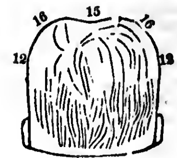

Fig. 18.

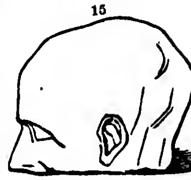

Fig. 19.

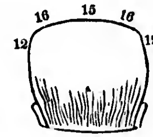

Fig. 20.

Clarke in the fitness of things; while Hutcheson, Cudworth, Kames, Reid, Stewart, and Brown, all contend for a *faculty* which produces the sentiment of right and wrong, independently of all other considerations. Mr. Combe says that these conflicting theories will serve "to convey some idea of the boon which phrenology would confer upon moral science, if it could fix on a firm basis this single point in the philosophy of mind —that a power or faculty exists, the object of which is to produce the sentiment of justice, or the feeling of duty and obligation, independently of selfishness in any form, hope of reward, fear of punishment, or any extrinsic motive; a faculty, in short, the natural language of which is '*Fiat justitia ruat cœlum.*' Phrenology does this by a demonstration, founded on numerous observations, that those persons who have the organ now under consideration large, experience powerfully the sentiment of justice; while those who have that part of the brain small, are little alive to the emotion. This evidence is the same in kind as that adduced in support of the conclusions of physical science." Without this faculty, the sentiments which guard, or rather constitute, morality, would be incomplete. Benevolence prompts to kindness, and is offended with cruelty; Veneration induces piety, and is shocked with blasphemy; but neither of these faculties gives the perception or feeling of obligation, duty, incumbency, truth— in a word, justice. When, however, Conscientiousness is added, the defect is supplied, and morality completed —that morality which Scripture recognises in the precept "to do *justly*, to love *mercy*, and to walk humbly with *God*." This is a beautiful accordance of Scripture morality with natural, and demonstrates the identity of their divine origin. In the last quotation we have distinguished by *italics* the three words which correspond to Conscientiousness, Benevolence, and Veneration. The word "*humbly*" is important; it expresses the self-abasement of Veneration, when directed to its highest object, the Omnipotent, and the utter incompatibility of pride, which was not made for man—in other words, the abuse of Self-Esteem—with that lofty sentiment. In these three words there is a complete system of ethics or morals; for an action is right which satisfies all, and wrong which offends any one of these three faculties. So simple is truth—a few words thus make clear what volumes written in the dark have failed to do.

Conscientiousness gives the emotion of justice, but intellect is necessary to show on which side justice lies. The judge must hear both sides before deciding, and his very wish to be just will prompt him to do so. This faculty regulates all the other faculties by its rigid rules. It says to them, "thus far and no farther, or you will do injustice." Benevolence and Veneration themselves require its guardianship, to prevent the one from running into generosity without justice, the other into bigotry, fanaticism, and persecution. Conscientiousness not only curbs our faculties when too powerful, but stimulates those that are too weak, and prompts us to duty even against strong inclinations. To cultivate it in children is most important. No organization, however favourable, compensates a want here; yet phrenologists are forced to confess that it is not the largest organ in the great majority of brains, and hence the injustice that is, silently as well as openly, at work in society. The training of it by practical exercise in infant education is explained in the volume on Infant Education in *Chambers's Educational Course.* Conscientiousness not only prompts to honesty and truth, in opposition to common fraud and falsehood, but, more delicately still, renders the individual who is blessed with it in large measure candid and fair in his judgments of the conduct, opinions, and talents of others. It is from its defect to this extent, that in controversy we hear so much complaint of misrepresentation and misquotation. It pays debts, keeps appointments, performs promises, and gives a beautiful consistency and trustworthiness to the whole conduct, which secures the respect, and, when blended with Benevolence, the love, of all within the range of its influence. Without Benevolence, it is apt to be too severe and stringent. When Conscientiousness is weak, or when, as happens in perfectly "*honest*" and "*honourable*" people, in the broad sense of these terms, it is not something more than average in its power, the defect will run through the whole conduct and judgments of an individual. It is important to observe the manner of this. Mr. Combe says, "The predominant propensities and sentiments thus act without this powerful regulator. If Adhesiveness and Benevolence attach the individual to a friend, he is blind to all his imperfections, and extols him as the most matchless of human beings. If this model of excellence happen to offend, he becomes a monster of ingratitude and baseness; he passes, in an instant, from an angel to a demon. Had Conscientiousness been large in the offended, the other would have been viewed all along as a man; esteem towards him would have been regulated by principle, and the offence candidly dealt with. If Love of Approbation be large, and Conscientiousness deficient, the former will prompt to the adoption of every means that will please, without due regard to justice and propriety. If an individual have a weak point in his character, Love of Approbation will lead to flattering it; if he have extravagant expectations, it will join in all his hopes; if he be displeased with particular persons, it will affect to hate with his hatred, altogether independently of justice. In short, the individual in whom this faculty is deficient, is apt to act and also to judge of the conduct of others exactly according to his predominant sentiments for the time; he is friendly when under the influence of Benevolence, and severe when Destructiveness predominates; he admires when his pride, vanity, or affection give him a favourable feeling towards others; and condemns when his sentiments take an opposite direction, but is always unregulated by principle. He is not scrupulous, and rarely condemns his own conduct, or acknowledges himself in the wrong. Minds so constituted may be amiable, and may display many excellent qualities, but they are never to be *relied on* where justice is looked for. As judges, their decisions are unsound, and often partial; as friends, they are liable to exact too much, and perform too little; as sellers, they are prone to misrepresent, adulterate, and overcharge; as buyers, to depreciate quality and quantity, or to evade payment." This is a painful but true picture of what is too often found in society. We often hear people complaining that a particular friend is "*uncertain.*" This word expresses concisely the defect of Conscientiousness above described. The faculty powerful, is essential, in both parties, to a sincere and lasting friendship.

Honour, as it is misnamed in society, is often Pride or Self-Esteem, and Love of Approbation, without Conscientiousness. The individual will fight, and thereby increase the wrong he has done, but he will not acknowledge the wrong by an apology. There is no philosophic mind without powerful Conscientiousness. Without it, scientific men only acknowledge *fashionable* truth. Mr. Combe again says on this point—"I have observed that individuals in whom Love of Approbation was large, and Conscientiousness not in equal proportion, were incapable of conceiving the motive which could lead any one to avow a belief in phrenology, while the tide of ridicule ran unstemmed against it. If public opinion should change, these would move foremost in the train of its admirers. They instinctively follow the doctrines that are most esteemed from day to day, and require our pity and forbearance, as their conduct proceeds from a moral deficiency, which is their misfortune rather than their fault." The existence of Conscientiousness as an independent element in the human constitution, renders intelligible many supposed inconsistencies in human conduct—that a man, for instance, will be kind, forgiving, even devout, and yet not just. It is a great mistake with regard to those who, after many years of sanctimonious professions, are detected in dishonest acts, to say that they must have been all along mere hypocrites. It is quite possible that many of their religious feelings and convictions may have been sincere, but only insufficient in force to compensate for the lack of direct Conscientiousness. Conscientiousness gives remorse when the individual has been tempted to sin. Criminals seldom experience remorse; it is erroneously supposed that they do; their terrors are dread of punishment only. In fig. 18, Conscientiousness is large; in fig. 17, it is small, and appears in a slope from Firmness; and in fig. 20, it is small, from the general flatness of the coronal region above fig. 12, or Cautiousness. In this last, Firmness itself is small. It represents the head of a boy remarkable for falsehood and deceit. The organ is larger in some nations than others. It is larger generally in Europeans than in Asiatics and Africans; very generally it is deficient in the savage brain. It evidently grows in civilization; indeed, it constitutes an essential of civilization. English and Scotch skulls, found in numbers in old cemeteries and battle-fields three and four centuries old, present much greater deficiency in that organ than modern skulls of the same nations.

The organ is often found diseased, and the insanity consists in morbid self-reproach, imaginary debts, and unfounded belief in merited punishment. Cowper, the poet, once believed that the arrangements were made in the market-place for his own execution for a fancied crime.

Mr. Combe's theory to account for the denial by some philosophers of a sense or sentiment of justice, is, that it was weak in themselves, from defect of organization. Those in whom the organ is large express astonishment that the existence of a moral faculty, primitive in man, could ever be the subject of doubt. The organ is established.

No 17.—Hope.

The organ of this faculty has its place on each side of Veneration, partly under the frontal, and partly under the parietal bone. It was discovered by Spurzheim, but never admitted by Gall, who considered Hope as a function of every faculty that *desires.* To this Dr. Spurzheim answered, that we desire much of which we have no hope; a criminal on the scaffold intensely desires life, but has no hope of it. Dr. Spurzheim considered Hope a faculty *sui generis*, producing hope, in general, of good, or gratification to the other faculties; and, by careful observation in nature, found the organ in the situation just described. It seems to have been given to man to make him happy. It produces gayety and cheerfulness, looks on the sunny side of every thing, and paints the future with bright colours. When not regulated by the intellect, Hope leads to rash speculation, and, in combination with Acquisitiveness, to gambling, both at the gaming-table and in the counting-house. It tends to render the individual credulous, and often indolent. In religion, hope leads to faith, and strongly disposes to a belief in a happy life to come. Mr. Combe observes (*System*, vol. i. p. 372): "I have already stated an argument in favour of the being of a God founded on the existence of a faculty of Veneration, conferring the tendency to worship, of which act God is the proper and ultimate object. May not the probability of a future state be supported by a similar deduction from the possession of a faculty of Hope? It appears to me that this is the faculty from which originates the notion of futurity, and which carries the mind forward in endless progression in periods of everlasting time. May it not be inferred that this instinctive tendency to leave the present scene and all its enjoyments, to spring forward into the regions of a far distant futurity, and to expatiate, even in imagination, in the fields of an eternity to come, denotes that man is formed for a more glorious destiny than to perish for ever in the grave?" Addison beautifully enforces this argument in the *Spectator*, and in the Soliloquy of Cato; and phrenology gives weight to his reasoning by showing that this "ardent hope, this longing after immortality," are not factitious sentiments, or a mere product of an idle and wandering imagination, but that they are the results of two primitive faculties of the mind—Love of Life, and Hope, which owe at once their existence and their functions to the Creator. The well-known lines of Pope introduce hope as the foundation of the Indian's anticipation of a happy hereafter:—

"Lo! the poor Indian, whose untutor'd mind
Sees God in clouds, and hears him in the wind,
His soul proud science never taught to stray
Far as the solar walk or milky way:
Yet simple Nature to his *hope* has given
Beyond the cloud-topt hill an humbler heaven—
Some safer world in depth of woods embraced,
Some happier island in the watery waste,
Where slaves once more their native land behold,
No fiends torment, no Christians thirst for gold."

The metaphysicians admit Hope as a primitive faculty; phrenology, therefore, only points out its organ, and the effects of different degrees of its endowment.

No. 18.—Wonder.

The organ of this faculty is situated on each side of that of Benevolence, with one other organ, that of Imitation, interposed. Technically, it has its place in the lateral parts of the anterior region of the vertex. Dr. Gall discovered it by observing it large in the seers of visions and dreamers of dreams, and in those who loved the marvellous. Socrates, Tasso, Joan of Arc, and Swedenborg, were examples. The two first believed they were attended by a familiar spirit.* Swedenborg believed and declared that he was admitted to the presence of God in heaven, to receive a revelation of the true religion. Joan of Arc related that she *saw* St. Michael, and received from him her commission to raise the siege of Orleans, and enthrone Charles VII. as king. There are many other examples in the phrenological books. In modern times, Joan of Arc would have been held to be a mere maniac.

Persons with the faculty powerful are fond of news, especially if striking and wonderful, and are always expressing astonishment; their reading is much in the regions of the marvellous, tales of wonder, of enchanters, ghosts, and witches. When the sentiment is excessive or diseased, it produces that peculiar fanaticism which attempts miracles, and with Language active, speaks with unknown tongues. It draws the ignorant and fanatically-inclined, who have the organ large, with ease by its pretensions; hence the numerous followers of Johanna Southcote, Courtenay or Thom, and Edward Irving. Mr. Combe says of the latter—"I examined his head before he was established as a preacher, and when his peculiarities were unknown, and observed that the organs of Wonder and Self-Esteem were very large. They gave a tinge to his whole public life. The organs of Benevolence, Conscientiousness, Veneration, and Intellect, were also amply developed, so that he possessed the natural elements of the Christian character in great strength, but their direction was rendered unprofitable by the predominance of Wonder and Self-Esteem." Mr. Combe quotes the extraordinary case of Dr. Anderson, of Cupar-Fife, who was tormented by the belief that there were invisible enemies planning his destruction by supernatural means. On examination of his brain after death, an inflammatory deposit, of apparently old standing, was found over the organ of Wonder. During life the part was painfully heated, and Dr. Anderson was in the habit of sponging it with cold water. Pain in the seat of the organ of Wonder has been localized by several ghost-seeing patients, who knew nothing of phrenology. Many instances are mentioned in the phrenological books. Second sight, as the Highlanders call it, is explained by over-excitement of the organ of Wonder. Mr. Combe adds—"At the same time, it is difficult to comprehend how an exalted state of this organ should produce these effects, unless we suppose it to excite the organs of Form, Size, Colouring, and Individuality, so as to prompt *them* to conjure up illusions of objects fitted for the gratification of Wonder, just as the involuntary activity of Cautiousness during sleep excites the intellectual organs to conceive objects of terror, producing thereby frightful dreams. This theory is rendered probable by the fact, that morbid excitement of the knowing organs produces spectral illusions, independently of an affection of the organ of Wonder. Mr. Simpson has communicated an admirable paper on this subject to the *Phrenological Journal* (vol. ii. p. 290), to which I shall have occasion afterwards to refer." We shall also refer to that paper in the sequel. The general function of the organ is held to be ascertained, but the metaphysical analysis is still far from being perfect. Dr. Spurzheim named the faculty Marvellousness instead of

* Mr. Combe has thus translated from the French, as given in *Black's Life of Tasso*, the following anecdote, extracted from the *Memoirs of the Marquis of Villa*, the friend of Tasso. "Tasso, in his delirium, believed that he conversed with familiar spirits. One day, when the marquis endeavoured to drive that idea from his mind, Tasso said to him, 'Since I cannot convince you by reason, I shall do so by experience; I shall cause the spirit in which you refuse to believe to appear before your eyes!' 'I accepted the offer,' says the marquis, 'and next day when we sat by the fire conversing, he turned his eyes towards the window, and looking with steadfast attention, appeared so completely absorbed, that when I called to him he did not answer.' 'See,' said he at length; 'see! my familiar spirit comes to converse with me.' 'I looked with the greatest earnestness, but could see nothing enter the apartment. In the mean time, Tasso began to converse with the mysterious being. I saw and heard himself alone. The subject of his discourse was so elevated, and the expressions so sublime, that I felt myself in a kind of ecstasy. I did not venture to interrupt him, or to trouble him with questions, and a considerable time elapsed before the spirit disappeared. I was informed of its departure by Tasso, who, turning towards me, said, 'In future you will cease to doubt.' 'Rather,' said I, 'I shall be more skeptical, for though I have heard astonishing words, I have seen nothing.' Smiling, he replied, 'You have perhaps heard and seen more than'—He stopt short, and fearing to importune him by any questions, I dropt the conversation.'" We hope to account for Tasso's spectral illusion, for it could be nothing else in the sequel.

Wonder, because, as he argues, it causes astonishment by the contemplation of both natural and supernatural circumstances. Mr. Combe holds Wonder to be the better name for the fundamental feeling, just because it is excited by natural circumstances, to which Marvellousness does not apply.

No. 19.—Ideality.

The organ of this faculty is situated farther down, but close to that of Wonder, along the temporal ridge of the frontal bone. Dr. Gall discovered it in the busts and portraits of deceased, and in the heads of a great number of living, poets. This confirmed to him the old classical adage, that the poet is born, not made; in other words, that his talent is the result of a primitive faculty. Dr. Gall called the organ the organ of Poetry. Dr. Spurzheim corrected this, and gave it the elegant name it now bears; which has, as well as others of the expressive names of the phrenological organs, been adopted into ordinary language. He says—"It is impossible that poetry in general should be confined to one single organ, and I therefore think that the name 'Organ of Poetry,' does not indicate the essential faculty. In every kind of poetry the sentiments are exalted, the expressions warm; and there must be rapture, inspiration, and what is commonly called imagination or fancy."

The faculty delights in the perfect, the exquisite, the *beau-ideal*—something beyond the scenes of reality—something in the regions of romance and fancy—of the beautiful and the sublime. Those writers and speakers who possess it large, adorn all they say or write with its vivid inspirations. It is the organ of imagery. The sermons of Chalmers owe much of their charms to it, and the organ is very large in his head. Shakspeare created such beings as Ariel, Oberon, and all the imaginings of the "Tempest," and "Midsummer Night's Dream," under its influence. Prospero's speech, when he abjures the art of magic and breaks his staff, is unequalled as a specimen of Ideality. The passage is well known—

"I have bedimmed
The noontide sun, called forth the furious winds,
And 'twixt the green sea and the azure vault
Set roaring war," &c.

The faculty renders conversation elevated, animated, and eloquent, the opposite of dry and dull.

Nature abounds in beauty and splendour to gratify Ideality—a proof of pure beneficence in the Creator; for it is a pleasure of unmixed gratuity, if we may so speak; man might have been created without it, but Divine goodness superadded that, the most exquisite, to his other enjoyments. The organ is small in criminals and other coarse and brutal characters, for it is essential to refinement. It prompts to elegance and ornament in dress and furniture, and gives a taste for poetry, painting, statuary, and architecture. Some religious sects, as the Friends, condemn elegance and ornament. They should revise their standards, now that it is discovered that a faculty is given to man whose function it is to enjoy these without abusing them. A point of interrogation is placed on the bust on the back part of the region of this organ, conjectured to be a different organ, but one allied to Ideality. Some phrenologists have considered it the organ of the Sublime, from its touching on Cautiousness, which the grand, at least the terrific grand, in some degree affects. A writer in the *Phrenological Journal* suggests the love of the past as its function. The existence of the faculty of Ideality demonstrates that the sentiment of beauty is an original emotion of the mind, and settles the controversy in which Professor Stewart, Lord Jeffrey, Dr. Brown, and others, took a part, as to the origin of our perception of beauty.

The following passage from Combe's *System* (vol. i. p. 407) is well worth quoting. It gives practical aid to our conceptions of the nature of Ideality, and affords an example of the application of phrenology to literary criticism. "In composition, this faculty imparts splendour and elevation to the style, and manifests itself in prose as well as in verse. The style of Lord Bacon is remarkably imbued with the splendour of Ideality, sometimes to excess, while that of Locke is as decidedly plain; and the portraits of both show that their heads corresponded with these different manifestations. Hazlitt's head indicated a large development of Ideality, and the faculty glows in his compositions. It was the sustaining power which gave effect to his productions, for he was eminent for neither sound principles, correct observations, nor extensive knowledge. He seems to have relied chiefly on his imagination and language for his success, and his works are already sinking into the shades of oblivion. In Lord Jeffrey's head, as it appears in the bust, Ideality does not predominate. The report was current at the time, that the review of Lord Byron's tragedies, which appeared in No. LXXII. of the *Edinburgh Review*, (Feb. 1822,) was the joint production of these two celebrated authors; and keeping in view the fact, that Mr. Hazlitt's Ideality is larger than Lord Jeffrey's, it would not be difficult, by a careful analysis of the article, to assign to each the sentences which he wrote. Lord Jeffrey's predominating intellectual organs are Eventuality, which treasures up simple incidents or events; Comparison, which glances at their analogies and relations; and Causality, which gives depth and logical consistency to the whole. Hazlitt, on the other hand, possessed a large Comparison, respectable Causality, with a decidedly large Ideality, elevating and adorning his intellectual conceptions. Proceeding on these views, I would attribute the following sentence to Lord Jeffrey's pen, as characteristic of his manner. Speaking of the qualities of Shakspeare's writing, the reviewer says, 'Though time may have hallowed many things that were at first out common, and accidental associations imparted a charm to much that was in itself indifferent, we cannot but believe that there was an original sanctity, which time only matured and extended, and an inherent charm from which the association derived all its power. And when we look candidly and calmly to the works of our early dramatists, it is impossible, we think, to dispute, that after criticism has done its worst on them—after all the deductions for impossible plots and fantastical characters, unaccountable forms of speech, and occasional extravagance, indelicacy, and horrors—there is a facility and richness about them, both of thought and diction, a force of invention and a depth of sagacity, an originality of conception and a play of fancy, a nakedness and energy of passion, and, above all, a copiousness of imagery, and a sweetness and flexibility of verse, which is altogether unrivalled in earlier or in later times, and places them in our estimation, in the very highest and foremost place among ancient and modern poets.' In this passage we have the minuteness of enumeration of Eventuality, the discrimination of Comparison and Causality, and the good taste of a fair, but none of the elevation, ornament, and intensity of a large, Ideality. In another part of the review we find the following sentences. In Byron 'there are some sweet lines, and many of great weight and energy, but the general march of the verse is cumbrous and unmusical. His lines do not vibrate like polished lances, at once strong and light, in the hands of his persons, but are wielded like clumsy batons in a bloodless affray. * * * He has too little sympathy with the ordinary feelings and frailties of humanity, to succeed well in their representation. "His soul is like a star, and dwells apart." * * * It does not "hold the mirror up to nature," nor catch the hues of surrounding objects, but, like a kindled furnace, throws out its intense glare and gloomy grandeur on the narrow scene which it irradiates.' Here we perceive the glow of Ideality, the simplicity of the former style is gone, and the diction has become elevated, figurative, and ornamental. I am not informed regarding the particular sentences which each of the above-named gentlemen wrote in this review, but these extracts will serve as brief examples of the differences produced on style when Ideality sheds few or many beams on the pen of the author; and I regard the probabilities as very strong that the passages are assigned to their actual sources." The organ is established.

No. 20.—Wit, or the Ludicrous.

The organ of this faculty is situated before, and a little lower than that of Ideality. When large, it gives a breadth to the upper region of the forehead. In the portraits of Sterne, his forefinger is represented resting on this angle of the forehead, which in him was very large, and the mental manifestation powerful.

The phrenological writers have discussed at great length, and with not a little controversy, the metaphysical nature or analysis of this faculty. We do not require to follow them into this inquiry, as most of them are agreed that, by means of this faculty, we see and enjoy the *ludicrous*, and experience the emotion of laughter. Man is the only laughing animal, and the impulse and its result are too well marked characteristics not to be the manifestations of a special faculty. Dr. Beattie's theory is the most satisfactory of any—that the objects of the ludicrous are incongruities, with a certain mixture of congruity. When the butcher put his wig on his dog's head in the pit of the theatre, that he might wipe his heated brow, Garrick was so tickled with the incongruity, mixed, be it observed, with the congruity of a wig belonging to *a head*, that he ran off the stage to conceal his laughter. When this organ is large, the individual both enjoys and creates the ludicrous, and is apt to give a ludicrous turn to every thing that passes through his mind. For the discussions in which Mr. Scott, Mr. Watson, and Mr. Schwartz of Stockholm, have taken a part, as well as for the opinions of Gall, Spurzheim, and Combe, we must refer to Mr. Combe's *System* (4th edition, p. 416.) We may observe that Mr. Scott and Mr. Hewet Watson consider the organ, No. 20, as that of an intellectual and not an affective faculty. Mr. Scott views it as the faculty by which we discriminate or observe differences; and this, by much ingenious reasoning, he is inclined to hold to be the function of a different faculty from that by which we perceive resemblances. Mr. Watson thinks the function of No. 20 is to investigate what may be called intrinsicalities—the intrinsic nature of things. Mr. Combe thinks the facts adduced by Mr. Watson make it probable that there is a faculty for this power, but that it is not No. 20. Dr. Spurzheim unsettles both Mr. Scott's and Mr. Watson's theories anatomically, by showing that the portion of brain is in the same region with Ideality, and is therefore the organ of an affective and not an intellectual faculty. He farther holds, that the same faculty which perceives resemblances perceives differences; and both he and Mr. Combe, observing that all those who deal largely in the ludicrous have the Organ 20 large, conclude, that whatever may be the object or objects of the ludicrous in nature—whether something specific, like colour, or odour, in a rose, or some *condition* of things, which in themselves are not necessarily ludicrous—there is a mental sentiment or emotion which moves, or *is* laughter. No. 20 is the organ essentially of this emotion, and so far they hold it established. Our own observation in numerous instances confirms this conclusion. Primitive function is best observed in extreme development, and when No. 20 is very large, the individual exists in a world of the ludicrous. This conclusion is agreed upon, generally, by all the controversialists on the function of this faculty, as their discussions relate to the metaphysical analysis of the faculty only. Curran and Sheridan were both considered witty men, yet in neither is the organ 20 large. Mr. Combe thinks that their cases only confirm the view of the faculty, which he with Dr. Spurzheim is disposed to take. He thinks that in Curran's works there are none of the witty contrasts of Sterne, Voltaire, and a living wit, the Rev. Sydney Smith. Curran's is burlesque humour, of a coarse satirical kind. Secretiveness and Imitation, with Eventuality and Comparison, gave him fertility of invention, copiousness of illustration, *savoir faire*, and tact, and Destructiveness gave his ideas a pungent sting, which he wielded with much address. Sheridan, again, notoriously *stole* from others his witty sayings, and applied them in his own compositions. "The Rev. Sydney Smith," says Mr. Combe, "is a living example of a really witty mind. His wit is always pertinent to the object about which he reasons. It is the seasoning to solid argument, and in fact is often in itself argument. Sheridan, when he drew on his own resources, manifested Individuality Eventuality, and Comparison, in enumerations and descriptions of physical objects and events, and by means of a moderate organ of wit, he tinged them with the ludicrous. Sydney Smith, on the other hand, impregnates the abstract deductions of reason with wit, presenting the strongest arguments in the most ludicrous attire, yet keeping the wit always subordinate to the logic. Causality, combined with a large organ of Wit, appears to me to be indispensable to the manifestation of these qualities." Mr. Combe adds the following true observation, which every one is enabled to verify in the circle of his own acquaintance. "Some individuals, who possess a large development of Individuality, Eventuality, and Comparison, particularly when Secretiveness and Imitation (which are great elements in the talent for acting) are also large, often enjoy a great reputation for wit and drollery among their companions, although in them the organ of the Ludicrous is by no means large. Two explanations may be given of this fact. First, the conceptions formed by the faculties here named are palpable and striking, and if even a moderate portion of the ludicrous be infused into them, they produce a great effect on ordinary minds. Secondly, many persons take every thing for wit that makes them laugh, and, in consequence, dignify with that name mere imitations, and sometimes even absurdities, when uttered with a confident air, as if they had legitimate pretences to be considered ludicrous."

No. 21.—Imitation.

This organ is situated on each side of that of Benevolence. Dr. Gall found the protuberance accompanied by instinctive and often irrepressible mimicry. A deaf and dumb boy had this power quite unconsciously. The purpose of the faculty is to enable the young to learn from the more advanced, and keep a convenient uniformity in the manners and externals of society. Celebrated players always possess it largely, and by it imitate the supposed manner, and even feel the sentiments, of their characters. In the *Transactions of the Phrenological Society* (page 169), Mr. Scott has shown that Secretiveness must concur with Imitation to complete the actor. He must conceal his own, as well as imitate the character he plays. The Imitative arts depend on this faculty; and its organ is found large, accordingly, in painters and sculptors of eminence. Ventriloquism, as shown by Mr. Simpson in two papers in the *Phrenological Journal*, is nothing more than exquisite power of imitating sounds according to position and distance. What a fund of amusement and delight comes from the group of faculties whose organs are all in this one region of the head, well named "The Poet's Corner," namely, Ideality, Wonder, Imitation, Wit or the Ludicrous, Time and

Tune! The faculty of Imitation has been recognised in a state of disease, when the impulse to mimic is beyond the individual's control. Pinel makes mention of an idiot girl who was affected in this way. Parrots, monkeys, and the mocking-bird, imitate and mimic. The last-mentioned often attracts other birds by the cries of their own kind; and then, waggishly, as it were, scares them away with the cry of some bird they dread. The organ is established.

ORDER SECOND.—INTELLECTUAL FACULTIES.

By these faculties man and animals perceive or gain knowledge of the external world, and likewise of their own mental operations. The object of the faculties is to know what exists, and to perceive qualities and relations. Dr. Spurzheim divided them into three genera:—1. The External Senses; 2. The Internal Senses, or Perceptive Faculties, which procure knowledge of external objects, their physical qualities and relations; 3. The Reflecting Faculties.

From the great length to which our observations on the Feelings have extended, and from the more metaphysical nature of the analysis of the Intellectual Powers, we must be more brief in our exposition of them—referring to the phrenological books for a fuller treatment of this branch of the subject.

GENUS I.—EXTERNAL SENSES.

By these, man and the inferior animals are brought into communication with the external material world. Much metaphysical acumen has been wasted, and much nonsense written, about the senses. Before phrenology discovered *internal* faculties, of which the senses are the ministers—they themselves giving only passive impressions called sensations, but forming no ideas—the senses were considered the *sole* sources of our knowledge. They are necessary to that knowledge, but would never of themselves have completed it. The subject is admirably treated by Mr. Combe in his *System* (4th edition, page 436). By each sense we discover some quality of material nature. The Senses, as generally received, are five in number—*Touch, Taste, Smell, Hearing*, and *Sight*. There are certainly two more, namely, the *sense of Hunger* and *Thirst*, and the *Muscular sense*, or that by which we feel the state of our muscles as acted upon by gravitation and the resistance of matter. Without this last sense we could not keep our balance, or suit our movements to the laws of the mechanical world. Dr. Thomas Brown conjectured this sense many years ago, and Sir Charles Bell has thrown much light on it by proving that separate roots, afterwards joining in one apparent nerve, but evidently being two, give muscular motion and muscular sensation. Mr. Simpson has long given his attention to this interesting subject, and thrown so much light upon it, as to render it next to certain that all animals have a *passive sense* of material resistance, and also an *active faculty* for applying counter resistance—both being necessary to every muscular exertion.* The senses, there is every reason to hold, are not five, but seven in number.

GENUS II.—INTELLECTUAL FACULTIES, WHICH PROCURE KNOWLEDGE OF EXTERNAL OBJECTS, OF THEIR PHYSICAL QUALITIES, AND VARIOUS RELATIONS.

These faculties correspond in some degree with the perceptive powers of the metaphysicians, and form ideas.

No. 22.—Individuality.

The organ of this faculty is situated in the middle of the lower part of the forehead, immediately above the top of the nose. It takes cognisance of individual existences—of a horse, for example. Other knowing faculties respectively observe the form, colour, size, and weight of the horse, but a faculty was necessary to unite all these, and give the individual idea of a horse. It furnishes the substratum which has form, colour, &c., an old desideratum of the metaphysicians. Individuality is the storehouse of knowledge of things that simply *exist*. It is often large without being accompanied by reflecting power; when this is the case, the individual has been compared to an encyclopædia, full of facts, but unable to reason from them. All the objects of Individuality are *noun substantives*. Verbs and adjectives are the perceptions of other faculties to be afterwards noticed. As Individuality merely observes existences without regard to their modes of action, it is the faculty of the naturalist. Those who possess it large and active, observe the minutest objects; nothing escapes them, and they remember even the minutest objects so well, that they will miss them when taken away. On the contrary, those who have it small, observe nothing, and give the most imperfect account of the objects which have been in their way. In the artist, the faculty gives great minuteness of detail, and with Imitation and Form, great power of hitting likenesses in portrait-painting. The faculty prompts to personification of abstract ideas, as Fame, Envy, Wisdom, Folly. Mr. Combe says—"In adults, the *frontal sinus* is generally present at the situation of this organ, and this throws a difficulty in the way of judging of its size. The function, however, is ascertained by observing young persons in whom the sinus is not formed, and also by the negative evidence; that is, when the external part of the skull at the top of the nose is narrow, contracted, and depressed, the portion of brain below is necessarily small and then the mental power is found invariably weak This concomitance of large size and great power in young persons, and of deficiency of size and feebleness of power in all ages, proves the function." The organ is established: the metaphysical analysis of the faculty requires further inquiry. For able discussions on this field of inquiry by Mr. Scott, Mr. Hewet Watson, and Mr. Schwartz of Stockholm, see *Phrenological Journal* vol. v. 226, vi. 328, and vii. 213.

No. 23.—Form.

This organ is situated on each side of, and close to the *crista galli*, and occupies the space between the eyes In those who have it large, the eyes are wide asunder and *vice versa*. Dr. Gall discovered the organ in persons remarkable for recognising faces after long intervals, and although, perhaps, only once and briefly seen. The bust of George III. furnishes the best example in the Phrenological Society's collection; and it is well known that he never forgot a face. Townsend, the famous Bow-street officer, had the same talent, one most essential to his office. As every material object must have a form, regular or irregular, this faculty was given to man and animals to perceive forms, and they could not exist without it. When large, it constitutes an essential element in a talent for drawing, but requires Size and Constructiveness to perfect the talent. Forms are capable of great beauty, and of affording much pleasure, and in nothing more than in the human figure.

Many persons who have the organ of Form large, connect their words and ideas with forms, and these often fanciful and of their own creating. A singular instance of this is recorded in the *Phrenological Journal*, vol. viii. p. 216. Mineralogists and crystallographers generally possess this power in large endowment. The celebrated Cuvier owed much of his success in comparative anatomy to his large organ of Form. De Candolle mentions, that "his (Cuvier's) memory was particularly remarkable in what related to forms, considered in the widest sense of

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* See *Phrenological Journal*, vol. ix. 193, x. 535, xi. 275, and previously in vol. iv. 266. Sir George Mackenzie has contributed an ingenious paper on this subject, vol. ix. 349; and Mr. Noble of Manchester, x. 730, xii. 206. See additional views by Mr. Simpson, in *The Lancet* of 17th July, 1841.

that word; the figure of an animal seen in reality or in drawing, never left his mind, and served him as a point of comparison for all similar objects." Mr. Bewick, the first celebrated English wood-engraver, showed an uncommonly great distance between the eyes. The organ is established.

No. 24.—Size.

Every object has a size or dimension Hence a faculty is necessary to cognise this quality. The organ is situated at the inner extremities of the eyebrows, where they turn upon the nose. A perception of Size is important to our movements and actions, and essential to our safety. There is no accuracy in drawing or perspective without this organ. A singular instance of a defect in the power of perceiving perspective, accompanied with a small organ of Size, is mentioned by Mr. Combe (*System*, vol. i. p. 472). "Mr. Ferguson, tutor in the family of Sir George Mackenzie, stated that he had a difficulty in 'understanding a landscape' in a picture, and explained that 'it appeared to him to present a group of objects on a plain surface, without any perceptible fore or back ground.' He attributed this defect in his perceptions to his not having been taught the rules of perspective at school. In the course of further interrogation, he stated that he sees the forms of objects distinctly, as also their colours; that he likes brilliant tints best, and that in nature he perceives distances also. He has visited Roslin (in the neighbourhood of Edinburgh), and not only perceived the beauty which characterizes that delicious spot, but enjoyed it with a keen relish. He has also seen many pieces of Highland scenery, and been delighted with them. Rivers, meadows, trees, and cultivated ground are, however, the objects which interest him most. On turning his back upon any natural landscape, or shutting his eyes, his recollections instantly become very confused. He is not able to call to his mind the 'relative positions' of the objects, while he distinctly recollects the *pleasing impressions* which they made upon him; this remembrance does not soon fade." Mr. Ferguson's organs of Ideality, Wonder, and Intellect, are good; but his Size, Form and Locality, are all deficient. His description of his experience looks very like a defect in all three. Sir George Mackenzie thinks that the faculty of Size, as it cognises dimension of every kind, whether in length, breadth, thickness, height, depth, or distance, is that faculty whereby we perceive *space* in general, analogous to to the faculty of Time, by which we perceive time. Different individuals manifest different degrees of the power of perceiving size. Some seem not to possess the power of estimating distance or dimension, while others can draw a circle without compasses, and find the centre of one already drawn with the greatest accuracy. A young lady is mentioned by Mr. Combe, whose drawings were accurate in the form, but always erroneous in the size of the objects or parts. The organ is established.

No. 25.—Weight.

Weight is a quality of matter quite distinct from all its other qualities. The weight of any material object is only another name for its degree of gravitating tendency—its attractability to the earth. A power to perceive the different degrees of this attraction is essential to man's movements, safety, and even existence. There must be a faculty for that perception, and that faculty must have a cerebral instrument or organ. Phrenologists have generally localized that organ in the superorbitar ridge or eyebrow, immediately next to Size, and farther from the top of the nose. But as yet the function of the Organ 25 has given rise to so much discussion, as to leave it far from certain what that precisely is. Mr. Combe says, "Persons who excel in archery and quoits, and also those who find great facility in judging of momentum and resistance in mechanics, are observed to possess the parts of the brain lying nearest to the organ of Size largely developed; and the organ is now regarded as probable. Persons in whom Individuality, Size, Weight, and Locality are large, have generally a talent for engineering, and those branches of mechanics which consist in the application of forces; they delight in steam-engines, water-wheels, and turning-lathes. The same combination occurs in persons distinguished for successful feats in skating, in which the regulation of equilibrium is an important element. Constructiveness, when Weight is small, leads to rearing still-fabrics, rather than to fabricating working machinery. Mr. Simpson has given much attention to this faculty (*Phrenological Journal*, vol. ii. p. 412), and opened up some original views for discussion in the phrenological world;—a new chapter, as Mr. Combe calls it, in the science of mind. He cites a number of noted mechanicians and engineers in whom the Organ 25 is large. In the bust of James Watt it is particularly prominent. Children who walk early and steadily have uniformly the organ large, and the inference was drawn that the faculty gives the power of preserving equilibrium, or that balance of forces which is essential to the application of animal power, and even to animal existence. The instances of Mr. John Hunter, the anatomist, a young lady, Miss S. L., and the English Opium-eater, are adduced in confirmation of the action of this power, these persons exhibiting the effects of a suspension of it. Mr. John Hunter, in an illness, felt as if he had drunk too much, although he had been extremely temperate—as if he were suspended in the air, as if the room went round with him, and as if he were insensible of his own centre of gravity—so he expressed himself. The young lady had the same sensations, and *saw perpendiculars at other angles*. The Opium-eater felt as if he were falling millions of miles, as he expresses it, without ever finding a bottom. Intoxication sports with *perpendiculars*, it is well known. Sir George Mackenzie suggested Resistance as the function of this power. Mr. Simpson considers Resistance to be the passive sensation of a *sense* (see External Senses), and the Organ 25 that of applying Force, or, the adaptation to resistance of counter-resistance. For his matured views, see *Phrenological Journal* (vol. ix. p. 193). Mr. Richard Edmonson of Manchester, in the *Phrenological Journal* (vol. vii. p. 106, and ix. p. 624), argues that the Organ 25 gives the perception of the *direction* of gravitating force—in other words, the *perpendicular* or *vertical*; and cites instances among his own numerous workmen, and others, of individuals who could guess the perpendicular without applying the plumb-line; and Mr. Edmonson, as he himself states, makes use of Mr. Simpson's facts, especially the cases of diseased perception above cited, in support of his own theory. There is much worthy of reflection and farther observation in this view. A standard of the direction of gravitation is essential to our safety in person, buildings, &c., and the standard is *the vertical*. A fine perception of this is certainly necessary to the engineer and mechanician. But it appears to us that the perception of the mere *direction* of gravitation were useless to us without the perception of gravitation itself, which is just another term for Weight. Mr. Hytche, in a paper in the *Phrenological Journal* (vol. xiv. p. 109), adduces many proofs in favour of the conclusion, that No. 25 is the organ of the application of mechanical power. In a paper lately read to the Phrenological Association met in London,* Mr. Simpson suggests, that what appear to be different manifestations, according to the views of Mr. Edmonson, Mr. Hytche, and himself, seem all to be necessary to the action of one single power, the mechanical perception and application of force; in a word, that the labours of all three may be found tending to the same object. Mr. Edmonson, however, adduces some facts to show that the active application of force in its due proportion is the function of the organ of Con

* An abstract is published in *The Lancet* of 17th July, 1841.

struct veness. Yet *construction* is change of form, and all animals apply force, while few construct. The functions imputed by Mr. Edmonson to both 25 and 9 are yet "an open question," waiting for further proofs by facts. The student of phrenology should read all the papers to which we have referred.

No. 26.—Colouring.

As every object must have a colour, in order to be visible, it seems necessary that there should be a faculty to cognise this quality. The organ is the next outwards from Weight in the eyebrows, occupying the precise centre of each eyebrow. A hollow there, into which the end of the finger could be put, or such a flatness in the ridge of the eyebrow that a perpendicular line dropped from it would pass through the eyeball, has, times without number, been found to be accompanied with a want of power to discriminate colours, often to a ludicrous extent. A mercer's apprentice, who used to offer red to match green, was dismissed as unfit for his trade. The organ is large in great painters, especially great colourists, and gives an arched appearance to the eyebrow; for example, in Rubens, Titian, Rembrandt, Salvator Rosa, Claude Lorraine, and others. A large endowment of the organ gives great delight in flowers and brilliant colouring of all kinds. Nature has widely and profusely provided for the gratification of this faculty, by the exquisite colouring in which her works are dressed. Some metaphysicians consider the pleasure we derive from colours to be the result of the association of ideas. Phrenology has discovered that it is the direct gratification of an organ forming part of our constitution. Like that of Ideality, the pleasures we derive from Colour are gratuitous goodness from the Creator's hands. Light and shade, mere black and white, might have rendered objects visible, but what a sombre hue would nature in that case have worn! In some individuals the love of flowers amounts almost to a passion. This organ is held established.

No. 27.—Locality.

Dr. Gall was led to the discovery of this faculty as primitive, by comparing his own difficulties with a companion's facilities, in finding their way through the woods, where they had placed snares for birds, and marked nests, when studying natural history. Every material object must exist in some part of space, and that part of space becomes *place* in virtue of being so occupied. Objects themselves are cognised by Individuality; but their place, the direction where they lie, the way to them depend on another faculty, a faculty given for that purpose. Without such a power, men and animals must, in situations where objects were numerous, and complicated in their positions, as woods, have lost their way. No man could find his own home, no bird its own nest, no mouse its own hole. The use of the faculty will be rendered plain by considering what it is we do when we wish to remember our way through the streets of a large city; we note particular objects, buildings, for example, and observe how they stand in relation to each other, and these relations we can remember, although with a faint recollection of the forms of the objects themselves. This induced Sir George Mackenzie, in his "Illustrations," to attribute to this faculty the perception of *relative position* of objects. It is evident that the objects must be fixed—at least, if movable, fixed for the moment—in order to be in a particular place, to enable us to find or go to that place. There is another relation, namely, that between ourselves and the place. Hence the use of the points of the compass, which are the [illegible] of determining the direction of places in relation to ourselves and these places. The organ is large in those who find their way easily, and vividly remember places in which they have been. It materially aids the traveller, and is supposed to give a love for travelling. The organ was large in Columbus, Cook, Park, Clark, and other travellers. Geometricians, whose study is the relation of spaces, have the organ large—as was the case with Kepler, Galileo, Tycho Brahe, and Newton. The faculty, when active, prompts the individuals to localize every thing, and think of it as in its place. One glance at a paragraph or advertisement in a newspaper fixes its place in their minds, so that they will turn over the largest and most voluminous newspaper, and know in what column, and part of a column, they will find it; or direct others to do so. Many public speakers make use of the faculty by connecting their topics with places; and those who have written their speeches, remember the pages, or parts of pages, where particular parts of their discourse are noted down. Indeed, the word *topic* is derived from the Greek *topos*, a place; hence, too, the word *common-place* subjects. A person with the faculty powerful, will go in the dark to find what he wants, and will find it in its place. Skilful chess-players invariably have the organ of Locality large, and it is believed that it is the organ of which they make the principal use; for it gives the power of conceiving, before making a move, the effect of new relative positions of the pieces. Migratory birds are believed to be directed by this organ; and animals, like dogs, and, it is said, cats—which, after being carried far from home, contrive, to the astonishment of every one, to reappear there, however distant. We refer to the *Phrenological Journal* (vol. vii. p. 747) for an amusing instance of a temporary suspension of the power of using the faculty of Locality, which will perhaps better explain the nature and use of that power than much abstract description.*

No. 28.—Number.

The organ of this faculty is placed at the outer extremity of the eyebrows and angle of the eye. It occasions, when large, a fulness or breadth of the temple, and often draws downwards the external corner of the eye. When it is small, the part is flat and narrow between the eye and the temple. Their number is a very important relation or condition of things, and requires a distinct perspective power. Our safety, and even existence, may depend on a clear perception of Number. Dr. Gall called the faculty "*Le Sens de Nombres*," "The Sense of Numbers," and assigned to it not only arithmetic, but mathematics in general. Dr. Spurzheim more correctly limits its functions to arithmetic, algebra, and logarithms; geometry being the exercise, as already shown, of other faculties. Dr. Gall first observed the organ in a boy of nine years of age, near Vienna, who could multiply and divide, mentally, in less time than expert arithmeticians could do with their pencils, ten or twelve by three figures. Dr. Gall adds, "he had created his own method." An advocate of Vienna regretted to Dr. Gall that his son was so much engrossed with calculating, that he attended to nothing else. Dr. Gall compared the heads of these two boys, and found no particular resemblance but in one place—that described above—where they exactly agreed. Dr. Gall then went to noted arithmeticians—among them an author of tables of logari[illegible] the same [illegible]tion. Many othe[illegible] found in the phrenological books; and the organ is easily observed in nature. The most wonderful arithmetical prodigy yet known to phrenologists is George Bidder, now a civil engineer. When quite a child, and without any instruction, he showed an extraordinary talent for mental calculation. When he came to Edinburgh—where some scientific gentlemen undertook to educate him, with the view, if possible, of ascertaining his method, which they never

* Reprinted in *Chambers's Edinburgh Journal*, No 506.

did, as he is yet unable to put it in words—he was eleven years of age, and could, in a minute or two, answer the most complicated questions in algebra, without writing down a figure. He was presented to Mr. Combe, along with two other boys, all three strangers to him, one deficient in arithmetical power, and another clever at school in that line. Dr. Combe at once pointed out the deficient and the good arithmetician; and, by the largest organ of the three, without difficulty decided that the third was George Bidder. The case of Zerah Colburn, detailed by Dr. Gall, was a striking one, but less so than Bidder's; casts of both are in the Museum of the Phrenological Society in Edinburgh. Neither of these young men turned out more than ordinary geometricians. In Humboldt, brother of the traveller, the organ and power are both great. The negative evidence is also strong; there are individuals in whom the organ is small, and who find great difficulty in mental calculation. Some have been utterly unable to learn the multiplication table.

Some savage tribes are unable to count above thirty or fifty. Humboldt particularizes the Chaymas of South America, who, with an expression of great mental labour, can reach these numbers; and it is curious that Humboldt remarked that the external angles of their eyes are turned *up*, instead of down, as they are when the organ is large. The Greenland tribes can reach twenty by the aid of their ten fingers and ten toes. The inferior animals, there cannot be a doubt, possess the faculty. A dog was accustomed to be fed by successive small pieces thrown to him. He went away satisfied when he had received the full tale, but not one morsel sooner. Magpies, it is said, count three. Dupont de Nemours asserts that they count nine.

The organ is often found in a state of diseased activity; and when the other faculties were dormant, it has been known to perform most difficult arithmetical and algebraical feats. Mr. Combe saw a patient in the Lunatic Asylum in Newcastle, in whom he observed a very large organ of Number, and was informed by the resident surgeon that he was perpetually employed in figures. The organ is established.

No. 29.—Order.

The organ of this faculty is placed in the eyebrow, between Colouring and Number, and is large and prominent, and often pointed like a limpet-shell, in those who are remarkable for love of method, arrangement, and symmetry, and are annoyed by confusion and irregularity. The marked love of order in some persons, and their suffering from disorder, are feelings which no other faculty, or combination of faculties, seems to embrace. Several cases are mentioned in the phrenological books, where it characterized idiots, deficient in almost every other faculty. An idiot girl in Edinburgh would not enter her brother's room, which was always in confusion; and Dr. Spurzheim mentions the Sauvage de l'Aveyron, who replaced every thing instinctively which others, often purposely to try him, disarranged. Mr. L., a late medical gentleman in Edinburgh, was remarkable for the organ and its manifestation. He was pointed in his engagements—for the faculty gives this important habit—neat and careful in his writings, regular in his accounts, precise in his dress, and cleanly in his person: the last-mentioned habit being likewise one manifestation of order. The faculty was hereditary in that gentleman; for his father was so precise in his arrangements, that on one occasion, having put his penknife into a *wrong* pocket, he would not for some time be persuaded to try any other than what he held to be the *right* one. He yielded, however, at last, and was much disconcerted when he found the unwontedly misplaced article. In savages, whose habits are slovenly, filthy, and disgusting, like the Esquimaux, the organ is small. When we consider the abridgment and facilitation of our labour which result from arrangement, we can see a purpose in the endowment of this faculty. We doubt not that a more extended and careful analysis may discover for it yet more important functions. The organ is established.

No. 30.—Eventuality.

The organ of this faculty is situated in the very centre of the forehead, and when large, gives to this part of the head a rounded prominence. Individuality has been called the faculty of *nouns*; Eventuality is the faculty of *verbs*. The first perceives mere existence; the other motion, change, event, history. All knowledge must be of one or the other of these two descriptions—either things that *are* or things that *happen*. In the following examples—the MAN *speaks*, the WIND *blows*, the DAY *dawns*, the nouns cognised by Individuality are printed in capitals, while the verbs, addressed to Eventuality, are in italics. The first is simple existence; the other is action, event, history. Dr. Gall distinguished, as the metaphysicians do, *verbal* memory, *local* memory, *real* memory. It is now phrenological doctrine that all the intellectual faculties have their own memory. Form remembers forms; Colour, colours; Size, dimensions; Individuality, objects; Eventuality, actions; Tune, music; Comparison, resemblances and analogies; Causality, logical reasons.

The most powerful *knowing* minds have a large endowment of both Individuality and Eventuality; and such individuals, even with a medium reflecting organization, are the clever men in society—the acute men of business—the ready practical lawyers. When the one organ is more developed than the other, the difference will be marked in the writings of the individuals. Mr Combe (*System*, p. 518) adduces some striking proofs of this in extracts from celebrated writers, and refers to some acute and interesting observations by Mr. Hewet Watson (*Phrenological Journal*, vol. vi. pp. 383–451) on this aid to literary criticism. The organ of Eventuality is generally well developed in children, and their appetite for *stories* is well known. Those, however, in whom eventuality is moderate, and Individuality large, are prompted less to listen to tales than to "see things," as they call the exercise of their more powerful faculty. In after life, the latter will observe minute existences—will tell how many nails are in a door, and miss one if taken out before their next inspection. Miss Pratt, in the novel called the "Inheritance," is an example. The former will make use of incidents when they wish to recall any matter of memory. Dame Quickly convicts Sir John Falstaff of a promise of marriage, by recalling to his recollection a whole catalogue of simultaneous occurrences (*Second part of Henry IV.*, act 2d, scene 2d). Both faculties are important, we may say essential, to a teacher of youth. The organ is established.

No. 31.—Time.

Whatever be the essence of time as an entity, it is a reality to man, cognisable by a faculty by which he observes its lapse. Some persons are called walking timepieces; they can tell the hour without looking at a watch; and some even can do so, nearly, when waking in the night. The faculty also marks the minute divisions of duration, and their relations and harmonies, which are called *time* in music, and *rhythm* in versification. The impulse to mark time with the head, hands, feet, and whole body, is too common, too natural, and too strong, not to be the result of a faculty; it is the impulse to dance, and almost universal in both savage and civilized man; and its existence settles the question with the "Friends," of the innocence or *sinfulness* of dancing. In some, the impulse, when well-marked time is offered—the better if combined with music, though a well-beat drum may be danced to—is often irresistible.

It exists in a diseased state, for we have seen dancing madmen. Mr. Combe refers to a paper by Mr. Simpson in the *Phrenological Journal* (vol. ii. page 134), in which much light is thrown upon this faculty. Mr. Simpson accounts for the dancing of the deaf and dumb; time being communicable through the eye, and by touch, quite as much as through the ear. Masters of time in music are called good *timists*. The organ was deranged in a lady of Copenhagen attended by Dr. Hoppe: she complained that she had no conception of time; things that happened appearing sometimes very long ago, and sometimes only a few moments. She complained of pain in the forehead, and placed her finger on the very organ. Dogs, and even horses, give plain indications of possessing the faculty, by their conduct on the return of particular days, occasions, &c.: Mr. Combe mentions several instances. The organ, situated on each side of Eventuality, is held to be established.

No. 32.—Tune.

The organ of this faculty is situated still farther out than that of Time, giving roundness to the point where the forehead turns to form the temples. It is large in great musicians; and when small and hollow, there is an utter incapacity to distinguish either melody or harmony. The organ is sometimes diseased. A young lady, a patient of Dr. Combe's, was seized with an irresistible craving for music, which haunted even her dreams, and she complained of pain in the very situation of the organ. Music may be defined as a species of natural language, depending immediately on either a melodious succession, or a harmonious unison, of tones—tones, again, being distinguished from simple noises by a peculiarity in the mode of their production. A noise is the result of some isolated concussion of the air; when concussions or impulses on the air follow in a sufficiently rapid succession, they melt into each other, and the effect is a tone. These are facts in natural philosophy, and have been curiously illustrated by a piece of mechanism, which, in its slow movements, produces only noises, but, when impelled with great rapidity, gives forth tones. The musical notes are repetitions of a series of seven tones, each of which is produced by a certain number of impulses on the air within a given space of time, and the numbers of these impulses all bear certain nice mathematical relations to each other. The organ of Tune in the human brain appears to have been constituted in relation to these physical facts, and, in cases of good endowment, to have a most exact perception of all their niceties, and a power of using them to the production of the species of natural language which we term music. Cases of a low endowment of the musical faculty, or of persons said to want *musical air*, are of frequent occurrence, though, perhaps, in many such instances, early culture would have brought out some trace of the faculty. The great bulk of mankind possess the organ in a moderate endowment, so as to be capable of enjoying music in some degree. The individual possessing it in high endowment becomes, in all stages of society, a distinguished artist, exercising a peculiar power over his fellow-creatures, so as to rouse, melt, soothe, and gratify them at his pleasure. But the gift, in this active form, is liable to be much modified according as it is accompanied by Ideality, Benevolence, Wit, and other faculties. The organ, as connected with music, is held established; but its fundamental function—suggested by Mr. Simpson to be *sound*,* or the perception of the sonorous in nature—yet remains far from being fully elucidated.

No. 33.—Language.

When the faculties are in activity, either singly or in combination, the impulse in almost all individuals is strong, in many irresistible, to communicate to others the feelings or thoughts produced by them. This may be done by signs, which is natural language, or by words, which constitute conventional. A faculty is given to man and animals which connects feelings with signs and cries; but to man alone is given articulate speech. The comparative facility with which different men clothe their thoughts in words, depends on the size of this organ, which is situated in the super-orbitar plate, immediately over the eyeball, and when large, pushes the eye outwards, and sometimes downwards, producing, in the latter case, a wrinkling or pursing of the lower eyelid. There is no fluent speaker deficient in this organ. There is some doubt of the faculty giving the power of learning languages, and the spirit of languages in philology; the prevailing opinion is, that the faculty of Language has less to do with this power than Individuality, imitation, and some other faculties. Learning the words and structure of other languages is quite a different thing from applying our own to express our thoughts.

None of the organs have been better proved to be primitive, by diseased manifestation, than this. The instances are numerous of persons losing the power of finding words for their thoughts, and recovering it again; and in many of these cases, the brain in the organ, when examined after death, has been found diseased. Pain in the region often accompanies the loss of appropriate speech, in plague, yellow and typhus fever. But we must refer, for further information on this interesting subject, to the works on phrenology, especially Mr. Combe's *System* (4th edition, p. 542). Mr. W. A. F. Browne, Medical Superintendent of the Dumfries Lunatic Asylum (lately of the Montrose), has enriched the subject (*Phren. Journal*, vol. ix.) by classing the cases of disease, either in involuntary activity or deprivation of this faculty, which have come under his own observation—such as rapidity of voluntary and involuntary utterance, partial loss and total loss of memory of words, loss of perception of the relation of words to things. Mr. Browne has had patients who have, for many years, spoken with unknown tongues; thereby explaining a recent exhibition in this country of insane fanaticism. Mr. Browne's work on Insanity is an invaluable contribution to this subject. Dr. William Gregory observed, that taking morphia produced in himself loss of control over the faculty of Language, so that he could not stop speaking. He concluded that that medicine acted on the anterior lobe of the brain, especially the convolutions of Language. (*Phren. Journal*, vol. viii. p. 161.) Some intoxicated persons are more talkative than when sober, pouring out mere words without meaning. Dr. Gregory entreats phrenological medical men to note the effect of different medicines on the faculties, as a possible source of valuable light. Dr. Otto, of Copenhagen, physician to the King of Denmark, read a paper to the Phrenological Association, which met in London in June, 1841, on this subject. (See *Phrenological Journal*, vol. xiv. p. 288). The inferior animals communicate with their kind by, to them, intelligible language; and the dog, the elephant, the cat, even the horse, can be made to comprehend words, otherwise there would be no use in talking to them. How well a dog that wishes to walk understands and disrelishes, "Go home, sir!" This organ large, with its corresponding manifestation, in a companion of Gall first suggested phrenology. It is established.

Internal Excitement of the Knowing Organs—Spectral Illusions.

The Knowing Organs are for the most part called into activity by *external* objects, such as forms, colours, sounds, individual things, &c.; but internal causes often excite them, and when they are in action objects will

* See papers in *Phrenological Journal*, ii. 120, 530; x. 436, 731; xi. 33, 207, and xiii. 193.

be perceived which have no external existence, and which, nevertheless, the individual will believe to be real. This is the explanation of visions, spectres, and ghosts, and at once explains the firm belief of many that they have appeared to them, and the fact that it never happens that two persons see the same spectres at the same time. The Marquis de Villa did not see Tasso's familiar spirit, although sitting beside him when he declared it appeared to himself. We formerly remarked, when treating of Wonder, that excess or disease in that organ predisposes the patient to believe in the marvellous and supernatural, and probably stimulates the knowing organs into action, when spectral illusions are the consequence. We promised to return to the subject, and submit this as the proper place, after having concluded our analysis of the Knowing Organs. Mr. Simpson has given much attention to this subject. In a paper furnished by him to the *Phren. Journal* (vol. ii. p. 294, and several other confirmatory communications), he has succeeded in clearing up the mystery of apparitions, which have so long terrified mankind; and in doing so, has at the same time furnished the most pointed evidence of the distinctive functions of the organs situated along the eyebrows—organs so much doubted, because of their small size, although chemists and naturalists have to distinguish much smaller, often microscopic, objects. A young lady, known to Mr. Simpson, and mentioned in the phrenological books by the initials of S. L., lived in indescribable horrors for above a year, in consequence of the visits of the spectral forms of persons and other objects, and the perception of bright lights, brilliant colours, music, and other illusions. At the time of these false perceptions, as we stated when treating of the organ of Weight and the sense of Resistance, she lost the power of preserving her balance, and saw perpendiculars and horizontals at other angles. She complained of sharp pain when her visitants appeared to her; and although ignorant of phrenology, and even the situation of the organs, she put her finger and thumb, when asked where she felt the pain, to the organs of Form and Individuality. For several weeks, these were the site of her pain exclusively; and then the figures which appeared to her were *forms* without *colour*, resembling, as she stated, cobweb. Here plainly was Form active, but Colouring dormant. Some weeks after this, her objects became naturally coloured, and the pain extended along the eyebrows, including the organ of Colouring. Embracing, as the progress did, Size, her illusions referable to that organ in morbid activity were singular; she saw objects sometimes gigantic, sometimes dwarfish, and even minute. The pain proceeding onwards along the whole eyebrows, Order and Number became affected, and her visiters came in great numbers and most annoying confusion, so that sometimes they seemed to tumble into her apartment like a cascade, a confused mass of persons, limbs, heads, &c. Her apparitions began at last to *speak* to her, and her terrors were much aggravated. It was probable that the organs of Language and Tune became affected; for she often heard bands and choruses of music. We may add, that she was greatly relieved when the true nature of her spectres was explained to her. In time the affection left her entirely.

It is likely that the proximate cause of these morbid manifestations was an undue determination of blood to the region of the head where the knowing organs are situated. Nicolai, the bookseller of Berlin, when subject to the same disease, applied leeches along the eyebrows; and as the leeches filled, the illusions vanished, becoming fainter and fainter. Such are often the slight causes, revealed by science, of important and otherwise bewildering effects. The mysteries of the English Opium-Eater have been made plain by the case of Miss S. L. He saw faces in millions, insufferable lights, brilliant colours, &c., and, as we have stated when treating of the organ of Weight, he lost the sensation of support or resistance, and seemed to fail millions of miles. Mr. John Hunter, the anatomist, whom we mentioned as having something like that horrible sensation, likewise suffered from illusions of *Size* and *Weight*, his leg often extending, as he thought, many miles in length, and having the weight of a mountain. Many persons suffering from the same cause, and experiencing the same effects, have communicated their cases to the *Phrenological Journal*, since the publication of those above mentioned.

GENUS III.—REFLECTIVE FACULTIES.

The Intellectual Faculties already considered, give us knowledge of objects, and the qualities and relations of objects, also of the changes they undergo, or events. The two remaining faculties, according to Dr. Spurzheim, "act on all the other sensations and notions;" that is, they judge of the relations of different ideas or classes of ideas produced by the Knowing Faculties. They minister to the direction and gratification of all the other faculties, and constitute what by excellence is called reason, in other words, reflection.

No. 34.—Comparison.

Dr. Gall discovered the organ of this faculty in a man of science, who reasoned chiefly by means of analogies and comparisons, and rarely by logical deductions. He *illustrated* every thing, and carried his opponent along with him with a flood of resemblances, concluding that the thing disputed must be true, being *like* so many things that are known to be true. In his head was a fulness in the form of a reversed pyramid, just in the middle of the upper part of the forehead. The faculty perceives analogies and resemblances. Every faculty can compare its own objects. Colouring can compare colours; Weight, weights; Form, forms; Tune, sounds; but Comparison can compare a colour with a note, or a form with a weight, &c. Analogy is a comparison not of things but of their relations. The Saviour, for example, in his parental apostrophe, does not compare Jerusalem with himself as two objects; but compares the relation of a hen to her chickens covered with her wings, with the relation of his own benevolent feelings towards that devoted city. In doing this, he addressed the faculty of Comparison in his hearers. It is constantly addressed in Scripture by similes, parables, allegories, and all kinds of analogies. As the faculty deals in these, and in illustrations in general, it forms the great power of the popular orator. Dr. Spurzheim thought that the faculty perceives difference. Mr. Scott dissents from this, and attributes that function to the faculty of Wit. The precise fundamental function of the faculty is yet controverted. Mr. Hewet Watson (*Phrenological Journal*, vol. x. p. 168) argues ingeniously that it is the perception of *conditions*, of the condition in which objects exist. "The *young* man dies." Man is cognised by Individuality—his act of dying by Eventuality; but neither the one nor the other of these can take notice of his condition, as being young; and as it requires the adjective to qualify a condition, Comparison is the *adjective* faculty, as Individuality is the *noun*, and Eventuality the *verb* faculty. Mr. Combe thinks there is soundness in Mr. Watson's speculation, and that it is really *conditions* we do compare—the condition, for example, of the hen covering her chickens with that of the Saviour gathering Jerusalem under his metaphorical wings. As the organ of analogies, similitudes, and comparison of ideas, it is established.

No. 35.—Causality.

This is the highest and noblest of the intellectual powers, and is the last in the phrenological analysis of the faculties. Dr. Spurzheim so named it, from obsering that it traces the connection between *cause* and *effect*, and sees the relation of ideas to each other in respect of *necessary consequence*. Its organs are situated on each side of Comparison. Some metaphysicians have held that we have no idea of cause, but see only sequence, or one thing following another. It is true that we do see sequence. When, for example, fire is put to gunpowder, Individuality perceives the existence of the powder and of the match; Eventuality sees the motion which unites them, and the change or event which takes place in the explosion; but we have a *third* idea, namely, that of power, agency, or efficiency, existing in some way in the cause, to produce the effect. Whence do we get this third idea?—from a third or distinct faculty, and that is Causality. We are just as little entitled, by means of Causality, to deny the perceptions of Individuality and Eventuality, which the celebrated Bishop Berkeley did, who denied the existence of a material world, as by these last to deny the conclusions of Causality. With a powerful perception of *causation*, the individual reasons from cause to effect by logical or necessary consequence. It is the faculty which sees principles and acts upon them, while the other two faculties only try experiments. Resource in difficulties, and sound judgment in life, are the result of powerful Causality. Dr. Thomas Brown came very near the phrenological division of the intellectual faculties into Knowing and Reflecting, when he distinguished them into powers of simple suggestion and relative suggestion. Causality existing as a faculty gives powerful aid to the natural argument for the existence of God. Causality desiderates a cause, and goes upwards to a First Cause, as that which *must* exist; else the faculty in man has no legitimate object, and was bestowed in vain. This proof, added to that drawn from the existence of the faculty of Veneration for the adoration of the First Cause, as traced by Causality, constitutes an immense addition to the argument for the existence of God from the light of nature; and when yet further fortified by the existence of faculties in man of Benevolence and Justice, which necessarily imply a benevolent and just Creator, phrenology may be said to have been a contributor to the evidence of the highest and holiest of truths, the existence and attributes of the Most High. The organ is established.

Adaptation of the External World to the Intellectual Faculties of Man.

We quote the following passage from Mr. Combe's *System*, (4th edition, p. 593:)—"The human mind and the external world having emanated from the same Creator, ought, when understood, to be found wisely adapted to each other; and this accordingly appears in an eminent degree to be the case. If the reader will direct his attention to any natural or artificial object, and consider, 1st, its existence; 2d, its form; 3d, its size; 4th, its weight; 5th, its locality or relation in space to other objects; 6th, the number of its parts; 7th, the order of physical arrangement of its parts; 8th, the changes which it undergoes; 9th, the periods of time which these require (we would add here, its sound-producing quality or sonorousness, as quite different from all those enumerated); 10th, the analogies and differences between the individual object under consideration and other objects; 11th, the effect which it produces; and, lastly, if he will designate this assemblage of ideas by a name, he will find that he has obtained a tolerably complete notion of the object." We may add, that the relations between the affective faculties or feelings of man and the moral world are not less harmonious; and demonstrate design in a manner altogether irresistible.

Relation between the Functions and the Structure of the Brain.

In the introduction to his translation of that part of Dr. Gall's work on the *Physiology of the Brain* which treats of the functions of the cerebellum, Mr. Combe has stated the result of certain observations of his own, which tend to confirm as true the allotment of function to the different regions of the brain, which has been ascertained by phrenologists. An accumulation of facts, which amounts to proof more cogent than is to be found in regard to any other physical truth, has connected with the *anterior* lobes of the brain the Intellectual Faculties, and with the *middle* and *posterior* lobes, the Feelings. The Intellectual Faculties constitute the WILL of man, and in obedience to the will are the *voluntary* motions. But the feelings, when in activity, as is well known, have certain *involuntary* motions connected with them. Now, the spinal cord has two columns, the one, the anterior, observed to produce the motion, and therefore called the *motory* tract; and the other to produce sensation, and therefore called the *sensory* tract. These two tracts join the brain by what is called the *medulla oblongata*: and here a most striking distinction takes place. The motory tract *alone* communicates with the anterior lobes, in which, in the intellectual organs, resides the will. Hence, in *voluntary* motion, as an effect of will, the motory tract obeys the anterior lobe alone; in other words, the anterior lobe of the brain *manifests* will, and the motory tract *executes* will. The sensory tract has no connection with the anterior lobes or intellectual organs.

Again, the *sensory* tract has a fibrous connection with the middle and posterior lobes of the brain, and with the cerebellum, and most appropriately, for these are the organs of the *feelings*. But as the feelings have *involuntary* motions when acting, these are provided for by a fibrous connection between the organs of the feelings and *both* the sensory and motory tracts. Yet, as the motions consequent upon the energy of passion are not voluntary but instinctive, we should expect a separate motory tract for instinctive motion, with which, and not with the tract of voluntary motion, the organs of the feelings should be connected. This distinction, however, has only been conjectured, it is not yet ascertained. Mr. Combe farther adds—"It is certain that mental *emotions* exercise a powerful influence over the organic functions; when the emotions are agreeable, they stimulate these functions to healthy action; and when painful, they depress their energies and produce liability to disease. Reciprocally, when the organic functions, such as digestion, respiration, and secretion, are disordered, an irritable and distressing state of the mental feelings is induced. The intimate relations between the convolutions of the brain devoted to the mental emotions and the sensory tract of the spinal cord, is in harmony with these facts. The habit of contending with *intellectual* difficulties, if unconnected with feeling, does not injure the organic functions so severely as do strong and powerful emotions; but it weakens the locomotive powers. Sedulous students of abstruse problems acquire a great aversion to locomotion. These facts correspond with the arrangements of structure, by which the convolutions of the anterior lobes, devoted to intellect, spring from the motory tract, and are not connected with the sensory tract of the spinal marrow." We are not aware that anatomical and physiological investigations have unfolded facts more interesting than those now detailed. The light they throw on phrenology, and the support they afford it, are truly invaluable.

Natural Language of the Faculties, or Pathognomical and Physiognomical Expression.

What has been stated in the preceding section will prepare the reader for the fact, that, by means of involuntary motions, each organ of feeling produces movements, attitudes, and expressions peculiar to itself. The chief aim of the dramatic actor and pantomimist is to study and represent these movements, attitudes, and expressions; and hence such of them as have studied phrenology have declared that it affords them the most valuable guidance. Dr. Gall's *Physiology of the Brain*, and Dr. Spurzheim's *Physiognomical System*, enter fully into this curious subject, and have ascertained the laws which determine the natural language of the faculties. It has been laid down as the leading principle, that the instinctive motions are always *in the direction of the organs.* Self-Esteem, for example, throws the head high and slightly backwards, vulgarly called "turning up the nose" at any thing. Firmness gives an erect stiffness to the person. Cautiousness throws the head backwards and to the side. Veneration slowly forward; hence the reverence and the bow. The involuntary motions extend to the features of the face; hence the dark and harsh expression of Destructiveness, and the smile of Benevolence and Love of Approbation. The countenance tends to take a permanent expression from the prevalence of particular feelings. It is this which renders the physiognomy of phrenology scientifically trustworthy. It was in Lavater's hands a mere empirical art. Skilful phrenologists have often predicted the organs from their expressions in the countenance; and when aided by the pathognomy, or attitudes and motions, and, not least, the sounds of the voice—Destructiveness giving harsh, and Benevolence soft, &c.—there is a power possessed by phrenologists of judging of character which almost renders manipulation of the head unnecessary. When this last, however, is added, the key to character is complete.

The Organs arranged in Groups.

It is instructive to find the organs of such of the human faculties as have an affinity to each other, placed contiguously in the brain, and to observe that, by an apparent sympathy, they stimulate each other to activity. 1st, The supposed organs of the Love of Life and Alimentiveness—the essentials of Self-Preservation—lie contiguous in the brain. But man has a carnivorous stomach and teeth, and must destroy animal life to preserve his own. Destructiveness, accordingly, lies close to the two organs mentioned. He must not only devour the gentler animals, but must not be devoured by the ferocious; hence his Cautiousness, Combativeness, and Secretiveness, are all close neighbours of the three organs mentioned, and of each other. The accumulation of surplus, above his immediate wants, so important to man's preservation, is prompted by Acquisitiveness; while, without Constructiveness, he would perish for want of shelter and clothing. Thus a cluster of no fewer than *seven* organs forms to man the *self-preservative* group of faculties. 2d, Man is commanded to do more than "subdue;" he is enjoined, by multiplying his species, to "replenish the earth." Behold, then, another group of faculties for this purpose, which may be called the *species-preservative*, or *domestic* group—Amativeness, Philoprogenitiveness, Inhabitiveness, and Adhesiveness. 3d, Designed for the society of his fellow-men, man asserts his own rights and legitimate power by Self-Esteem or Self-Love; while he is influenced, by the opinion of others, to the proper regulation of his conduct, by Love of Approbation, or regard to character. Firmness aids Self-Esteem in asserting right. The three organs located close to each other form our *rights and character-preservative* group. 4th, The *moral* group, by excellence, is formed by Conscientiousness, Benevolence, and Veneration *earth-directed*. 5th, The *religious* group is formed by Veneration *heaven-directed*, Wonder, Hope, and Ideality; the last being claimed as a religious faculty by Sir George Mackenzie, as the love of the perfect. 6th, A bountiful Providence has provided a rich fund of recreative pleasure for man, in what may be called the *poetical* or *recreative* group of his faculties, namely. Imitation, Wonder, Ideality, Wit, Tune, and Time, all lying contiguous in the brain, and not inappropriately called the "Poet's Corner," as they form a corner of the head. These are the faculties addressed by artists of every kind—the poet, the actor, the painter, the architect, and the musician. The theatre engages them all. Lastly, Turning to the intellectual powers, we have them in one splendid and "godlike" assemblage in the forehead of man, subdivided into three groups, according to their uses. The lowest range, the *simply-perceptive* group, gives the perception of objects and their qualities. Above it is placed the *relatively-perceptive* group, for perceiving the relations of objects and events; and, above all, the organs of the highest of man's faculties, his reflecting powers, which perceive the relations of ideas, and reasons upon them; or the *reflective* group. The organs of the human brain, as found to be grouped in correlative clusters, were not so discovered. The great majority of them were observed singly, and the full display of their harmonies came forth on the completion only of the successive emergence of the organs, and presented a combined force of truth which well merits the character of irresistible: "There is magic in the web of it."

CONTINUATION OF PHRENOLOGY AS A COMPLETE PHILOSOPHY OF MIND.

The phrenologists have chiefly confined their attention to the organs of the brain, and the various faculties of which these are the instruments. The former writers on mind (Reid, Brown, Dugald Stewart, and others), gave, on the contrary, their chief care to the mental acts called Attention, Perception, Conception, &c., which they considered as faculties. The phrenologist does not overlook the importance of this department of mental philosophy, but differs from the metaphysicians in considering perception, conception, &c., as only *modes* in which the real faculties above described *act*. This distinction is one of great importance.

According to the phrenologists, the faculties are not mere passive feelings; they all tend to action. When duly active, the actions they produce are proper or necessary; in excess or abuse, they are improper, vicious, or criminal. Small moral organs do not produce abuses; but they are unable to prevent the abuse of the animal organs, as the larger tend to do; thus, small Benevolence is not cruel, but it does not offer sufficient control to Destructiveness, which then impels to cruelty. Large organs have the greatest, small the least, tendency to act—each faculty producing the feeling or idea peculiar to itself. Seeing that all the organs tend to action, the Creator must have intended a legitimate sphere of action for them all. *He* could never have created either bad or unnecessary faculties.

The PROPENSITIES and SENTIMENTS cannot be called into action by the will. We cannot fear, or pity, or love, or be angry, by willing it. But *internal* causes may stimulate the organs, and then, whether we will or not, their emotions will be felt. Again, these feelings are called into action in spite of the will, by the presentation of their *external* objects—Cautiousness by objects of terror, Love by beauty, and so on. The force of the feelings, whether excited from within or without, will be in proportion to the activity of the temperament. Excessive action of the affective faculties, or the removal of their object, causes pain. Excessive rage is painful to Destructiveness; and the death of an infant pains the Philoprogenitiveness of the mother. Insanity is a frequent result of over-activity of the affective feelings. An affective faculty may be diseased, and yet the intellect sound. The converse is also true. When the organ is small, its feeling cannot be adequately experienced. Hence the frauds of those with small Conscientiousness and large Secretiveness and Acquisitiveness. The will can *indirectly* excite the affective feelings, by setting the intellect to work to find externally, or conceive internally, the proper objects. This accounts for different turns and pursuits. The value of the truth, that large organs give strong, and small weak impulses, is incalculable in society; all the practical arrangements by which persons may be selected to perform certain functions, and excluded from others where they would be profitless or unsafe, depend upon it. Moral training by educators is founded on it. The weak faculties should be strengthened, and the strong regulated. Lastly, the affective faculties do not form ideas, but simply feel; and therefore have no memory, conception, or imagination. They have *Sensation* only; in other words, they feel. Hence Sensation belongs to all the faculties which feel, and to the external senses and nervous system in general. Sensation, therefore, is a state or condition, not a faculty, as it is held to be by the metaphysicians.

The Knowing and Reflecting Faculties, or Intellect, form ideas, perceive relations, and are subject to, or rather constitute, the Will; and minister to the affective faculties. They may be excited by external objects, and by internal causes. When excited by the presentation of external objects, these objects are *perceived*, and this *act* is called Perception. It is the lowest degree of activity of the intellectual faculties; and those who are deficient in a faculty cannot perceive its object. We often see, for example, inability to perceive melody, colour, analogy, or necessary consequence, from defective Tune, Colouring, Comparison, and Causality. Every faculty, as a percipient, has its own perception.

Conception is also a mode of action of the faculties, not a faculty itself. It is the activity of the faculties from internal causes, either willed, or involuntary from natural activity. Imagination is Conception carried to a high pitch of vivacity. Thus, Perception is the lowest degree of activity of any of the intellectual faculties, Conception the second, and Imagination the highest. Imagination is often confounded with Ideality, but is quite distinct from it. Each faculty conceives in its own way. Form conceives forms, and may *imagine* them exquisitely beautiful; Tune conceives music; and so on. Curious effects result when these faculties are morbidly active. The whole mystery of spectral illusions is thus made plain.

Dreaming, to account for which so many volumes have been written in vain, is at once explained by the excitability of the organs from *internal* causes; and as some organs may be awake while others are asleep, the disjointed images of our dreaming moments are, to the phrenologist, a thing which was to have been expected. The kind of dreams most frequent with us could be predicted by the phrenologist from the size of the predominating organs.

Memory, too, is not a faculty, but a mode of action. It necessarily follows that there can be no such thing as the *general* memory of the metaphysicians, but every faculty must have its own memory. Memory belongs, however, only to the intellectual faculties. It differs from Conception and Imagination in this, that it recollects *real* objects or events which it has actually perceived, and adds the consciousness of time elapsed since they were perceived. The other named modes of action do not require realities or time.

Judgment, in its proper sense, is the perception of adaptation, fitness, and necessary consequence; and is a mode of action of the reflecting powers. In a certain sense, the knowing faculties may each be said to possess judgment; as Colouring judges of colours, Form of form, Tune of music. When, however, we use the word judgment, we mean right reasoning, sound deciding. To this a proper balance of the affective faculties is essential. There is no sound judgment, even with great reflecting powers, if any of the feelings are excessive. Hence the difficulty of convincing each other experienced by heated controversialists. What is called a person of good sense, is one who has not only clear and strong reflecting powers, but well-balanced feelings, thus allowing the reflecting powers to have undisturbed action.

Consciousness is the knowledge which the mind has of its own existence and operations, whether these last are affective or intellectual; but as it does not reveal the existence or nature of the powers themselves which think and feel, it was an error in the metaphysicians to attempt to discover these powers by reflecting on their own consciousness. As they could have, by this means, no access to know the consciousness of others, they fell into the error of supposing all men constituted alike.

Attention is not a faculty, but the stretch, application, or *tension*, of any or all of the intellectual faculties.

Association is that succession of ideas in the mind, each seeming to call up that which succeeds; so that, in our waking hours, the mind is never without an idea passing through it. This is a state or condition of the faculties, not a faculty. The metaphysicians have endeavoured to discover laws by which, in every mind, this succession is regulated. This attempt is utterly vain—as vain as to subject the succession of the fleeting clouds or fitful breezes to regular laws. The uniform associating powers, according to the old notions, are resemblance, contiguity in time and place, and contrast; yet any one who thinks on the subject, cannot fail to be sensible that there are many connecting links of thought which cannot be reduced to any of these three. The phrenological view is, that the predominant faculties in each mind create the associations. It is in the philosophy of Mr. Stewart that Association is made to play a part most disproportioned to its actual nature. He even holds that Association produces *new* principles of action, and names *Avarice* (which phrenology proves to be the abuse of a primitive faculty called Acquisitiveness) as one of them. Association is a very important principle in mental science. There is a mutual influence of the organs, which produces associations; a natural association between certain external objects and certain faculties; and artificial associations may be formed between objects and faculties. For example, long exercise of a particular organ or organs in performing certain acts, renders those acts easy, by the rapid association of the ideas necessary to their performance. Professional skill, in all its varieties, is thus accounted for. Mutual action of the faculties arises from the beautiful arrangement or grouping which we have already described. The organ of Language associates signs with ideas, with well-known rapidity. Artificial Memory, or *Mnemonics* as it is called, avails itself of our most easy and natural associations, which will always be regulated by our organization. One person will connect his ideas with *forms*, another with *colours*, and many do so with *places*. Prejudices are associations of false ideas with the feelings. In short, to arrive at any thing like laws of association, we must not look to the ideas themselves, but the faculties that form them.

Passion is any faculty in excess. Thus, there are as many passions as faculties. Love is the passion of Amativeness in union with Veneration; avarice of Acquisitiveness; rage of Destructiveness.

Pleasure and Pain also belong to each faculty, according as it is agreeably or disagreeably affected.

Patience and Impatience are respectively the results of certain combinations of faculties. Thus, Benevolence, Veneration, Hope, Conscientiousness, and Firmness, with moderate Self-Esteem, produce a quiet, meek, resigned, and patient spirit. Apathy is quite different, although often confounded with Patience; it arises from lymphatic temperament, or deficient brain. On the other hand, Self-Esteem, Combativeness, and Destructiveness when larger than Benevolence, Conscientiousness, and Veneration, will be impatient of contradiction. Large Time and Tune give impatience of bad music.

Joy and Grief arise from agreeable and disagreeable affections of the faculties by causes of considerable power. Wealth, power, and praise, give joy to Acquisitiveness, Self-Esteem, and Love of Approbation; while, on the other hand, the death of a beloved relative affects Adhesiveness with grief.

SYMPATHY, as its name (from the Greek) signifies, is feeling with another, or partaking of his emotions. The laws which regulate the activity of the faculties show the nature of this affection and the circumstances in which it occurs. Two individuals of similar constitution of mind naturally feel alike. This is the sympathy felt in the theatre, listening to eloquence, or witnessing distress and suffering. But there is another kind of sympathy, namely, that which is called up by the activity of a particular feeling in another's mind, manifested by the natural language of the active faculty; thus, the haughty air of Self-Esteem instantly calls up a defensive Self-Esteem in those who witness it, if the faculty be powerful in them. On the other hand, Benevolence, with its kind natural language, excites the same feeling in another. Wonder, too, spreads rapidly; and so on. We sympathize with the animal feeling of Combativeness and Destructiveness only when they are awakened and guided by Conscientiousness and Benevolence. But we sympathise with Benevolence directly, provided we do not detect a mixture of a selfish feeling in the actions it produces, such as vanity or love of gain. The doctrine of sympathy leads to valuable practical consequences in life. In education, for example, it explains the greater power of Benevolence than of Self-Esteem and Destructiveness in the treatment of the young—of kindness than of harsh and imperious commands and punishments.

HABIT may be defined as the power of doing any thing well by frequently doing it. But before it can be done at all, there must be the faculty to do it, however awkwardly. Habit, then, is the acquired strength of the faculty by its repeated exercise. The act of performing skilfully on a musical instrument is the best illustration. Mr. Stewart erred when he held that "a genius for poetry, painting, music, or mathematics, is gradually formed by particular *habits* of study or of business. These phrenology shows to be the results of original primitive powers which habit does not form, but only improves.

TASTE was held by Mr. Stewart to be a faculty, and acquired by habit. Phrenology holds that good taste is the result of a harmonious action of all the faculties. Bad taste is evinced when particular faculties, especially propensities, break out beyond due limits. Lord Byron's Destructiveness and other animal faculties often prompted him to sin against good taste. Too much Causality is bad taste in Poetry; while Homer and Moore have too much Comparison. Social converse is injured by bad taste in various ways—by displays of vanity, disputatiousness, &c. Bad morality is bad taste; but it is more, it is turpitude. A standard of taste, about which so much has been written, is not a decision of certain objects or qualities of objects as beautiful or perfect to *all* men. This were a vain attempt; but it may be approximated, by appealing to the taste of individuals of very favourable and harmonious organization, which has received the highest possible culture. It cannot fail to strike that good taste, sound judgment, and good morals, all require well-balanced faculties.

For other conditions of mind, which may appear to require explanation, we must refer to the works of the phrenologists.*

[BOOKS ON PHRENOLOGY.

The writings of Gall and Spurzheim will always be entitled to respect on account of the discoveries of those eminent phrenologists. Other writers have been successful in enlarging the science, giving it greater exactness, and making it popular. Among these Mr. George Combe has been one of the most industrious and best known. He has published "*Elements of Phrenology*," "*Lectures on Phrenology*," and a phrenological "*Tour in the United States*." These works are written with great ability, and are particularly valuable on account of the great mass of facts and illustrations bearing upon the subject which they present. His work on the Constitution of Man also contains many important facts connected with phrenology. A small book entitled "Uncle Sam's Recommendations of Phrenology," is a familiar exposition of the leading principles of the science, intended for young people and beginners.

"*Fowler's Phrenology*" is an excellent popular view of the subject. There are several phrenological journals published in Europe and the United States, to which the student who wishes to devote himself to a thorough investigation of the subject will have recourse.—*Am. Ed.*]

* Those who may have little opportunity of knowing the extent of phrenological literature, are referred to the following list of works, and their authors:—

ELEMENTARY WORKS ON PHRENOLOGY.

Gall on the Anatomy and Physiology of the Nervous System and Brain, in French, with an Atlas of 100 Engravings. This work has been translated at Boston, United States. Spurzheim's Phrenology, Philosophical Principles of Phrenology, Physiognomical System. Phrenology in Connection with Physiognomy, Outlines of Phrenology, and Anatomy of the Brain and Nervous System. George Combe's Outlines. Elements. System of Phrenology. Letter to Mr. Jeffrey, and Translation of Gall on the Cerebellum. Abernethy on "Gall and Spurzheim." Sir George Mackenzie's Illustrations of Phrenology; Vimont's Human and Comparative Phrenology (the Phrenology of the Inferior Animals); Scott's Phrenology, as affording a systematic view of human nature: Deville's Manual; Caldwell's Elements; Elliotson's Translation of Blumenbach's Physiology, with Notes; Macnish on Phrenology; Sidney Smith's Principles: Toulmin Smith's Synopsis; Hewet Watson's Statistics of Phrenology; Noble on Estimating Character; the Phrenological Journal. 14 volumes; Selections from the First Five Volumes of the same.

WORKS ON THE APPLICATIONS OF PHRENOLOGY.

Generally to Human Life.—Spurzheim's Sketch of the Natural Laws of Man; Combe's Constitution of Man, Moral Philosophy, and Notes on the United States.

To Education.—Spurzheim's Principles; Combe's Lectures; Poole on Education: Simpson's Philosophy of Education; Caldwell on Physical Education: Brigham's Mental Culture; Dr. A. Combe's Physiology Applied to Health and Education, Physiology of Digestion, and Treatment of Infancy; Sir George Mackenzie's Observations on Education; the same author on Taste: Bray's Education of the Feelings.

To Insanity.—Spurzheim on Insanity; Dr. A. Combe on Mental Derangement; W. A. F. Browne on Insanity and Asylums.

To Treatment of Criminals.—Simpson's Treatise on Criminal Treatment, and on Homicidal Monomania—both appended to the first edition of his work on National Education; his Treatise on Capital Punishment for Murder, in *London Monthly Chronicle* for June, 1841; Sampson's Criminal Jurisprudence in Relation to Mental Organization.

Also, the Phrenological Journal, on all these applications. Watson's Statistics of Phrenology, page 171, gives a list of sixty-four phrenological and eleven anti-phrenological published works.

PRINCIPLES OF CIVIL GOVERNMENT.

INTRODUCTORY.

It is impossible to imagine man, such as we know him, existing out of society. Man is a being who, from his birth to his death, is continually undergoing changes from weakness to strength, and from strength to weakness. Without the aid of others, the child could not live to become a man. Again, any one man's powers of observation would be quite inadequate to procure for him any thing like the amount of knowledge which a number of men, imparting their information to each other, and disputing about it, store up by means of this co-operation. Lastly, the wishes, fears, likings, and dislikings, in which a man habitually indulges, and the actions which they prompt him to undertake, and the opposition which he meets with from others, contribute to form what we call his peculiar character. These feelings could not be excited to the extent they are, without the sympathy and antipathy of beings like himself, nor could he anywhere meet with opposition to his wishes so strong as what he experiences from the rivalry of his fellow-men. In short, man is, during a great part of his life, dependent upon the assistance of others for the preservation of his existence; the passions which spur him on to act are excited, or at least strengthened, by the sympathy or opposition of men feeling like himself; his knowledge is increased, and his wits are sharpened by conversation with other men. It is barely possible to imagine a creature of flesh and blood, with a thinking principle like our own, living in utter solitude; and such a being, could it exist, would differ widely from man, made what he is by living among creatures like himself.

Again, government of some kind or another seems necessary to the very existence of society. Two men cannot be long together, but there will be a chance of their both desiring to take possession of the same object, or one of them wishing the other to give up some pursuit in which the latter is engaged, in order to assist him in his. The stronger, or the cleverer of the two, contrives to force or persuade his companion to comply with his wish; in other words, he governs him. Among all rude people, we find women and children old enough to be able to work, in short, the weaker members of society, governed by the strong—made to do what the strong want them. In societies a little more advanced, we find individuals not possessed of much bodily strength, making up for the want by cunning, by winning manners, or by reasoning, or by a mixture of all these. The kind of government which, as a society advances in civilization, immediately succeeds that which savage tribes call the "fighting-men," is that of the priests. Priestly government, in its rudest form, is found in the *fetishes* of the Negro nations, and the "great medicines" of the red Indians of America. It is a proof of a narrow mind, when a man can see nothing but what is bad, even in these (to us) ludicrous instances of priestly government. The priest-ruler is generally more of a thinking being than the mere "fighting-man." He must have experienced the influence of devotional feeling—rude as his own uncultivated mind, but substantially the same elevating emotion which adds such a dignity to the most enlightened minds—or he would not be capable of laying plans to work upon that feeling in the minds of others. He is not necessarily altogether or maliciously selfish; for history has many examples even of the juggler-priest playing off tricks upon his dupes in order to frighten them into good behaviour. Most governments that the world has seen, have been a compound of the government of the "fighting-men" and the priests—an alliance between these two classes, each acknowledging the power of the other, and giving up something to secure its assistance. The few whose strength and courage, or whose ambition and talents, enable them to become warrior chiefs or priests, were stimulated, some by desire of luxury, some by desire of wealth, some by desire of power, some by desire of doing good. Even the merely selfish among them were obliged to do good to some, in order to procure faithful servants. The government of the wise (the word *wise* is used here comparatively—they were wiser than those they governed) and the strong was yielded to by some, because they were all used by their rulers, by the rest, because experience taught them that the settled condition of a society in which there is a recognised government, is better than the irregular condition of a society in which the ruler of to-day may be the slave of to-morrow. When a government has existed for a considerable time, a number of the persons living under it must have been born under it: it was a government at the earliest time of which they have any recollection, and is a government still. As in every thing else, men jump at the conclusion in this matter, that because they can remember no other state of affairs, there can have been no other. They come to look upon the government under which they live as something that necessarily exists, that cannot be otherwise. It is in this way of thinking that we must seek the origin of those notions regarding the rights of royal and noble families, which, combined with men's sense of the power of the warrior castes, have, from the time that history begins down to a very recent period, made up most men's conceptions of a government.

Some of our readers may think that it was not necessary to take up so much time and room as we have bestowed upon the two preceding paragraphs, in order to prove that men have always lived in society, and that society has always had a government of some kind or another. It can, however, easily be shown, that the detail into which we have entered is not useless. Men need, more often than they confess or are aware of, to be told over again what is not new to them. It is not enough to hear a thing, unless some effort is made to understand it, and keep it in mind. Our object in laying so much stress upon so undeniable a fact, as that we know nothing of man but as he has been made by society, is to impress upon the reader's mind, so that the truth shall be constantly present to him, the fact that to live in society is as necessary and unalterable a condition of our existence as to breathe. A man, by bringing some of his neighbours to think with him, and by subjecting them to his power, may produce a small, very small change, in the condition of that part of society which is within his reach; but, in return, society makes him almost all that he is. Society is not a thing that man can make, but the result of natural tendencies. It has assumed, in every civilized country, the character it bears, from the natural operation of the mental and physical constitution of man—we find in all a variety of professions and pursuits, some of high and others of inferior intellectual endowment, and, from a concurrence of causes, one class leisurely and wealthy, and another more constantly employed and depending more for subsistence on personal exertion. That even in the best organized societies there are faults, no one denies; but in as far as any such are inconsistent with man's mental faculties, they are susceptible of remedy, and will accordingly be remedied as the society advances in mental culture. Viewing these faults in too gloomy a spirit, men have, on various occasions, endeavoured to reorganize society on new, and, as they believed, more rational principles; but all such attempts have signally failed. Efforts, for example, to establish universal equality of condition, with community of goods, as well as to banish religious belief, have in every instance come to naught, because they were absolutely incompatible with the fundamental principles of human nature, which are the same, only slightly varied by circumstances, in every age and country. All reformers who have set out with the opinion that society must and can be reconstructed upon other principles than those that have hitherto held it together, from the days of Plato down to those of Robert Owen, have been attempting an impossibility and throwing away their labour.

Further, the detailed exposition of the nature of government was entered into for the purpose of impressing upon the reader's mind, in a lively and lasting manner, the fact, that as society is necessary to the existence of man, such as we know him, government is inseparable from the existence of society. Wherever two or three are met together, there must be government; it may be good or bad, wise or foolish government, but government of some kind there will be. There will always be in every society some who have a desire to rule over others—to make others work out their purposes—and some who are satisfied to submit to the domination of those who are more ambitious. There will always be among those who are ambitious of government some who unite to the desire, the talents necessary to enable them to attain their ends, and others who do not; some who seek to found their power upon their own force, or upon the superstition of others, or upon their power of persuading or convincing men that they know better what is good for them than they do themselves. The propensities and faculties which induce and enable some men to aspire to be leaders, others to contest the leadership with them, and others, again, contentedly to follow the lead, are implanted in them by nature; they cannot help having or exercising them. But it is with these elements of our nature as it is with our instinctive propensities to eat and drink, to love or hate; by the proper use of their knowing and reflecting powers, men may so control and direct them as to render them instruments for producing great good and happiness to the whole human race. A long experience was necessary to teach men this truth; it is, therefore, not to be wondered at that nothing approaching to a clear conception of it dawned upon the minds of men till within the last two centuries, or that even yet it should be acknowledged by comparatively few, and rightly understood by a still smaller number. The idea, however, after visiting, with less and less of obscurity, the minds of great thinkers in different ages, has, in the progress of time, revealed itself with considerable clearness, and has been spoken aloud, and has fallen on the ears and touched the hearts of men. The history of the European race for the last hundred years, is little more than an account of men's efforts to apprehend aright, and apply in practice this important truth—of errors, and controversies, and unreasonable getting angry, and attempting to convince each other, not by arguments but by hard blows. Society has become convinced that government may be converted into an instrument of greater good than it has ever yet proved, and will not rest till it has solved the problem.

These remarks have appeared to us a necessary introduction to the PRINCIPLES OF CIVIL GOVERNMENT—necessary, in order to place in a clear light the nature of the thing proposed to be inquired into, and the object of the inquiry. The study of government embraces two distinct questions—What is government? In what manner can government be made productive of the greatest amount of good; or in what manner can any mischievous tendencies it may have be most effectively neutralized? Government is simply the exercise of power by one person or by many associated persons. The inquiry into the nature of government is therefore an inquiry into the source of its power. Its power must be derived from some peculiarities in the characters of those who obtain and exercise it, on the one hand, and from some peculiarities in the characters of those over whom it is exercised, on the other. The inquiry into the faculties and propensities which make some men governors and others subjects, exhausts the inquiry into the nature of government. This investigation, it is clear, must precede the inquiry, how government can be most effectively rendered productive of good, or prevented from doing harm. Having arrived at a distinct notion of what constitutes a government, of wherein consists its power, the second, the practical question thus subdivides itself—In what cases is the interference of a government likely to be productive of good to the great body of society? In what cases is its interference likely to be productive of evil? By what means can government be rendered capable of producing the greatest possible amount of good, in cases where its interference is of use? By what means can government be kept from meddling where its interference is likely to do harm?

The answers to these two classes of questions constitute the principles of civil government, or the theory of civil government. The reader cannot fail to have observed that they imply, on the part of the person able to solve them, some acquaintance with the constitution of man. There are few persons of this class likely to take an interest in these pages, who can be entirely ignorant of the nature of man: they may not have an accurate or systematic knowledge of it, but by reading and conversing, they must have picked up a sufficiency of floating notions regarding it to enable them, with ordinary attention, to follow us whenever we may have to touch upon that branch of knowledge. At the same time, it is right to tell them that their understanding of the principles of government will be rendered much easier and much more correct, by a careful perusal of some book or treatise giving a clear and concise account of the constitution of man. Mr. George Combe's work bearing that title, is what we would recommend as the best.

A theoretical knowledge of the principles of government is not, however, enough: or, we would rather say, that the mere study of a systematic explanation of those principles is not enough to enable a man to master them to any good or practical purpose. You cannot get a right knowledge of any thing by looking at it from one point of view only. If you want to have a correct knowledge of a country, it will not do to stick close to the high road, though that will carry you most easily through it. You must turn into by-lanes, to the right and to the left. You must ascend hills to obtain bird's-eye views, and you must scramble through valleys to get a notion of the shape, size, and position of hills. Again, if any man would have a correct judgment of what human life really is, and what its value, he must not hastily decide, when in youth or early manhood he sees the untravelled path stretched out before him: he must wait till he has at least attained the midway heights of life, and can look back on the ascent he has climbed, forward upon the descent before him. And so, whoever would thoroughly comprehend the principles of civil government—who would obtain such a practical mastery of them, that he shall be able to make them a rule of action—must seek to look at them from different points of view. He must accustom himself, on the one hand, from such a study of the nature of government, and the means of turning it to the best account, as we have just chalked an outline of, to provide himself with a standard whereby to judge the actions of government. And then, again, he must accustom himself to read the history of past ages and other countries, and to keep a dispassionate watch over what is going forward in his own, with a view to find in these observations practical lessons regarding the nature and operation of government, that may modify and render more accurate his abstract opinions, or serve as illustrations and explanations to enable him to understand them more thoroughly.

In accordance with these views, we propose to subdivide this tract into two sections. In the first, we will treat of the principles or theory of civil government, according to the plan that has been already laid down; in the second, we will analyze the constitution of our own country, in order to point out the actual working of these principles, and to furnish the reader with illustrations of the principles stated in the first section, and an experimental test of their truth. The first of these sections is entitled THEORY OF CIVIL GOVERNMENT; the second, GOVERNMENT AS IT ACTUALLY EXISTS.

Any thing that a mere man can teach another, must be necessarily incomplete—the partial knowledge of a limited, a finite mind. When a man has done his best to make a subject clear, he must, if his object be to disseminate truth, rest his hope of success, in no small degree, on his power of stimulating those he addresses to think and inquire for themselves. It is on this account that we earnestly wish that every one of these our tracts may inspire our readers with a resolution to inquire farther into the matters they treat of. We hope, for example, that we shall be able to give such a foretaste of the important and interesting study to which this number is devoted, as will induce them, when they have leisure, to consult different authors who have treated of it—to compare or contrast their opinions with ours, and with one another. In the hope that some at least may do this, we have added a third section, containing a very short list of the principal authors. It has been the practice of some writers to prefix a history of their science to their systematic explanations of it. To us, on the other hand, a distinct conception of the nature and sphere of the inquiry, such as can only be obtained from entering upon it, is requisite, to enable us to derive advantage from a record of the successive efforts which have brought it to the stage of advancement in which we find it. Every science, however, and most of all a practical science like the theory of government, has light reflected upon it by tracing it from the undeveloped form in which it first presented itself to men's minds, through the various efforts and casualties which have brought it to the condition in which we find it. But the only way to master the history of a science, is to read the works of the great men who have treated of it one after another, and to note how each, taking the subject up where his predecessor left it, has been enabled to advance it. And it is impossible to escape misunderstanding authors, unless, by studying the history of their science, we know the preconceptions which they entertained, and the practical objects they had immediately in view in writing, inasmuch as these necessarily warped their judgment, and led them to adopt their peculiar forms of expression.

SECTION I.—THEORY OF CIVIL GOVERNMENT.

1. What is Government?

Many writers upon government, some of them of no mean note, have thought it necessary to start with a definition of what they mean by the word *government*. This affectation of severe exact thinking is copied from the forms of demonstration adopted by mathematicians, but is out of place in reasonings about things which exist independent of the reasoner. The mathematician may define his circle, because part of his process is to construct his circle; but the reasoner on government does not make government; he finds it existing before him.

We use the word government in its common, it may be unscientific, but perfectly intelligible, application. When we talk of *a* government, we mean the same thing as when we talk of the British government or the Chinese government. We mean simply that man or body of men who govern, or, in other words, exercise power over a nation. So long as such a man or body of men possess power over a nation, are obeyed by it, so long are they a government; when they cease to be obeyed, they cease to be a government. They may be an unjust government, and continue to reign, or they may be unjustly deposed; that does not alter the state of the fact. The holders and exercisers of power are a government, by whatever means they exercise that power, or whether they exercise it for good or evil.

The government of a nation is the man or body of men possessing and exercising power over the rest of the community. By power, we mean what was possessed by the centurion, who said to our Saviour, "I say to one man, go, and he goeth; and to another, come, and he cometh; and to my servant, do this, and he doeth it." Power, as was intimated in the introductory part of this essay, may be acquired by different means. A strong man punishes a weak man for not obeying his commands; and the weak man, convinced that similar disobedience will always draw down upon him a similar punishment, obeys him ever after. A cunning man persuades a foolish man, that he possesses supernatural powers—that his prayers and invocations can call down blessings or curses upon others; and the dupe obeys him, in order to obtain the one and escape the other. A wise man convinces a man of good understanding that he understands what is for their common advantage, and thus persuades him to follow his advice, which is a more polite way of expressing—to obey him. When a certain number of individuals have, by the use of one or more of these means, secured the obedience of a certain number of followers or dependents, another, in the same manner, secures their obedience (and with that of all their retainers) to himself. In this manner small states were first formed, which, in process of time, by the operation of wars, alliances, and other means, were melted together into great ones. But the greatest and most civilized states, when closely examined, will be found to be still held together by the same means which were originally instrumental in forming small ones. A man who has much wealth, has influence with a certain number of his fellow-citizens. A man who does much good, has influence with another portion of them. A man who is believed in any way to have it in his power to do good or harm to others, possesses similar influence. Two or more of the persons possessing such influence, form a party, and choose or are gained by a leader; and the man or association of men who, by this complicated process, command the services of a decided majority of the citizens, are the government.

This is the case in every nation that has a government, whatever the external name and form of that government may be. In an enlightened country like our own, in which men have acquired a habit of obeying the laws, the process is carried on in conformity with the forms of law. In countries less advanced in civilization (as was the case among our own ancestors), the acquisition of power, and its transference from one party to another, is effected by means of violence. But in both instances the fact remains unaltered, that the man, or combination of men, who possess the largest amount of stored-up capital, the greatest quantity of practical talent for managing men, and by those means the services of the greatest number of the strong and resolute men of a country, always exercise, directly or indirectly, in their own names or in the name of some other persons, the sovereign power in that country.

It is clear from this analysis that the source of all political power is intellectual ability; that the means by which all numerous bodies of men are kept in obedience, is their being led to believe in the ability of their rulers —led to believe that it is more for their advantage to obey them than to resist them. In other words, the only means by which a government can establish its power upon a stable and permanent foundation, is, by making the great body of the people feel or believe that it contributes to their happiness. We certainly read of nations which have submitted to the exactions, oppressions, and contumelies of despots and powerful aristocracies, but on closer examination we will see that even their benefits, real or imaginary, were the influences which kept the people in subjection. The uncivilized man is incapable of looking beyond the necessities of the day—of making arrangements with a view to provide for the security and comfort of years—of sacrificing the gratification of the moment to ensure a greater and more lasting pleasure at a future time. A class of men a little more enlightened than the rude crew we have been describing, can easily, by conferring upon them cheap immediate pleasures, incline them to submit to lasting sacrifices; and when a portion of them experience a passing discontent, put them down with the aid of those of their own number who happen to be satisfied at the moment. A few capable of making combinations can thus hold in check a multitude less enlightened. But still their chief engine of authority is their ability to persuade at least a portion of their subjects that they are kind to them. They may cheat them in the bargain; but still the bargain is, "Do us good, and rule over us." But comparatively highly civilized nations, it will be said, have been seen tamely submitting to tyranny, as was the case in France before the revolution. In such cases, it will be found, either that the rulers have flattered the vanity of the people, paid them in false coin which they took for sterling, or that the people have thrown themselves into the arms of a despotism as a refuge from evils of which, having experimental knowledge, they were more afraid—invasions, it may be, by foreigners, or internal anarchy. Still, the prospect of advantage to themselves was the source of the subjects' allegiance; they acted upon the principle—of two evils, choose the least.

Having thus attempted to show what government is, in answer to the first question proposed in the introduction, we now proceed to try to solve the questions involved in the second branch of our inquiry:—By what means the beneficial tendencies of government may be increased to the greatest extent, and any mischievous tendencies it may have most effectively neutralized? These questions constitute the next two heads of this division of our subject.

2. In what Cases is the Interference of a Government, with a view to control its Subjects' Liberty of Action, calculated to be productive of Good to the great Body of Society, or the Contrary?

In attributing "liberty of action" to individual members of society, we do not pretend to decide upon the knotty question of the liberty or necessity of human actions. We use the word *liberty* merely to express a man's freedom from physical control exercised by others —his power of action in conformity to the dictates of his own will, whether that will be a free or a necessary agent. We find, on looking to the practice of different governments, that some have been accustomed to command or prohibit actions, which others have left their subjects free to perform or leave undone as their own choice determined. The laws of China are said to prescribe the very forms of domestic mourning for the loss of relations—matters which with us are left to the discretion of individuals or to the vague unauthoritative laws of fashion. On the other hand, the imperfect regulations of the old feudal governments of Europe allowed a latitude of action to the powerful barons, which seems to us incompatible with the existence of an efficient government or the security of private citizens. Again, some governments leave the speculations of commerce to be regulated by the judgment of the merchant; others take upon them to teach him which channels of trade are most advantageous, and to order him to abstain from some and embark in others. All nations, however, have practically declared that there ought to be limits placed to a government's right or power of controlling its subjects' actions. We are now about to inquire whether this opinion be well founded, and what actions ought to be left free, what subjected to regulation.

Among the actions over which almost all governments have attempted to exercise a control, are those actions or operations of the mind by means of which men's opinions are formed. Penalties have been attached to the avowal of certain opinions; nay, tribunals have been established (as, for example, the Spanish Inquisition) with a view, by cunningly devised questions, and even by the application of torture, to extort from men confessions that they entertained opinions which they had jealously concealed from all the world. It is not probable that any person who peruses these pages will require any argument to show the impossibility of preventing men from forming opinions. Opinions are not matter of choice; a man cannot think or believe what he pleases; punishment cannot deter him from forming opinions, which come upon him whether he will or not. Again, opinions kept to a man's self do harm to no one. If they are of a nature to incline him to commit dishonest actions, these actions are punishable, and that punishment is a sufficient safeguard against his depraved inclinations. Penalties attached to the secret entertaining of obnoxious opinions are, therefore, at once unnecessary and incapable of producing any effect. To punish men for holding opinions, the utterance of which can only be wrung from them by deceit and cruelty, is to inflict suffering on human beings for no purpose—it is a wanton waste of cruelty. The case of individuals who not only entertain but openly avow their opinions, and seek to gain converts to them, is somewhat different. It is possible to deter men from uttering certain opinions; and it is possible that men may seek to disseminate opinions, which, if acted upon, must do harm. Even in this case, however, serious difficulties present themselves. Who are to decide what opinions are dangerous? Is punishment an efficient method of checking opinions admitted to have a bad tendency? History furnishes us with numerous examples to show that it is unsafe to leave to government the determination as to what opinions are dangerous. Bad and unjust governments necessarily think or pretend all opinions mischievous which have a tendency to make their actions appear in their true colours. Again, most men are afraid of novelty of any kind in matters of thought, and ready to condemn an opinion as dangerous, merely because it is contrary to some that they entertain. Socrates, and a greater still, are not the only persons who have suffered for teaching truths with benevolent intentions, in consequence of rulers taking upon themselves to punish men for uttering opinions which they thought, or pretended to think, dangerous. To place in any human hands a power of punishing the promulgators of opinion, is a step quite as likely to repress true and useful opinions as those which are false and dangerous. Again, no opinion was ever put down otherwise than by fair argument. Punishments may have impeded the progress of an opinion, but they have more frequently, by raising up martyrs, given it a more rapid currency. The reign of error is necessarily of short duration, and it has never been abridged by penalties; the reign of truth, once established, is eternal; it has been postponed, but never hastened, by the operation of penal laws. Laws commanding the punishment of avowed opinions, are quite as unavailing as those which command the punishment of concealed ones. The only possible effect of either is to make martyrs or hypocrites. Here, then, we have a broad and marked limitation of the power of government. Whenever government interferes to repress free thought, or the free utterance of opinions, it does harm. What the lawyers call "overt acts"—actions in the common acceptation of the term, physical actions, or words which may injure the reputation and feelings of others—are the only legitimate objects of government control.

Turning our attention next to actions, properly so called, we find that, with regard to some even of them, there has always existed in men's minds a jealousy of the interference of government. Is that jealousy well or ill founded? and in what cases? The power of government, we have seen, is derived from the conviction entertained by the subjects, that they derive benefit from being subjected to its control. There are some actions, regarding which it is at once apparent to dispassionate minds that all have an interest in government interfering to prevent them. Thus, when two men quarrel, and proceed to blows, it is clear that if one of them be dangerously or fatally wounded, it would have been for his advantage had government interfered to prevent their fighting. But as a general rule, every person has an interest in government preventing fighting among its subjects; for it is more for a man's advantage to be secured from the danger of being hurt and killed, than it is to retain the power of hurting and killing others. It is clearly for the good of all, that government should interfere to prevent any one of its subjects from hurting, or killing, or committing any injury upon the person of any other. In the same way, it might be shown that every body will derive benefit from government interfering to prevent any one of its subjects depriving any other of his property by force or fraud. In a virtuous and highly civilized community, the chastity of its women, and the purity of both sexes, are so clearly recognised to be advantages of which the owners ought not to be forcefully or fraudulently dispossessed, that the enforcement of laws forbidding such offences is acknowledged by all to be generally beneficial. A man's (or woman's) reputation for integrity, is not only an object of commendable pride, and therefore a possession the loss of which must occasion pain, but a valuable property for all who are engaged in business. There is, therefore, a universal assent given to the laws which inflict punishment upon those who defame their neighbours. This brief retrospect is sufficient to show that the whole community will be benefited by government interfering to prevent any one citizen injuring another—in person, property, or reputation; and to oblige him who has inflicted an injury upon his neighbour, in these respects, to make amends as far as he can. It is evidently for the advantage of the criminal, that his punishment, and the reparation he is to make, shall be decided by an impartial third party, not by the person injured; and but little reflection is required to show that even the party injured will derive benefit from such an arrangement, inasmuch as, where no man is allowed to take the law into his own hands, there can be no colourable excuse invented for the aggression made upon him, while he is, at the same time, secure from the after dangers incurred by all in his position in those countries where retaliation is tolerated by the government.

An opinion has been very commonly entertained, that government can benefit society, not only by prohibiting men from doing injury to one another, but by obliging them to do good to one another. The fallaciousness of this opinion can be easily demonstrated. The aggregate happiness of the community cannot be increased by any man doing good to another at the expense of injuring himself. It cannot even be increased by any action, the tendency of which is to increase the happiness of the person receiving the benefit, in a less degree than it diminishes the happiness of the person conferring it. These are intricate and delicate questions, regarding which even the parties mentioned can scarcely ascertain the truth, much less any third party, and least of all a government encumbered with a multiplicity of distracting calls upon its attention. The safest way for the government is to leave the performance of benevolent actions to the consciences of its subjects: by trying to enforce the performance of them, it is quite as likely to create unhappiness as the reverse.

There remains a numerous class of actions which contemplate neither good nor harm to a man's neighbours. To this belong all pursuits of enjoyment by means which injure no man—all attempts to increase a man's fortune by perfectly just and honest means, though without any reference to the advantage of others. It might appear an unnecessary affectation of omitting nothing, to state that government ought in no way to interfere with actions of this class, to hinder, promote, or direct them; and yet the sheer love of meddling, so strong in some men, has constantly led governments to transgress this law of common sense. If the hunter after pleasure, by means which harm no one, seek it where it is not to be found, it is only his own loss: no one can say positively that another cannot find pleasure in certain pursuits, for no one can know how another's mind is constituted; and therefore to prescribe to him that he shall abstain from such and such pursuits, is to run the risk of diminishing his happiness. It is also, on the part of the government, wasting time that might be better employed. In the pursuit of wealth by honest industry and enterprise, a man's whole attention is generally severely tasked; the government, encumbered with other affairs, is not likely to discover what he, whose eyes are sharpened by self-interest, has overlooked. The meddling of governments with the mercantile speculations of their subjects, has its origin in the absurd notion that what is one man's gain must be another's loss—in forgetfulness of the truth, that the wealth of the whole community is merely the sum of the fortunes of all the individuals composing it, and that to impede the gains of any one is to diminish the total increase.

It appears sufficiently, from these considerations, that the interference of government with the conduct of its subjects one to another, ought to be cautiously guarded, in order to secure their prosperity and happiness. It ought to be restricted almost exclusively to what is, in the technical language of the laws of England, called "preserving the peace." This opinion does not necessarily imply what imaginative enthusiasts would call low and narrow views of the capacity and destiny of man. To say that security in person, property, and reputation, is the highest benefit that can be bestowed upon man through the instrumentality of a government, is not to say that these are the utmost benefits man is capable of receiving. Government cannot make a man wise: that must be accomplished by the exertion of his own intellectual faculties. Government cannot make a man good; that must be the consequence of the habitual regulation and control of his feelings and actions, by the efforts of his own will, directed by his own reason. Government cannot make a man rich (except by making others poorer); that must be the result of his own sagacious and persevering industry. But though government cannot make any man wealthy, wise, and good, it may render it more easy for the great body of its citizens to become all three, by establishing security of person, property, and reputation, for all who act honestly and peaceably, and thus removing temptations to do wrong, diminishing the dangers against which men must guard, and leaving them a greater amount of leisure to devote to industrious pursuits, or to the cultivation of wisdom and virtue.

What has already been said, has included both what government must do and abstain from, in so far as its own subjects are concerned, in order to promote their happiness. It has also in its power to contribute to their prosperity, by guarding them against injuries at the hands of those who are not its subjects. It can watch the approach of danger from without, and take precautions to avert it. It can organize, arm, and discipline its subjects, to defend their homes, or to extend their protection to their fellow-citizens engaged in the pursuit of their honest industry on the ocean or in foreign countries. With a view to the defence of the country from foreign aggression, the government may, to a limited extent, and generally for a limited period of time, interfere with the actions of its citizens, in a greater degree than could with propriety be conceded, when the internal relations of rulers and subjects alone were taken into consideration. The nature and limits of this more extended interference will appear from the discussion of the topics which occur under the next division of our subject.

3. By what Means can Government be Rendered Capable of Accomplishing the Greatest Possible Amount of Good, and most Effectually Prevented from doing Harm?

A government is an association of men with all the feelings of other men. They are possessed of power, and liable, in consequence of the propensities of human nature, to abuse it in two ways:—By indolence, or neglecting to use their power—that is, by not performing the duties of their station; by excessive or wrong exercise of their power—that is, by meddling where they can only do mischief, or by acting, with a short-sighted selfishness, in a manner injurious to the great body of the nation. The only way of guarding against these abuses, is by instructing the people, in the first place, accurately as to what are the duties of government; and by furnishing them, in the second place, with some plan, which may be easily understood, and worked by men of average capacity, for checking government when it exceeds its powers, or urging it on when it is lazy, by orderly and legitimate means.

The general abstract view of the principles of government, laid down in the preceding head, will not be found sufficient for the purpose of informing the people what are the duties of government, so as to enable them to say, at any given time, government is doing what is right, or government is exceeding its powers, or government is neglecting its duty. No one man can, in his own person, execute all the functions of government. Its members must take different departments, and be assisted in them by a number of clerks and other subordinate officers. But as the great end of government is one—to protect its subjects in the full enjoyment of security in person, property, and reputation—and as all these departments are only of use in so far as they contribute to that end, there must be one master-mind controlling and directing them all, taking care that they do not clash with or counteract each other. It is only when people know what are the different departments of government, and what is the proper task of each, that they can mark the exact points in which government is negligent or oppressive, lay the blame upon the real defaulters, and thus make such applications for redress, so clearly stated, that it is impossible to evade them.

In watching over the security of its subjects, government has to guard it against attacks from two quarters—from violence offered by one citizen to another; from violence offered to one or more citizens by persons who are not its subjects—by foreigners. The discharge of the former duty belongs to what is called the *home department* or *domestic affairs*; the latter to the *foreign department*. The great engine by which a government preserves security of person, property, and reputation, to its subjects, in so far as these are threatened by disputes among themselves, is the law. To the production of a good and efficient body of law there are requisite—first, the legislator, or law-maker; second, the judge, or the person who declares in what manner the general precepts of the law apply to particular cases; third, the executive power, which enforces the decision of the judge when the party against whom it is given proves contumacious. The means by which government defends its subjects against aggression from foreigners, or procures them redress for injuries done by foreigners, are twofold. They are either peaceable, that is, by the way of representation, persuasion, and argument; or they are forcible, that is, by the way of war. The management of the former mode of averting or redressing injury, belongs to the diplomatic; the latter, to the war department. The business of government, like all other kinds of business, requires money to defray its expenses, and this renders necessary another department—that of finance. It appears from this review that the great natural departments among which the business of government falls to be distributed, are as follows:—

The Home Department, which resolves itself into the *Legislative*, *Judicial*, and *Executive* Departments.

The Foreign Department, which resolves itself into the *Diplomatic* and *War* Departments.

The Financial Department.

These embrace all the necessary, essential functions of a government. Even in rude tribes, among whom one ruler takes upon him the whole task of government, and finds it too little to occupy the whole of his time, he must, in a scrambling way, discharge all the offices of these departments, though he never thinks of distinguishing and classifying them. He must lead or send out the warriors of his tribe to drive away intruders upon their hunting-grounds; he must treat with the sachems of neighbouring tribes, when the hatchet is to be buried or dug up; he must devise laws, decide between litigants, and enforce his own decision; he must levy his "ways and means"—the duty least seldom neglected. Even among highly civilized states, limited in point of territory and population—although, for the sake of order and the facility it gives in the transaction of business, the offices of these departments and their records will be kept separate—it will sometimes be found, for the sake of economy, or because there is not enough of business in any one of them to occupy a man's whole time, that the duties of more than one are discharged by the same person. On the other hand, in large and powerful states like our own, it is found necessary still further to subdivide them. Thus, instead of a simple war department, we have an admiralty, a secretary-at-war with the Horse Guards, and an ordnance department. The number of offices, of departments (of *bureaux*, to adopt the French phraseology), is comparatively unimportant; the great matter is to have the business of government so distributed that every man, knowing exactly what he has to do, may set about it with the least possible degree of confusion and embarrassment, and that all men knowing what he has to do, the force of public opinion may more easily be brought to bear upon him if he exceed his powers or neglect his duty. Some of these departments, however, from the peculiar nature of their duties, ought never to be intrusted to the same individual. For example, the office of making the laws ought never to be intrusted to the person who has the charge of explaining and applying them; and neither task ought to be intrusted to him who is called upon to enforce them. When the judge is not the law-maker, he will interpret the law according to its apparent tenor; but if the law-maker be judge, he may say, I meant so and so, and explain it in a way nobody ever suspected. If the judge is law-maker, he may take upon him to supply deficiencies in the law on the spur of the moment, and thus expose citizens to the injustice of being tried by a law not in existence at the time they are said to have offended. The qualities required in a good executive or police minister are quite different from those required in the judge or lawgiver, and rarely combined with them in the same person. Above all, however, the functions of finance minister ought never, in whole or in part, to be intrusted to the minister of any other department. The practice which prevails in many governments, of allowing office-bearers to pay themselves, and intrusting the collection of different branches of the revenue to various departments of government, is sure to lead to extortion and peculation, to profligate waste of money, and oppression of the subject.

These are the essential departments of a government—their duties are those which, however rudely or confusedly, must be discharged whenever there is any government at all. There are other departments, not certainly of less importance, but without which many governments have been carried on; and the duties of which have been discharged by private exertions, but which may with advantage be discharged by the general government. The departments to which we allude are those which have the charge of national education and the provision for the poor.

The circumstance of the state or government taking upon it to direct the education of the whole people, has been brought about, in point of fact, by a variety of contradictory causes. Among heathen people it was owing to the strong influence acquired, at a very early stage of civilization, by the priesthood; the continuance of the power of a priestly *caste* depended upon the people continuing to believe in their pretensions to supernatural power and more than ordinary virtue. The most natural way to keep up this belief was by graving it deeply on the minds of the young. In the small states of Greece, as they advanced in civilization, the secular statesmen emancipated themselves from the alliance of the priests; and, in consequence, we find the influence of the latter as teachers superseded to a great extent, especially at Athens, and in the small Greek kingdoms erected out of the fragments of Alexander's empire, by philosophers in the pay of the government. In the great Roman empire, which incorporated into itself all those Greek and many other minor heathen states, both the philosophers and the priests ceased to be the authorized immediate agents of a government education, though in the provinces they continued to teach. The founders of the Christian religion disclaimed such connection with the state as had been maintained by the priests who preceded them; accidental circumstances, however, connected with the decline of the Roman empire, united again, in the persons of the dignitaries of the Christian church, the offices of teachers and rulers. In the countries throughout which the Mohammedan religion gained the ascendency, that modification of the Christianity of the time has become, as among heathen nations, an engine of government. Among the nations of Europe, and those which have been planted in different parts of the world within the few last centuries by Europeans, the progress of science has produced an effect analogous to that mentioned as having been produced by it among the small Greek states of antiquity. It has shaken, not the belief in the Christian religion, but the opinion of the benefit derived from making it, like the old heathen religions, an engine of government. At the same time, the opinion of the importance of civilizing the whole body of the people by the influence of education, has led men to inquire whether government could not with advantage undertake the task of educating them. The bigoted advocates of a dominant church fear secular education, as calculated to encourage a spirit of free inquiry inconsistent with implicit belief in a state creed. Many advocates of secular education, irritated by this opposition, see in the established clergy nothing but a body of men who would put down all instruction except what is calculated to impress ineffaceably the belief of their peculiar dogmas on the infant mind. The discussion regarding the utility of a national system of education, and the best kind of national education, has hitherto been conducted with too exclusive a reference to the partisan views of these opposing parties.

This historical retrospect has been introduced for the purpose of placing the present state of the controversy in a clear light. It must be argued differently if we are to arrive at a true and practical conclusion. The success of state religions, in diffusing such a general knowledge of their dogmas among the community as is requisite to enable men to conform to them in outward appearance, is a proof that an organized government possesses great powers for the diffusion of information. By intrusting the superintendence of national instruction to a separate board, there will be no interference with, or obstruction of, the discharge of the other duties of government. Arrangements for providing a supply of competent teachers, books, instruments, &c., will be, as on a grander scale, more efficient, as they will at the same time be more economical than the desultory efforts of private individuals. So far the advantages of a national system of education are apparent. The difficulty is here: harm is done whenever government interferes with the free formation and expression of opinion, and it is difficult to teach without giving a bias to opinions. Out of this difficulty we are rescued by a suggestion, derived from viewing the question in another point of view. It is part of the essential duties of a government to take care that its laws are made known to all who are called upon to obey them, and that competent officers are intrusted with the management of the details of government. The invention of printing enables government to multiply to any extent the copies of its laws; but this is not enough, unless that the persons among whom these copies are distributed are able to read and understand them. The simplest mode by which a government can ensure the complete publication of its laws, is by teaching all the people the elementary branches of knowledge—reading, writing, and the grammar of their native language. Again, with a view to secure efficient officers of government, they must be educated for their employments: no one ought to be employed in any office under government who cannot show that he possesses the requisite knowledge. High schools or universities, supported out of the national funds, will be found the cheapest method of putting the means of acquiring this knowledge within the reach of the able and aspiring of all classes. There the lawyer, the soldier, the diplomatist, the lawgiver, the financier, the elementary schoolmaster, may procure the deeper scientific learning necessary to the right discharge of their respective duties, in the highest perfection and at the least expense. At these institutions, the young clergy of all churches might acquire their literary and scientific instruction: their peculiar theology might be taught them at institutions supported by their respective sects. A competent number of such elementary schools and universities, teaching only those branches of knowledge in which there is no sectarianism, would be for the advantage of all sects, and would interfere with the peculiar views of none. They are of the class of institutions which government has a right to establish, and neglects its duty if it does not.

The propriety of government taking upon it to raise and distribute funds for the support of the poor, admits of being more briefly illustrated. In all countries there has ever been, and as long as human nature continues what it is, there ever will be, a certain number of destitute poor—of paupers; and this number will be greater in proportion as population becomes more dense. The indolent, the weak-minded, the slaves of sensual passion, will remain in native poverty, or drift down into pauperism from a more affluent condition. It is in vain to say that it is their own fault. The revolutions of a commercial system like ours, so mighty and complicated that it sways those involved in it blindfold hither and thither amid its waves, often throw thousands at once out of employment and bread, without any fault of theirs. Even the dissolute and imbecile have their degrees of criminality—the guilt of omission, varying from highly culpable to venial. Human nature revolts from the thought of denying them relief; but if it be left to casual charity to relieve them, the donations will be insufficient to supply the wants of all; and the burden of supporting these encumbrances upon the public which supports itself, will be unequally distributed. The humane will be oppressed, while the callous pass free. But the main argument for imposing upon government the charge of supplying the wants of the paupers, is the fact, that, apart from all considerations of humanity, the relief of their necessities is a precaution tending to give additional security to persons and property. It is want that is the chief prompter to turbulence, violence, and dishonesty. It is among the classes who are dependent upon a precarious supply of food to relieve their daily necessities, that the half-savages are found, who prowl, in quiet times, under the shade of night, in search of plunder, and, in times of public excitement, rush from their hiding-places as infuriated mobs. It is among their squalid haunts that are engendered the pestilence and diseases which from time to time strike whole nations. It is the duty of government, in its office of preserver of the lives and properties of its subjects, to take measures for rendering this class less dangerous, by diminishing their temptations to dishonesty, and relieving them from that state of squalid destitution which endangers the health of the whole community.

When in any country the different labours of government have been parcelled out in the manner here suggested, and allotted to different functionaries, each having attached to him a sufficient staff of assistants, each being subjected to one recognised head of the government, whose business it is to watch over all their proceedings, to urge on the indolent, to check the erring, to appoint to vacancies, and remove offenders, a great step has been taken towards securing a just and efficient government. The peculiar and limited duties of government have been indicated to all, and the persons pointed out upon whom devolve the responsibility of discharging them. There remains, however, this danger to guard against. All men love ease, and all men love to have their own way. Again, men united for any purpose—the pursuit of either a business or a pleasure common to them all—immediately contract what the French call *esprit de corps*—a clannish or corporation spirit. They act and feel as having a common interest opposed to the interests of all who do not belong to their body. This *clique* or *coterie* spirit, animated by the love of ease, and the self-will more or less natural to all men, has a tendency to convert every organized government into a knot of oppressors. This reflection carries us, by a natural transition, to the remaining inquiry under the present head—By what means a government is to be kept in the line of its proper duties.

It cannot have escaped the notice of the reader, that every government acts upon its subjects by means of themselves; it employs its subjects to keep its subjects in obedience. The consequence of this is, that in every country, and in all ages, the most seeming despotic government is kept in check by the opinions of its subjects. No government has ever with impunity set at defiance the opinions, be they well grounded or be they prejudices, moral and religious, of its subjects. The Ottoman sultan, at the time when his power was greatest, never dared to act contrary to the law of the Koran. Henry II. of England was obliged to humble himself before the religious sentiments of his age, outraged in the person of Thomas-à-Becket. Thomas Moore, in his *Fables for the Holy Alliance*, has ludicrously but aptly illustrated this truth, by figuring the soldiers kept on foot by the monarchs of the Holy Alliance, as extinguishers made of combustible materials, and the military insurrection which brought about the Spanish revolution of 1821, as these extinguishers set on fire by the light they were meant to put out. This is no statement of what *ought* or *ought not* to be; it is a statement of what *is*—a fact that exists whether men affirm or deny it. Civil government—political action—is human ingenuity working by human means. It is this necessity under which every government lies, of governing its subjects by its subjects, which puts the whole community in possession of an engine, by the proper application of which, government may be obliged to work for the general good.

We have already pointed out what is necessary to enable the government to make justice and the good of the community its aim: it is to organize the government so as to render its action easy and powerful, and to enlighten it as to its duties. The same process is to be followed with the community, in order to enable it to act as a check upon the government when it is inclined to go wrong, and to organize the community in such a manner that its opinions and wishes may be brought to operate easily, powerfully, and, by consequence, tranquilly upon the government. There is another object to be gained by thus enlightening and organizing the people, besides that of making them an efficient check upon government when it goes wrong; it is only by enlightening and organizing the people that they can be rendered capable of lending due force to the operations of government, when these are what they ought to be. An unenlightened people is quite as likely to entertain mistaken notions of what is for its good as correct ones; it is quite as likely to oppose government when it tries to do what is right, and to support it when it tries to do what is wrong, as the reverse. Government was in the right when, about the year 1780, it repealed some of the worst enactments against the Catholics; but the people were so far from heartily approving of this act of justice, that Lord George Gordon's riots in London, and the rabbling of Catholic chapels in Edinburgh, had nearly frightened government out of its good intentions.

The first step, then, in making such arrangements as are necessary for keeping government in its just and useful line of action, is to enlighten the people. There goes more towards enlightening the people than merely schoolmastering them. It is not enough that the teacher tell what he knows, repeat line upon line and precept upon precept, or even make his pupil repeat what he has told him, to show that he remembers it. The pupil must himself be active, and make exertions to catch the true meaning of what he is taught; and in this he will not always, in spite of his best efforts, succeed at first. Every person who has exerted himself to master any branch of knowledge, must remember instances of this kind, where he has pored for hours, day after day, upon some dark passage in a book—some step in the reasoning which he must understand, or all that followed would be dark—and yet could not get at its meaning, till some time, when he was thinking of n thing less, taking a walk, and looking at trees or the running stream, or engaged in striking a bargain, some chance word or stray thought has recalled the puzzling passage to his mind, and all at once a light has broke in upon him. His previous reflections had not been so useless as they seemed; they had been gradually opening his mind, and had so far succeeded, that nothing but an accidental impulse from without was wanting to make him see his way. It is knowledge gained after this fashion that really instructs and forms the mind: information thus earned, we may say, in the sweat of a man's brow, is too deeply graven on his memory ever to be forgotten, and the rude exercise his struggles to understand have given his mind, strengthens and invigorates it for future exertions. All that teachers can do in the way of instruction, is to show their pupil what is to be learned, to tell him how to set about learning, and to watch over him, and, by motives either of pain or pleasure, to stimulate him to perseverance in the work. All the rest must be his own doing. Hence it is that some pass through the hands of a teacher and learn less than those who, from poverty and strong desire of learning, have been driven to teach themselves, with no other assistance than occasional hints. Hence it is, as most men who have received a regular education and made good use of it must be aware, that the most important part of their education is that which they have given themselves after leaving school, availing themselves of what they remembered of their teacher's precepts to enable them to acquire a complete understanding of what they had only repeated like parrots, and immediately in a great measure forgotten.

Our object in this seeming digression is to make as clear as we can that mere communication of instruction, which is all one human being can do for another, is not enough to enlighten and discipline a man's mind; that many receive it without being much the better, and that many make considerable progress in acquiring knowledge without having the benefit of it. There is an enlightenment—a practical training, and a storing of the minds of men with knowledge—that must in all cases complete what the teacher has begun, and that often carries men a good way without the aid of a teacher. It is the education which man's natural curiosity, cooperating with the observations forced upon him, and the exertions necessary to keep him alive, as it were, force upon him. The great source of men's amusement, that which is more or less within the reach of all, is conversation, which, even in its rudest and most stupid, or weakest and silliest form, is a giving and receiving of information more or less valuable. The rudest process by which the mere savage procures his daily food, involves an exertion of design or forethought. He resolves, it may be, to go to the sea-shore, and pick up shell-fish; he plans out beforehand what he is going to do, and he executes his intention. The changing of the seasons forcing him to procure food by different means at different times, or by making him experience want, suggesting the advantage of laying in a store beforehand, gives fresh exercise to what Dr. Reid has called "the active powers" of his mind. Acting in concert with others, debating what is the best plan of attaining their common object, getting angry and being soothed, or soothing another who gets unreasonable, defending his own share from a plunderer, or trying to outwit his associate—every action of a man's life, even in the rudest stages of society, is a part of education. As the society advances in wealth, it advances in the acquired knowledge and skill of its members. This is a process quite independent of design on the part of men, which is carried a great length before teaching, as we understand it, is ever thought of. Men become reasoners about what is right or wrong, practical politicians, skilful mechanics, projecting merchants, lawgivers, and lawyers, after a fashion, long before they give these pursuits their different names, or dream of theories, and science, and teachers. This is what we call *civilization*, which means the intelligence, and skill, and polish of manners which men acquire by living and acting in a numerous and wealthy society. Men never think of teaching or being taught until the society in which they live has made considerable advances in civilization. This is the kind of enlightenment which must prepare any people for acquiring a good government.

We cannot carry back our inquiries to the first origin of society, and show that it has advanced from rudeness to civilization in the way here described. But we know from history that a part at least of the process has been gone through by all civilized nations; and we know from the observation of travellers, that even in our own day there are tribes in different parts of the earth which are still in the mere rudiments of civilization. But there is a still more curious fact, which, for the purposes of the inquiry now in hand, it is most necessary to know, and in all our reasonings to make allowance for. In the same society or nation, especially if it be large, there may be, there almost always is, a great variety in the degrees of civilization which different classes of its citizens have attained; some may have reached a very high grade, whilst others remain as low as human beings have ever been found. This has been the case in every country where there has been a priestly *caste*—in old Babylon, Egypt, and Hindostan. This was still more strikingly the case in Rome, and is so at present in the slave-holding states of the European race. One frequent cause of this inequality of civilization in members of the same society, has been the establishment of great empires by conquest, by which means many different races have been brought under the same government. It is in this inequality of civilization that the institution of slavery has had its origin. The relation between master and slave could only be established where there existed a great disparity of intellectual culture between the governing and the governed class. Slavery must be admitted to be a necessary institution in such stages of society, although it has the disadvantage of perpetuating, and even of increasing, the inequality which gives rise to it, to say nothing at present of its other disadvantages. But it is not merely where it presents itself in this startling form that inequality of civilization exists among different classes of society. Wherever we find great inequality of power and privilege prevailing, we find this inequality of civilization giving rise to it. An aristocracy, a class of privileged nobles, has its origin in the circumstance that greater skill, enterprise, intelligence, and perseverance, at first threw a comparatively great amount of wealth and power into the hands of a few families; that the management of that wealth, and the exercise of the power and influence, were occupations calculated to give a greater practical development to the propensities and faculties of their descendants, than the routine drudgery of those who earned their daily food by their daily labour. We have no desire to palliate the evils of aristocratic government. That degree of enlightenment which enables men to lord it over others, is not necessarily accompanied by that higher enlightenment which teaches the beauty and utility of self-control and the exercise of justice to all. But we must not, therefore, shut our eyes to the fact, that aristocratic government is one of the stages through which all societies must pass in their way to something better; that society advances as man walks, by putting one part of the body foremost and dragging the rest up to it; that the love of power, and skill in acquiring and exercising it, must be realized in the few, in order to excite the desire of a share of it in all. That inequality of civilization, which gives rise to aristocratic power and influence, exists in many different forms and modifications. Even in our own country an uncivilized class is found—that unfortunate class which supplies the precarious demand for the lowest kinds of unskilled labour, and fills our police-offices and other courts of justice with the greater part of the victims to the security of society.

In a rude society, there is wanting that enlightenment which is necessary to confer upon the subjects or citizens the power of keeping their government in the path of its duties. In a partially civilized society—a society in which some classes are considerably advanced in civilization, while others are still rude, helpless, and ignorant —only a portion of the citizens will be able to exercise this control. They will exercise it to their own advantage, neglecting the interests of the powerless classes, most frequently from thoughtlessness, but sometimes at the impulse of motives still less excusable. The only guarantee men can have for good government, is their *power* to exact it, and the foundation of that power is knowledge or intelligence—intelligence imparted by civilization and heightened by teaching—knowledge diffused through all ranks of society. Wherever there is an ignorant class, it will be weak; and wherever men are weak, they will be oppressed.

But this power which the subjects or citizens of a government or state derive from knowledge and intelligence, must be rendered available by organization. It is true, on the one hand, that none but civilized, that is instructed and intelligent (we do not mean book-learned) men, can be organized, or can organize themselves, for the purpose of making their government do them justice. But it is also true, on the other hand, that unless men do associate, and each take upon him a certain part of the labour (which is what is meant by organization), they never can attain their end. Public opinion is strong; but unless public opinion is imbodied in public assemblies met to discharge certain business, or to choose the persons who are to discharge it for them, it is impotent when opposed to an organized government. The power which the citizens, meeting in public assemblies, possess of checking the government, is derived from a circumstance in the very constitution of government that has been noticed above—the fact that government can only enforce the obedience of its subjects by employing the organized force of a portion of themselves. If a decided majority of the citizens resolve not to obey the commands of government, not to become its agents in compelling others to obey it, and not to allow any of their fellow-citizens to enforce obedience from the rest, except under certain conditions, government must come to terms with them. Whenever, in any country, the great body of the inhabitants have discovered this truth, they have succeeded at intervals in averting the oppression of those who exercised the government for the time being. It was in this manner that the Roman plebeians, when they retired to the "Sacred Mount," obliged the patricians to abstain from tyrannizing over them. It was in this manner that the Dutch relieved themselves from the yoke of Philip II. of Spain. It was in this manner that the Swiss emancipated themselves from the house of Austria. It was in this manner that the Reformation of Religion was effected in all the Protestant countries of Europe. It was in this manner that our own Revolution in 1688 was effected.

We are not stating what ought to be done on such occasions—that might be mere matter of opinion: we are stating what has on all such occasions been attempted, with more or less success, and what, so long as man continues to be man, will be attempted. If a government persist in oppressing the people, it will drive them to revolt against it. If the people are sufficiently advanced in civilization to estimate the amount of their wrongs, and to devise some rational means of obtaining redress, their revolt must be successful. All parties have an interest in preventing matters from coming to this extreme. The members of government risk the possession of the power and profit which their subjects, for the sake of a tranquil and secure life, would gladly allow them. The great body of the people have their industrious pursuits interrupted, their property diminished, perhaps their personal security endangered. Whenever resistance is thus offered to a government, it is as the least of two evils—it is always in itself an evil, though it may be a necessary one. A conviction of this truth has, on more than one occasion, induced both governors and governed, while the evils of a struggle between them were yet fresh in their memory, to attempt to prevent its recurrence by some permanent arrangement. The Roman plebeians, for this purpose, obtained from their rulers, at different times, tribunes invested with power to guard their rights, the right of electing one of their own number to be consul, and various other concessions, which at the time appeared to them to be sufficient to assure them of just government in time to come. In our own country, Magna Charta and the Bill of Rights were bargains struck between the governors and the governed, for the same purpose. All these arrangements, whether well adapted to promote the end in view or not, are what are called constitutions, or constitutional governments. They are bargains struck between the government and the people at large, awarding to each party certain powers or privileges, which the other becomes bound to respect. The object in view is to render it possible to check those evils at the very outset, which, if allowed to go on, lead to revolts and revolutions; to enable the people, by keeping a steady watch over the motions of their rulers, to mark their first aberrations from the right, to remonstrate in time—to prevent injustice instead of revenging it.

Constitutions of government have been devised and adopted, as various as the habits, opinions, amount of wealth and knowledge, and distribution of them among the people who have devised them. Our own will be examined in the second section, and will serve as an illustration. Our object at present is to point out what the knowledge or opinions which prevail in Europe lead us to believe is the most efficient kind of constitution. A constitution is adopted in the belief, that it will secure the enjoyment of their just rights, alike to the governors and the governed. If it effect this, men will rest contented with it; if it do not, they will look about for a better. The only thing that has ever convinced a people that their constitution worked ill, has been experience. No people have ever changed their constitution in consequence of a mere abstract demonstration that the new one proposed to them was calculated to work well: no people have remained quiet under a constitution that worked ill. Any constitution, however imperfect, is legitimate, and ought to be obeyed, so long as the people are satisfied with it. The only use in trying to discover the most perfect and efficient constitution that can be adopted, is with a view to insure its permanency, to prevent the necessity of having recourse to the evil of a change. The plan of organizing society for the purpose of keeping government in the line of its duty—the constitution about to be traced—is not held out as recommendable or possible to our own or any nation at any given time: it is an attempt to imbody principles which ought never to be left out of view: it ought to be approached as nearly as circumstances admit.

It has been shown above, that opinion is, after all, the engine by which stable, permanent governments are maintained. The existence of a government is a proof that the great majority of the people are satisfied with it, or that it is the common belief that they are satisfied with it; and therefore any attempt to resist it is hopeless. Civil wars, except in a few cases where a minority have been rendered desperate by oppression, and have rushed on death rather than continue to suffer, have been promoted by the uncertainty whether the supporters or the adversaries of the existing government were the more numerous and powerful. The object of a constitution is to provide the means of ascertaining which party is the more numerous, in order that the less numerous may see the necessity of submitting, without being forced to do so by actual suffering. The only way in which this can be done is by coming to a vote. All *constitutions*, taking the word in the sense in which it is generally used in modern Europe, when investigated, are means of ascertaining by whom the people wish to be governed. They are adopted in the belief—that the people wish to be well governed, that is, that when the majority of the people are comfortable, they will not seek for change; and that when the majority are uncomfortable, they will seek for change; and that the minority who believe the choice of the majority to be wrong, will the more willingly submit, if they see that, should it be in their power to bring over a majority to their opinion, they can alter the decision. When a nation has got the habit of acting in this way, the conduct of government necessarily comes to be more narrowly scrutinized. The incessant cavilling of the discontented minority, provokes arguments in defence from the majority, and not an action of their rulers escapes discussion. Experience, if nothing else, teaches the government that this incessant disputation may, unless it is particularly guarded, loosen the hold it has on the opinions of the majority, and makes it more guarded in its proceedings; or if it misconduct itself, disregarding this hazard, its own blameable conduct diminishes the number of its supporters, until they become a minority. The object of a constitution being to afford a means of working out this process peaceably, it is clear that the first and most important requisite in a government—in a constitution—is a method of ascertaining beyond doubt to whom the majority of the people wish to intrust the charge of governing them.

The problem, then, is, How are we to ascertain the wishes of the whole people—their real, their sincere wishes? There is only one way, by allowing every one of them to declare who it is they wish should govern them, and allowing them to do this free from fear of the consequences. In states which consist, like those of the old Grecians, of a single city, the ballot-box and a convocation of all the citizens was sufficient for this purpose. In states which, like Great Britain, France, or the United States of North America, extend over a large tract of country, the votes must be taken by districts; otherwise many would be prevented from voting by loss of time and the expense of travelling, and thus the opinion of an unquestionable majority could not be obtained, and the election would occupy a dangerous length of time. The rule to be observed, in dividing the country into voting districts, is, that they shall be sufficiently small to admit of every citizen giving his vote at the expense of a very trifling loss of time and personal inconvenience; and that they shall at the same time be sufficiently large to contain such a number as shall prevent secret voting being merely nominal.

The next requisite in a constitution is, that care be taken to prevent confusion in the discharge of the different functions of government, and to ensure the greatest possible amount of fitness for their respective duties in the persons elected. It has been shown above, that it is of great consequence that the law-makers, and the law-expounders (judges), and the law-enforcers (executive government), should all be different persons, independent of each other. It is therefore advisable that the people should directly elect all these separate functionaries, with the express understanding that each is to confine himself to his own particular field. There is this difference between the first of these classes of functionaries and the other two, that its office is deliberative, while the offices of the others are to act. "In a multitude of counsellors there is safety;" it is desirable that the deliberative, the law-making body, should be numerous. On the other hand, experience teaches that, where action is required, the controlling power ought to be vested in as few as possible. Hence it is advisable that, in elections of executive governors and judges, the votes of all the districts ought to be added, as only a small number are required; but that, in elections of legislators, as the number required would be so numerous as to render it inconvenient for each district to vote upon all, each district should be allowed to send a certain number of legislators to the general assembly. By this means greater variety of character and opinion will be introduced into that body, which, though destructive of action, promotes discussion.

For the same purpose—the keeping the different functionaries of government independent of each other, and preventing as far as possible collusion among them, with a view to promote their own ends instead of the public good—it is desirable that each district should elect those local functionaries who are required to be resident within it. In a large country, it is necessary to have judges within reach of every man; and it is necessary to have one supreme judge, whose decisions shall preserve uniformity among all those different courts, and to whom those who are dissatisfied with the decision of their own court may apply to have it reconsidered. So, while the central executive government takes care of the whole nation, there are many little details to be attended to in every locality, which are best discharged by persons residing on the spot, which could not be so well managed by the central government, and would occupy an undue share of its time. These officials ought to be elected by the inhabitants of the district over which they preside, in the same manner as the great functionaries are by the whole nation. By this means alone can security be given that they will be chosen solely for their fitness, not with a view to secure interested supporters of the central government, which, were they nominated by it, they would infallibly become.

The last essential point is, that the elections of the functionaries of government should recur at brief stated intervals. The use of a constitution is to keep government in the line of its duty, by making it feel that it holds its power only so long as it retains the confidence of the people, and by enabling the people to change a government which it finds incorrigible. Unless the members of government are elected at first for a definite limited period, with a common understanding that the process of election is to be gone through at the expiry of a certain time, the object of framing a constitution will not be obtained. There will be no means of ascertaining when the whole country thinks it advisable to proceed to a change: the minority will pretend that the proper time for election has not come, and absent themselves, in order to have a pretext for denying that the result shows the opinion of the majority. The elections must therefore be ordained to take place at stated intervals, and these intervals must be calculated with a view to two considerations—they must not be so far apart as to allow a government time to do much mischief unchecked; they must not be so near as to prevent the government from developing in practice the system on which it intends to act—they must be long enough to enable it to be judged, not by isolated actions but by its general policy. At the same time, care must be taken to institute such arrangements respecting the period for which the elected should serve, as will conciliate and secure men of respectable standing in society—men, in fact, who may be supposed to be placed beyond the suspicion of serving for basely selfish purposes, and who are in the habit of taking enlarged views of social organization.

FORMS OF GOVERNMENT ACTUALLY EXISTING.

In the first section an attempt has been made to convey a distinct general notion of the ends proposed to be accomplished by government, and of the means by which the nature of man and society render it necessary for government to accomplish these ends.

The use of such general notions is to serve men as a test or standard whereby to ascertain how and to what extent any actual government approaches to or falls short of what it ought to be, and as a chart by which to work when circumstances offer an opportunity of introducing any improvements into the machinery of any existing government. In affairs of practical politics, as in all other human transactions, it is of great advantage to those who are called upon to act, to have it in their power to take up a position beforehand, from which they can see at once the whole field of operations, and the relative positions and bearings of all its parts.

But such general notions, if not combined with knowledge of practical details, are at times apt to mislead, and are not at any time sufficient of themselves to enable men to decide on any occasion what is best to be done. The preceding analysis of the elements of government is an outline of what exists in reality, but so general in its features that it is applicable to every government that has ever existed. Whoever would avail himself of the practical lessons that may fairly be deduced from those general truths, must first of all apply himself to ascertain the peculiar form under which those general principles exist and operate in his own country. He must not allow himself to be misled by vague sentiments—by predilections or antipathies for particular names or even forms of government, but endeavour to discover the amount and kind of the effects they produce, and judge of them by their effects. Liberty and loyalty—monarchies and republics, aristocratical or democratical—are words about which much argument and much blood has been wasted. And yet, after all, it is not the name of a government, nor even the external forms of its framework, that are of importance. If a government protects the persons and properties of its subjects, without interfering with their freedom of thought and action so long as they do not injure their neighbours; if, by example and precept, it encourages industry and intellectual development, and high moral and religious sentiment; and if its constitution is such as to afford a guarantee for its action being permanently (not by fits and starts) thus beneficial—be the name or form of that government what it will, it is a good one; and on further investigation it will be found that its goodness is owing, in the first place, to the aptitude of its organization for effecting the ends of government—that is, to the skilful organization of legislative, judicial, and executive functionaries; and in the second place, to circumstances which render these functionaries subject to the control of public opinion.

It must always be kept in mind, that government, in the great majority of cases, must be exercised by, as well as upon, individuals of the nation in which it exists, *by* individuals not materially wiser or better, in the average, than those whose imperfections render the control of a government necessary to preserve peace and justice in society. And it follows from this, as a necessary consequence, that at different stages of civilization, different forms of government may be not only the most easy to establish and support, but the most beneficial for the community. With all the defects necessarily attendant upon a non-resident government, there can be little doubt that the government of the British East India Company is not only a better than India ever had before, but a better than the inhabitants of Hindostan could at this moment give themselves, if left to their free choice. The feudal forms of government in Europe during the middle ages, the hierarchy of Thibet or ancient Egypt, the monarchy of Charlemagne, have all been in turn the best for the particular tribes subject to them at the particular period.

The mutual adaptation of governments and nations is a point that cannot with safety be left out of account, in cases where the shades of difference are much more delicate and difficult to detect than in those which we have selected for the sake of illustration. A difference in the kind as well as in the degree of civilization of two different nations, can render the government which works well in the one impracticable in the other. A nation is what we have attempted to show a government to be, more a necessary product of human instincts than a creation of conscious design. Governments and nations are the creatures of human intellect and will—but of whole races and generations, not of individuals, or even of the collective men of one age. There goes time, long time, to the making of both. They grew up together; they are inseparable but by the destruction of both; the capacity and peculiar character of the nation determine the kind of government fitted for it. Every nation must work out its own happiness—in consonance, it is true, with the universal general laws of human nature—but, at the same time, in harmony with all those minor differences which characterize, and throughout its history have characterized it as differing from all other nations.

DESPOTISMS.

At the present time, the greater proportion of the governments throughout the world are of the character of *despotisms*, and comparatively few possess what are called *constitutions*. Of the multifarious class of despotisms which exist among barbarous nations, it is here needless to say any thing; for the question of form of government only becomes interesting when applied to a wholly or partially civilized people.

Russian Government.—The most powerful despotism in Europe is that of Russia, which, in virtue of hereditary right, is governed by a monarch with the title of Emperor. No restraint can be imposed on the Emperor's government, except voluntarily; and, either from benevolence or fear, the Emperors have partially qualified their unlimited power, which is further moderated by rights and privileges enjoyed in certain parts of the empire, on which no monarch could infringe with impunity. (See article GEOGRAPHY.) Russia is chiefly distinguished as a great military power. Within the last seventy or eighty years, it has, by military rapine, acquired territories containing upwards of twenty-three millions of subjects; this extent of acquisition, however, is much less than that of Great Britain in India during the same period of time. A severe censorship of the press; the existence of seignorial rights of serfs (a kind of slavery); a widely ramified police spy-system; restriction of personal locomotion by passports; and, in short, a complete absence of all tokens of civil liberty, mark the Russian government as a pure despotism. The despotism of Austria is scarcely more liberal; the only qualifying features are the establishment of a national system of elementary education, and science is not persecuted.

Prussian Government.—Prussia at present offers the remarkable spectacle of great improvement in intellectual and social condition, with ample protection of life and property, and yet with a form of government very little removed from that of a pure despotism. As little is popularly known respecting the Prussian government, and as it is the best example we can give of its class, we shall go a little into detail on the subject.

Prussia has increased from the condition of a dutchy—that of Brandenburg—to a large kingdom, within less than two centuries. A liberal reception of persecuted religionists, and military conquest, have been the chief basis of its greatness. Protestants flying from persecution in the Netherlands in the sixteenth century, found a refuge in Brandenburg; and great numbers of the French

Huguenots, who fled from their country on the revocation of the edict of Nantz, were encouraged to settle there; both classes of immigrants, by the example of their skill and industry, richly repaid the retreat afforded them. The Brandenburg territories were the focus of the desolating activity of the Thirty Years' War; but the destruction thus occasioned, operating upon an industrious and energetic race, a large proportion of whose ancestors were martyrs for conscience' sake, only stimulated them to redoubled exertions when peace was restored. The last prince of the country, who bore the title of elector, Frederick-William the Great, who reigned from 1640 to 1688, was of a character similar to that of his subjects: he found his country a waste when he assumed the reins of government; he introduced a degree of civil and military organization, that rendered it, long before his death, not only the most powerful division of the German empire, but a state, the alliance of which was courted by the most powerful princes in Europe. From the time the sovereign of this state assumed the kingly title, down to the dissolution of the empire, its history has been little more than the development of the organization begun by Frederick-William, under the auspices of a line of princes, all of them possessing more than average talent, and one of them unquestionably a man of genius. Prussia continued, as before, a place of refuge for all who fled from oppression of any kind. The victims of the devastation of the Palatinate by Louis XIV. found a home here; the objects of religious persecution in Switzerland, Salzburg, and Bohemia, came in successive flocks to Prussia—in one instance 20,000 at a time; and all were welcomed. The peculiar relation of Prussia to the empire seems to have exercised a favourable influence on the policy of its monarchs: possessed of all the power of independent sovereigns, they were not embarrassed in their internal government by foreign interference; and at the same time, *nominally* subjects, they were encouraged in a taste for the homely household management of their territories. The narrow limits within which the Brandenburg territory, the nucleus of the state, was contained, rendered it more manageable; the complete organization was easily extended to later acquisitions. The circumstances attendant on the dissolution of the empire in 1806, were such as to impress a severe lesson of economy on the sovereign of the in every respect independent state; and the necessity of entering into a death-struggle against the conqueror of Europe for the preservation of that independence, gave the finishing touch to its organization. Prussia is every way an anomaly—an uncontrolled monarchy, with a highly educated population, every adult male of which has been trained to the use of arms—a monarchy, in every public department of which as severe an economy prevails as in the democratic republic of North America.

The government of Prussia is a hereditary unlimited monarchy; the state is one and indivisible. The King exercises generally, by his ministers, the supreme legislative and executive authority, and appoints the judges. All laws bear to be framed by the King alone; but in fact they are prepared by the Council of State (*Der Staatsrath*). This body (established by royal ordinance of 20th March, 1817) consists of—1. The princes of the royal family, who have completed their eighteenth year; 2. Officers of state, who are *ex-officio* members of the Council, namely, the President of the Council, the field-marshals, the Cabinet ministers, the President of the Supreme Court, the President of the Chamber of Accounts, privy-councillors, and (for military affairs) reporting adjutants-general, the President of the National Debt Office, the Secretary of State, the generals commanding provinces, and the presidents of provinces when in Berlin; 3. Officers of state specially appointed by the King. The Council meets regularly on appointed days for nine months of the year; fifteen members, exclusive of the royal princes, being required to form a *quorum*. During June, July, and August, it meets only in the event of pressing emergencies. The business of the Council is to deliberate upon questions of policy regarding which the ministers are not authorized by the constitution to decide; the establishment of principles for the guidance of. the executive authorities; the preparation of laws; the organization of the different departments of state; the settlement of contested jurisdictions between ministers; and, in addition to these, the scrutiny of any question submitted to them by the King. Six committees are appointed to put any business to be submitted to the Council into shape, before it is discussed in full assembly; namely, the Committees of Foreign, Military, Judicial, Financial, Domestic, and Educational Affairs. Each of these committees is composed of five councillors not holding executive offices in the department of state, the business of which is submitted to their review: the president from time to time appoints individuals who do not belong to the council—government officials, scientific or mercantile men, or landed proprietors—to attend the sittings of the committees, for the purpose of giving information. The minister of department subjected to the inspection of each committee, must be present at its sittings either personally or by deputy, for the purpose of giving all necessary information, but is not allowed a deliberative voice. Matters of business, thus brought into proper form, are discussed in the general meetings of the council. After the report of the committee has been read, any member of it who dissents from the report is heard in support of his peculiar views. The minister to whose department the business belongs, is next heard to speak. Any other members of Council who wish to be heard, intimate their desire to the president, who calls upon them in the order in which they stand in the list of members. When all who desire to be heard have been heard, the referendary prepares an abstract of the opinions expressed by each, and the president takes the vote. A simple majority decides; and, in the event of an equality, the president has a casting vote. After a decision has been come to, with or without discussion and a vote, the resolution or draught of a law, together with a report of the proceedings, is laid before the King, who approves, rejects, or modifies it. Resolutions, laws, and ordinances of the Council, have no authority until they receive the royal sanction. All representations from the provincial assemblies are submitted to the Council through the ministers of departments. The business of the committees proceeds uninterrupted during the annual vacations. The Secretary of State has the charge of preparing all protocols and draughts of laws, and superintending the signature of such as are approved. Each committee has an establishment of clerks. The Council has a library, which contains the laws of the monarchy and all its provinces, and all the laws of the states of the Germanic Union that have been printed.

The supreme judicial organization is very perfect, and so, likewise, is that of the provinces and inferior divisions. With respect to the central executive, it is conducted by ministers appointed to the different departments, including a minister for spiritual, educational, and medical affairs. The executive is charged with the duty of supervising the products of the press, each minister exercising a censorship over publications relating to the concerns of his own department.

The naturally stringent quality of despotic rule is somewhat modified by the peculiar organization of the provincial executive; in point of fact, certain popularly appointed local councils or municipalities restrain the action of the central despotism. The eight provinces of the monarchy are divided into governments, these into circles, and these again into communalties. 1. At the head of each province is a High President, (who, when in Berlin, has a seat in the Council of State,) to whom are attached a council, a secretary, and several subordinate officials. The High President presides in meetings of provincial consistories, and the commissioners of school and medical affairs; he transacts business with the representatives of the province; he makes arrangements with the generals commanding the troops of the province; he exercises the censorship of all publications in the province, with the exception of some reserved for the Cabinet ministers; he exercises superintendence and control over the executive authorities in each government of his province; he controls the tax-collectors of the province; and, in emergencies, he is authorized to act in name of the central government until directions can be received from the capital. In each province there is a representative body called the *Land-Stände* (*etats provinciaux*). The general edict of the year 1823, which "called these bodies into active existence," declares that property in land is the basis of the representation, and that the Stände is "the constitutional organ of all classes of subjects in each province." The Stände consists of noblemen having a right to appear in person, noblemen, or great landowners appearing as representatives of knots of five, six or seven, who have a "collective voice," and representatives of towns and of cultivators of the soil. In Saxony, Westphalia, and the Rhine Province, the representatives of the commons are elected by districts; in the other four provinces, by towns, districts of towns, and rural districts. A more distinct idea of the functions of the Stände, than can be derived from the vague expression "organ of all classes of subjects," is conveyed by the fact that courts of arbitration have been established in Prussia, Brandenburg, Pomerania, Silesia, and Saxony, in consequence of representations from those bodies. The Stände meets and deliberates, and represents to the crown, through ministers, what legislative or financial reforms they wish, the crown reserving to itself the power of refusing the request, or complying with it in its own way. Every province is divided into governments, at the head of each of which is a president and council, composed of heads of departments; namely, the councillor at the head of the executive department, the superintendence of schools and churches, and the management of *direct* taxes, demesnes, and forests; several councillors who have no specific department; and some assessors. Business of weight is transacted by meetings of the whole council; affairs of less importance in meetings of the councillors belonging to specific departments. The executive officers of a government are appointed by the president; the councillors and assessors are appointed by ministers, on the recommendation of the president; the government treasurer and some other officials, on the recommendation of the whole council. The public business of the circles into which every government is divided, is managed under the direct superintendence of the provincial government, by a councillor in each, with the assistance of a council composed of the Stände of the circle. The members of the last body are all proprietors of equestrian lands, (or, under certain restrictions, their delegates,) the representatives of the towns, and the representatives of the peasantry. The commonalties in each circle are either town or rural. The towns are managed by town-councils, elected by the burgesses, and magistrates chosen (with the exception of the principal burgomaster) by the council. To the magistrates is intrusted the care of the executive police: the council manages the town property, and all matters of local finance. At the head of every rural district is a village justice (*Schulze*), with two assistants (*Schöppen*), who exercise a limited authority in matters of police. The village judge and the magistracy of towns are under the control of the executive department of the government in which they are situated.

Although the nation generally may be described as still in a rude condition, and perhaps not able for self-government, great advances are making to give the whole population intelligence, which is the basis of all true liberty. The state, in many respects, exercises a paternal and kindly sway. It has established national education on the broadest possible foundation; for each child is legally compelled to receive elementary instruction at school, and it is considered a disgrace to remain ignorant of letters. The state also takes charge of all the public highways, and keeps them in the best condition. It protects travellers from imposition, by regulations affecting posting, innkeepers, &c. It restrains idleness and drunkenness, by compelling all men to support their families; and places barriers in the way of that source of many evils—too early marriages. It gives perfect toleration to all religions and forms of worship; and the security it affords to persons and property is quite equal to that afforded in England. The worst of its features is the censorship of the press, which strikes at the root of constitutional freedom. The people, also, cannot meet publicly to discuss political affairs; personal locomotion is restricted by passports; the towns are walled and garrisoned; every able-bodied male must serve for a time in the army—all which circumstances tend to show that the nation, with all its social improvements, is still in the infancy of civil liberty.

CONSTITUTIONAL MONARCHIES.

A *constitution* is a legal and fixed compact between governors and governed, that the just rights of all shall be respected; and therefore implies a liberal concession of the governing party to the opinions, wants, and wishes of the community. Europe abounds in constitutional governments, but many of them are scarcely entitled to the name. Sardinia, Saxony, Sweden, Hamburg, and all the smaller German states, have constitutions of one kind or other; that is to say, the king, grand-duke, chief-ruler, or by whatever title he is called, is restricted in his designs by estates composed of delegates from different orders of the people. We should consider it quite useless to present detailed explanations of these constitutions, because all, or nearly so, are little better than a mockery. The reigning monarch can either directly neutralize the will of the estates, or he and they, together or separately, are under the influence of armed intervention. The King of Hanover, for example, has lately trampled on the constitution of that country, and yet he is protected by the other states of Germany. In point of fact, the whole of central Europe is at the mercy of Prussia and Austria, whose armies can be marched to any point where constitutional freedom has the appearance of starting into life. The Dutch have a constitution, but they have no right of public meeting for political objects; their press is under a censorship; all must carry passports; and every citizen, in any kind of trade or profession, is required to pay for a license. The infant and still disorganized constitutions of Spain and Portugal it is unnecessary to notice.

The constitution of France, since the Revolution of July, 1830, has been greatly liberalized; but, from the occurrence of recent events, it appears that the press is liable to oppression, without legal remedy; that citizens can be treated as the vilest criminals before trial, and merely on suspicion; and that the people have not the liberty of meeting for political discussion. Passports are required, a number of the large towns are walled and controlled by garrisons, and the very capital (January, 1842) is in the course of being placed under the guns of formidable batteries. Constitutional freedom is therefore either not yet understood or appreciated in France, and future disasters, doubtless, await that naturally fine country.

British Constitution.—From the raw and ill-regulated constitutions of most continental nations, we ascend to the old-established and well-guarantied constitution of the United Kingdom of Great Britain and Ireland. The government of this large empire (which we need not here particularize, as it has been fully treated of in our article CONSTITUTION AND RESOURCES OF THE BRITISH EMPIRE) is a perfect anomaly, and, though frequently imitated, has never, in a monarchical form, been excelled. The legislature, as is well known, consists of a hereditary sovereign (king or queen, as the case may be), a hereditary House of Peers, and an elected House of Commons. A *Parliament* is the term used to express the collective bodies of King, Lords, and Commons. Electors of members of the House of Commons must be native or naturalized subjects, males of twenty-one years or upwards, of sane mind, not concerned in the management or collection of the revenue, not holding any office in the metropolitan police, and not legally convicted of perjury, subornation of perjury, or bribery. In counties, an elector must be possessed of property in perpetuity or liferent to the value of £10 yearly, or lands held at a yearly rent of £50. In cities or boroughs he must be proprietor of a house or shop valued, along with the land attached to it, at £10 yearly, and upwards; or must occupy premises for which he pays a rent of at least £10 per annum.

Such, with certain modifications, is the principle on which members are elected. In practice it is found that the great bulk of the elective privilege is exercised by, or under the influence of, the landed gentry, in which we include the titled aristocracy of the country. At no time have what are called the lower or working classes possessed the vestige of the elective privilege: and it has only been since the passing of the Reform Act that the middle classes (shopkeepers, master tradesmen, manufacturers, farmers, &c.) have had the semblance of direct representation. With this alteration, however, it cannot be said that the legislature has undergone any sensible improvement. In the main, the members are still nominees of the landed gentry, or of corporations; and so much time is usually spent in electoral intrigues, parliamentary debates which lead to nothing, as well as the conciliation of parties, that the business of the nation is continually falling behind, or improperly executed.

In whichever way it is viewed, the legislature of the United Kingdom is essentially the reflex of the landed gentry and aristocracy, and consequently the interests of these classes are uniformly the chief matter for consideration. The next great interest cared for is the West India interest; next the shipping interest; next the military and naval interests; and, lastly, the commercial interest, and the interest of the people. The executive, reposed in the hands of a responsible ministry, takes its character from these competing interests. The execution of any project of law or government is, to all appearance, rarely a result of principle, but in almost every case an immediate consequence of temporary expediency. Power is attained by skill in gaining a number of supporters, and retained by skill in keeping them together. So much of the British statesman's efforts, during his apprenticeship to power, and his exercise of power, are devoted to the getting and keeping of power, that he is necessarily deficient in natural and acquired administrative talent. The manner in which the administrative functions of government are executed, depends upon the industry and honesty of officials not responsible to public opinion, not liable to be dismissed unless convicted of gross dereliction of duty, and of whom their chiefs ask little more than sufficient attention and skill to save them from successful criminations by opposition. This kind of organization weakens the direct pressure of public opinion upon administration; and, at the same time, by encouraging personal canvassing for political support, and the cultivation of impressive oratory, diverts public attention from the dry business of government, to sympathize with personal squabbles, and attention to great abstract questions, more imposing but less immediately important than practical details. The consequence is, that the British government, more than any other in Europe, has been characterized by the aimless expenditure of immense energy with very disproportionate results.

Whether any further introduction of the democratic principle (lowering the elective franchise) into the constitution would improve its qualities, is extremely doubtful. The people, taken in the mass, are still far from being instructed. A vast number can neither read nor write: and such is the distressing state of poverty and wretchedness of large communities in towns, that, with their small knowledge of public affairs, and liability to be corrupted, it is to be feared they would appoint men of inferior qualifications, or whoever paid them most liberally. The freemen voters (working men) of Norwich and some other towns, make a regular sale of their votes on the occasion of elections. In this strangely complicated condition of affairs, with great class interests to be protected, the only real restraint on government is the action of public opinion, expressed through the medium of the newspaper press and public meetings. Without these two qualifying elements, the government and legislature would be, not only in name but in character, a powerful oligarchy. As the case is, the restraint, though clumsy, is on the whole efficacious; and, therefore, with all its errors and anomalies, the constitution is one of the most favourable to civil liberty. The very weakness of the executive, as respects the means of keeping its place, and its obligation to conciliate parties, is highly favourable to popular freedom. In no monarchy on the face of the earth is the executive so liberal —that is, interferes so little with private conduct. Under its administration, the following important conditions are secured:—Liberty of speech within constitutional limits; a similar liberty of the press in all its departments (newspapers, however, requiring to be stamped); liberty of personal locomotion, no passports being required; liberty of carrying on almost every branch of trade without inquiry or license; liberty of meeting in masses to be instructed by lectures on political or other subjects; liberty of meeting to discuss any political topic, general or local; liberty of presenting petitions to parliament and memorials to the crown; religious toleration, and liberty for the performance of all forms of worship; liberty of setting up schools to instruct pupils in any branch of learning; protection from the law to life and property, without respect of person; privilege of trial by jury, and of forcing on a trial for any alleged offence; privilege of being held as innocent till proved to be guilty; incorruptibility of judges, these being no way exposed to intimidation either from power or popular prejudice. To these great bulwarks of civil liberty may be added the absence of military conscription; the non-existence of fortified or walled towns; the promptitude with which riotous proceedings are quashed and the peace preserved; and the absence of any restriction to prevent the most humble individual from rising to the highest rank and consideration. The drawbacks on all these advantages may be comprised in the following circumstances:—The existence of a set of laws so complex as to be unintelligible, and so expensive in administration, that legal redress, as far as private interests are concerned, is almost beyond the reach of the lower classes; the most odious restrictions on free commercial intercourse with foreign nations; the too prevailing treatment of all great questions in Parliament with reference to classes instead of to the whole people, and consequently the imposition of burdens, in an irregular manner, difficult to be borne by the poorer orders of the community; and, lastly, the absence of a national system of education, which might in time elevate the minds and morals of the people, and altogether produce a more wholesome social condition. Fortunately, these circumstances are all of a nature which admits of amendment, and they will, as a matter of course, be amended, as *public opinion, enlightened by knowledge*, is brought to bear upon them.

REPUBLICAN GOVERNMENTS.

A republic or commonwealth is a form of government in which the people, or at least a large portion of them, are acknowledgedly the source of power, and have the direct appointment of the officers of the legislature and executive. There are few of this class of governments in existence. The only republics worthy of the name in Europe, are those of the Swiss cantons; each of which is a territory of generally a few square miles in size, and inhabited by a few thousands of people, chiefly engaged in husbandry. In these cantons there are no great properties, and no families equivalent to our landed gentry. There are some wealthy and intelligent merchants in the large towns; but the bulk of the population are a hard-toiling race of small farmers, and little is seen above a condition of mean mediocrity. The legislative and executive functions are conducted in accordance with this state of things. Some of the laws are contemptible, from the narrow-minded views they exhibit—such as laws in some cantons to prevent dancing, and to prevent the purchase of houses or land by strangers; but other enactments, particularly as to freedom of trade, are much to be commended. These republics, centering in a general diet or congress, are greatly under the influence of Austria and other monarchies, by which, indeed, they are in a great measure tolerated only from mutual jealousy, and because the country is in some places almost inaccessible to hostile invasion. A constant drainage of the overplus population into France and to North America, helps to avert the catastrophe of a universal degradation to semi-pauperism.

On the continent of America, various republics have been founded on the wreck of the colonial institutions of Europe. The principal is the United States of North America, now upwards of half a century old. We have alluded to this great modern republic in the article DESCRIPTION OF THE UNITED STATES, and have no intention of going deeply into the subject here. The form of the legislature and executive is very nearly that of England; the main difference being an elective President as chief magistrate, instead of a hereditary sovereign, and the appointment of judicial and other functionaries by the people, instead of by the crown. The country is not one but an aggregation of republics; each state being independent of the others as respects internal management. The power of legislation for the States, in their united character, is vested in a House of Representatives and a Senate, jointly forming a Congress. The House of Representatives is composed of members chosen every second year by the people of the United States. The electors in each state are required to have the qualifications requisite in the electors of the most numerous branch of the state legislature. Representatives are apportioned among the several states of the Union according to their respective numbers, which are determined by adding to the whole number of free persons (including those bound to serve for a term of years, and excluding Indians not taxed) three-fifths of all other persons. The House of Representatives consists of one member for every 77,700 persons in each state, estimated according to this rule: the enumeration is made by a general census taken every ten years. No person is eligible as representative who has not completed his twenty-fifth year, and been seven years a citizen of the United States, and who is not, when elected, resident in the state for which he is chosen. The Senate of the United States is composed of two senators from each state, elected by the legislature thereof for six years. One-third of the Senate goes out and is replaced by a new election every two years. A senator must be thirty years of age, nine years a citizen, and resident in the state for which he is elected. All members, both of the general and state legislatures, are paid for their services.

The President is elected by the whole people, for a term of four years: at the close of that period he may be re-elected; and, with the exception of three, all the presidents of the United States have been re-elected for a second term. Each state appoints a certain number of electors, who meet in their respective states, to vote for President and Vice-President, one of whom, at least, shall not be an inhabitant of the state. In Delaware, South Carolina, and Tennessee, the legislature chooses the electors; in Maine and Maryland, electors are chosen by the people voting for one or more in each district; in all the rest of the states, they are chosen by a "general ticket," upon which the whole of the electors vote. The electors transmit sealed lists of all the persons voted for as President, and all those voted for as Vice-President, to the president of the Senate, who opens the lists and counts the votes, in the presence of the Senate and House of Representatives. If for the person having the greatest number of votes for President, a majority of the whole electors have voted, he is declared President; if fewer, the House of Representatives elects by ballot one of the three who stand highest on the list. If for the person having the most votes for Vice-President, a majority of all the electors have voted, he is declared Vice-President; if not, the Senate names one of the two who stands highest on the list. The President and Vice-President must be natural-born citizens, thirty-five years of age, and fourteen years resident within the United States. The principle of electing representatives to the state legislatures, is almost that of universal suffrage; in most instances, every male citizen above twenty-one years of age, who has resided a year in the state, is an elector.

With an immensely large unoccupied territory, and general thinness of population, it is impossible to draw any just inference as to the stability of this still comparatively raw and untried republican government. It is suitable to the present condition of the country, but whether it will maintain this character after its population has become as dense as that of England, and great diversities of wealth and intelligence have arisen, is a question which time only can settle. In the meanwhile, the general character of the executive is feeble. The people, in a sense, are masters of the law, and have it in their power (in virtue of elective privileges) to intimidate its officers, or absolutely to set them at defiance. In the middle and eastern states, the efficiency of government for the repression of crimes is about the same as in Great Britain; but in the western states neither life nor property is safe from popular outbreak. The prevalence of slavery in the southern states aggravates this evil: personal security in New Orleans is at a lower ebb than in Italy or Madrid. Still, with these drawbacks, the United States is a great nation, in which civil freedom is on a grand scale, and is worthy of the enlightened community which has established and supports it.

GENERAL REMARKS.

The three great classes of governments which have been enumerated, among which Prussia is the most favourable type of a despotism, Great Britain of a constitutional monarchy, and the United States of a republic, require a word of concluding comment. Each of these nations has reached pretty nearly the same grade of civilization. The educated class of citizens in all of them will be found pretty nearly equal in respect to ge neral information, industrial skill, enterprise, and military courage. If the free citizens of the United States possess a greater amount of political power than those of Great Britain or Prussia, in neither of the two latter do we find a class of personal slaves. If the possession of the political franchise in Great Britain lends a greater degree of energy and self-respect to the middle classes of Britain than are possessed by those of Prussia, we will look in vain in the latter country for a class suffering such privations as the peasantry of Ireland, or the unskilled labourers of our den..ly peopled manufacturing districts. In America, the number of inhabitants who have received a common school education is greater than in either of the other; but the proportion which have received a university education is much lower. In Prussia, the direction given to the higher studies by the government, has placed the average scientific community far in advance of Great Britain: there has nothing been done in this country for the last twenty years to compare with what has been effected in history, geography, and science, *en masse*, in Berlin. On the other hand, British genius, developed uncontrolled by the school discipline, and encouraged by the demand of a wealthy community, has in individual cases soared to a higher pitch of invention. The morality of the three nations is much upon a level; as also the efficiency of their governments for repressing crime. The higher price paid by Great Britain for the services of government, is largely swelled by the amount of poor-rates: it is a compensating principle, redressing the less equal distribution of property which prevails in this country than in either the United States or Prussia. The price paid by Prussians for the services of government is greater than what is paid by Americans; but, in return, the organization of government over a large portion of America is more imperfect, and the protection it affords to person and property less complete. The secret of the high pitch of excellence to which government has been carried in all these countries, is, on the one hand, the power exercised by public opinion over the government; on the other, the power possessed by the state of availing itself of talent wherever it is to be found. Public opinion works directly upon government in the United States through the periodical elections; more indirectly in England, through the power of the press, and the House of Commons; more indirectly still in Prussia, through the training of the whole population to arms, and the constitution of the army. The universality of the elective principle in the United States, throws open the offices of state to all who are ambitious and capable. The forms of the British constitution oblige those possessed of political power to enlist the services of talent wherever they can find it. And in Prussia, the universities, and the appointment only of persons who have studied and undergone a severe examination, together with the order of promotion both in the civil and military service, open a career to the talent of all ranks. Government is well conducted in all these countries, in proportion as its duties are discharged as a matter of business, not of mere show or parade. The superstitious regard for the hereditary power of a monarch in Prussia, of an aristocracy in Great Britain, somewhat diminish the utility of government. On the other hand, the almost exclusive attention paid in America and Great Britain to guarding the individual rights of citizens, has left the organization of their executive government more slovenly. The executive of Prussia is more completely and skilfully organized: the individuals composing the executive governments of the United States and Great Britain evince, on the whole, greater robustness and energy of intellect; and we find in both these countries, what is found nowhere in continental Europe—an ability of self-government in localities far aloof from the central executive. On the whole, the review we have taken of the organization of these states, powerfully corroborates the conclusion arrived at in our theoretical section:—That good government, although it certainly promotes the civilization of a country, is much more its consequence than its cause; and that attention to the conduct and constitution of government, although a duty of the citizen, is only one of many public duties not less important and necessary, both to the general well-being of society and the happiness of the individual

LANGUAGE.

Language, in the largest sense of the term, may be defined as the means by which thought is expressed. Thought, as is well known, may be expressed by means of mute signs, as frowns, sighs, kind looks, gestures of the body; or by inarticulate sounds, as groans, cries, sobs, laughter. The first are usually called *natural language*, and the second *inarticulate language*; and these means of expression partly belong to the lower animals. Finally, there is *articulate language*, peculiar to man alone, and consisting of a multitude of sounds, each of which represents a distinct idea. To this last mode of expression, generally known by the simple term *language*, our attention is for the present to be directed.

ORIGINAL FORMATION OF LANGUAGE.

Overlooking the controversies which have taken place on this point, and from the revival of which no good could be expected, we are anxious on the present occasion to limit ourselves to the consideration of the hypothesis advocated by Dugald Stewart and others, that the formation of language is an effort within the scope of the faculties which man has received from his Maker. It may, we think, be considered under two points of view.

First, it is sufficiently clear that the vocal organs of men are constituted with a view to his expressing himself by speech. The larynx, epiglottis, pharynx, tongue, palate, and lips, are all of them framed in such a manner as to show incontestably that they were designed for producing such sounds as we employ in articulate language. It is scarcely less obvious that there is a distinct faculty of the mind for language. Some have powers of expression above all other intellectual endowments, so as to be considered as merely men of words. Others have good general powers of mind, but want adequate powers of expression, so that their gifts become of comparatively little use to their fellow-creatures. These diversities seem to shew that language is an intellectual faculty independent of all others. If, then, we consider that it is the nature of all faculties to be active, we can be at no loss to conceive how a variety of human beings, in a primitive condition, would begin to form language. They could not, indeed, be together, without beginning to use both their voices and mental gifts in a gabble, from which it would be but a work of time to resolve certain conventional sounds, as expressive of particular ideas. The imitative faculty would also help to form language. Objects would be named by words formed from sounds connected with them, as the wind from its whistling noise, the cow from its lowing, and so on. The Celtic language, which is probably one of the first that existed upon earth, is full of such descriptive words. In our own language, we still speak of the *mewing* of the cat and the *cawing* of rooks. The word *cuckoo*, so exactly descriptive of the note of the bird thus designated, ramifies through several languages. It is spelt *coucou* in French, and *cuculo* in Italian.

The other point of view in which we may contemplate the hypothesis, is that furnished by observation of the proceedings of children and of uneducated persons in expressing their ideas. The first language of a child is that of inarticulate sounds; it cries when it is hungry, screams when it is angry, moans when it is in pain. A tender mother can tell the state of feeling of her infant by the tone of its voice. Similar to these would be the first indications of feeling in the members of a primitive society; and by such means, unquestionably, they would communicate their sensations to each other. As children take the next step in language by imitation of the speech of the persons around them, they furnish us with no evidence as to the first formation of words in a primitive society; yet it is remarkable that, while the first consonants which children learn to articulate are those which are called *labials*, because formed by a meeting of the lips, the words denoting father and mother are, in most languages, composed of that very class of consonants. The strong resemblance which subsists between the words in different languages expressive of the first social ties, is also worthy of observation. Thus, the word mother is

Em and *am*	in Hebrew and Arabic.	*Modor*	in Anglo-Saxon.
Madr	··Persian.	*Moder*	··Swedish
Matr	··Sanscrit.	*Moder*	··Danish.
Mētēr	··Greek.	*Moeder*	··Dutch.
Mater	··Latin.	*Mutter*	··German.
Madre	··Italian.	*Mater*	··Russian.
Mère	··French.	*Mathair*	··Celtic.

Children and uninstructed persons show us how the next step would be taken—namely, how a word, originally applied to an individual or single object, would come to be applied to a whole species of similar objects. If a child, for instance, has been accustomed to call its father *pa*, it invariably, till it learns better, uses the same word with regard to any male stranger who may come into its presence. It considers that person as *a pa*. Adam Smith mentions that he had known a clown who did not know the proper name of the river which ran by his own door. It was *the river*, he said, and he knew no other name for it. His experience had not led him to observe any other river. The general word river, therefore, was, in his acceptation of it, a proper name signifying an individual object. If this person had been carried to another river, would he not, says Dr. Smith, have readily called it a river? We can thus see how, in a primitive society, if any of the chance sounds of their first jargon came to be applied to a natural object, such as a certain mountain near by, or a cave in which they took shelter, that sound would come to have a general application wherever they became acquainted with another mountain or another cave. And, in point of fact, we have still in existence examples of such primitive applications. *Uisk*, the Celtic for water, is the original of the names of a vast number of rivers throughout the wide territories originally peopled by the Celts: for instance, the Esk in Scotland, the Ouse and Isis in England, the Ouse in Holland, the Aisch in Bavaria, the Esker in Turkey, and the Uska in Southern Russia.

Grammarians have been struck by the remarkable fact, that the imperative mood is in most languages the simple form of the verb. For instance, in Latin, the imperative moods of the verbs, *dicere*, to say, *sonare*, to sound, *vivere*, to live, are *dic*, *sona*, *vive*. When, in Latin, the syllable *bam* is added to the imperative, it forms, in an immense number of instances, the imperfect of the indicative: thus, *sona-bam*, I did sound; *vive-bam*, I did live. This has suggested to philosophical inquirers into the origin of language, that entreaties and commands, expressions of the necessities and unregulated passions of primitive men, were the first form of the verb which they used, and that all other forms proceeded from these. Some even go so far as to say that this form of the verb must have preceded the formation of names of things. It is, however, generally admitted, that names of objects or nouns, and verbs, or words expressive of the motion and state of being of objects, were most probably the parts of speech first formed; and next to these, propositions, or that class of words which define the motion of verbs and show the relation of objects. "The noun and verb," says an eminent writer, "had each its archetype in matter and motion; and the proposition that marked local relation, and the termination or auxiliary that denoted the tenses of a verb, had each its original in space and time long anterior to the appearance of man upon earth."

Words expressive of the physical qualities of objects would probably be next introduced. Then words expressive of the nature, manner, quality, or intensity of the motions of those objects. The latter class of words grammarians have named adverbs.

The social feelings must have speedily given rise to the possessive pronoun; for it is natural to suppose that men would early learn to say *my* father, *my* brother, *my* daughter. When division of property began to be instituted, the selfishness and acquisitiveness which form such active principles in human nature, would lead to the frequent use of the possessive pronoun, and to the odious distinction between "mine and thine" (*meum et tuum*), which will create so much disturbance amongst us.

When man began to compare the qualities of surrounding objects, and to form consecutive sentences, another set of words, called by grammarians conjunctions, would necessarily be introduced. The word conjunction is derived from *con*, with, and *jungo*, I join, because it joins sentences together.

Interjections, or words intended to rouse the attention of the hearer, or to express the excitement of the speaker, would be used in the very earliest stages of society. The article, or word which is used to point out the noun, was apparently the last part of speech which was added to language.

The words used by the primitive members of society seem to have been all simple and uncompounded. What we now call compound words were, in many instances, originally composed of two distinct words, which, in process of time, have become inseparably joined. The two words which were united to form a third, were definitions of the object designated. Analogy and order can be traced in the construction of most primitive words; and it is probable that no word was originally formed from mere caprice. Even proper names, which now seem so destitute of signification, were originally indicative of some circumstance respecting the individuals or nations whom they designated. Thus, the King of the Goths, who was engaged in the destruction of the Roman empire, derived his name (Alaric) from two words signifying *universal king*. The name Ariovistus is compounded of two words which mean *much honoured*. The names of nations, countries, rivers, lakes, and mountains, were originally compounded on the same principles; so that the proper names of localities in different countries still serve as a sign to indicate by what primitive race the regions so named were inhabited in past centuries.

Language, after being first concrete, and then meta phor'cal, became, in process of time, abstract. There are two kinds of metaphor which pervade all language. The first kind of metaphor is used when the name of any object, in which a particular quality predominates, is diverted from its original signification to denote a similar quality in some other noun. For instance, the name *fox* was applied to men noted for their craftiness. A king of England was called Cœur de Lion, that is, *heart of a lion*, on account of his courageous deeds. The same kind of metaphor is used when we speak of the "silver moon." All languages abound with similar expressions. When the natives of Otaheite first saw horses, they called them "mighty hogs." The French call potatoes *pommes de terre*, literally, "apples of the earth."

The other kind of metaphor is used when we adopt a term originally applied to some physical object to denote some metaphysical abstraction. It has been observed that a sort of natural analogy exists between what comes within the scope of the senses and the abstract conceptions of the mind. Hence the metaphors of all nations, in every stage of civilization, are similar. No nation has yet been known to call truth darkness, or error light. Among all tribes, the word heart has been used metaphorically to express affection, the word rock to denote security, and sleep to signify death.

When the primitive men, advancing from early necessities and simple tangible ideas, found it necessary to have words to represent the abstractions of the mind, they still proceeded according to the dictates and analogies of nature. We have some trace of the course which they followed, in the history of the words which have been used to express the immaterial part of man. They felt that there was something within their corporeal frames which gave these impulse and direction, and they naturally formed the idea that this something was of an incorporeal nature. They also felt in the wind a something possessing strength and force, but which was impalpable to the sight. The wind, therefore, became at once a fitting emblem to describe the immaterial principle or soul of man. Hence, the Latin *anima*, the soul, is derived from the Sanscrit *an*, the wind. The Greek *psyche*, the soul, is connected with, and probably derived from, *psychos*, cold air. The Greek *pneuma*, a spirit (whence pneumatology, mental science), is from *pneō*, to blow. Our word spirit is from *spiro*, to breathe or blow. The Hebrew word for spirit signifies air or breath. Our word ghost or ghaist, a spirit, is of Saxon origin, and the same with *gust*, a blast of wind. These things evidently are so by virtue of a law of the mind, causing it everywhere to form the same ideas respecting the same things, and everywhere to pursue the same line of operations under certain circumstances.

The first framers of language pursued a similar course whenever they wanted a word to express any conception of the mind. In all languages, every term expressive of mental operations is borrowed from the material world. Some of the terms thus applied are signally appropriate. For instance, the word reflection signifies, primarily, the throwing or bending back of light; but, when applied metaphorically, it signifies, says Locke, "the bending back of the mind to take a view of its own operations." The same may be said of the verb to ruminate, which, in its original acceptation, means the action of an animal in chewing the cud; but, metaphorically, it signifies the action of the mind in recalling and meditating upon the knowledge (or mental food) previously acquired. Adjectives are constantly and familiarly used in a metaphorical sense. Thus we say "a warm heart," "a superior mind;" the adjective superior is simply a derivative from the Latin adjective *superus*, high. Prepositions are frequently used to convey metaphysical ideas. The words *above*, *below*, *under*, *beneath*, were originally applied to express the relations of natural objects. The primitive members of society, perceiving that the rain and the sunshine, the thunder and the lightning, proceeded from *above*, probably applied words synonymous with *above* to express what they admired and venerated in mental character. As *below* is the opposite to *above*, their ideas of what is degraded and vicious were expressed by terms synonymous with *below*; hence those common phrases—"he is *above* deception," she is *under* a mistake."

In the present stage of language we have become so habituated to the use of terms applied metaphorically, that we seldom reflect on their original import. There are many instances in which the metaphorical word remains, when its primary signification has been forgotten. For instance, the word *capricious* does not suggest the idea of a goat, although it is derived from the Latin *caper*, a goat, to denote the character of a person who bounds from subject to subject, without paying due attention to any; like a goat, which bounds from rock to rock, without settling long in any one spot.

During one period of the world's history, the only language may be said to have been that of metaphor. History, religion, systems of philosophy and of morality, were all wrapt up in allegory and metaphor. This is still peculiarly the language of the Eastern nations; perhaps it is mainly attributable to their imaginative and poetic temperament. The language of poetry, in every clime, is almost exclusively that of metaphor.

DIVERGENCE OF LANGUAGE.

The remarkable divergence in the languages of different nations is in part attributable to the following causes:—First, it is an ascertained fact, that few languages have any claim to be considered as the primitive dialect of any one race. Most languages afford indisputable traces of having been derived from some other language. Like many well-known operations in chemistry, by which the union of two or more substances produces a compound different in its properties and in its appearance from any one of its constituent parts, so, in many instances, several languages have contributed to form a new language, differing in its structure according to the proportion in which its constituent elements have been combined, and yet possessing distinctive characteristics of its own. These characteristics frequently vary according to slight peculiarities in the anatomical structure of the vocal organs of the individuals by whom it is spoken. It is well known that many people find it difficult, and in some cases impossible to pronounce certain consonants. A foreigner has great difficulty in articulating the English *th* in such words as thine, thee, and that. The English, on the other hand, seldom succeed in giving the right pronunciation to the guttural sound *ch*, which is of such frequent occurrence in the German language, and which is daily pronounced by the natives of Scotland, in such words as loch, light, and many others. Many persons are said to *lisp*, because they cannot pronounce the sound *sh*. The Ephraimites forfeited their lives from their incapacity of pronouncing this sound. If the Greeks had been at the fords of Jordan, they would likewise have found themselves in a similar predicament, for the syllable *sh* does not occur in the Greek language. The word *shibboleth* means an ear of corn, and in the Septuagint it is rendered by the word σταχυς (*stachus*), which in Greek has the same signification as the Hebrew shibboleth; but no Greek word could be found to express the sound *sh*; therefore in the Septuagint the narrative is imperfect. The natives of Otaheite could not be taught to say Captain Cook. They always called him *Toptum Toot*. The letter *c* does not occur in their alphabet.

It is impossible, at this distance of time, to calculate the amount of influence which this incapacity of articulating certain sounds must have had during the first periods of the world's history, in occasioning the present divergences of languages. It is a matter of daily observation, that children have great difficulty in articulating certain sounds every child has some particular way at first of pronouncing certain consonants, and uniformly exhibits the same peculiarity in the pronunciation of all words in which those particular consonants occur. Might not the dispersing children of a primitive society in this manner have carried away varieties of pronunciation, to be in time modified so far that resemblance was nearly or entirely lost? It seems natural to some men to sink certain consonants and to substitute others; this is particularly the case with those letters which have an organic affinity; thus, the Hebrew name *David* is in Greek *Dabid*. The Celtic word *pen* signifies an elevation; hence, the mountains which traverse Italy from north to south are called the *Apennines*. But the consonants which compose the word *pen* vary in different languages. Thus, in Scotland, we find the letter *p* converted into *b* in the names of mountains, as *Ben* Lomond, *Ben* Lawers, and *Ben* Nevis. In Spain, the consonants *p* and *n* are retained, but *g* is inserted; thus, in Biscay, there is a mountain called *Pegna* Cerrada, and another in Leon is called *Pegna* de San Romano. The Celtic word still retained in the Welsh language for a flow of water is *auon*: there are eight familiar instances in which the *u* in this word has been changed into *v*; for the name given to four different rivers in Wales, and to four in England, is *Avon*. Londoners make a constant practice of substituting *v* for *w* and *w* for *v*.

It seems natural, also, to sink one part of a word and to retain another. Instances of these abbreviations are very frequent. Thus the monosyllable *priest* is derived from the Greek πρεσβύτερος (*presbuterŏs*). The words *church* and *kirk* both come from the two words κυρίου οἶκος (*kuriŏu oĭkŏs*), literally, "the house of the Lord." The word *deacon* is derived from a word of four syllables, διάκονος (*di-ak-o-nos*). From the Greek word γάλακτος (*galaktos*), milk, the following words have sprung:—

Lacte in Latin.	*Leche* in Spanish.
Latte ·· Italian.	*Llaeth* ·· Welsh.
Leite ·· Portuguese.	*Lait* ·· French.

In all these words the first syllable of the original is omitted, and only part of the remaining syllables retained.

The principal sounds in a word are frequently transposed. The natives of Somersetshire, for instance, always say *claps* instead of clasp, *ups* instead of asp, *birsh* instead of brush. The word *garnet* is derived from the Latin *granatus*, and *purpose* from *propositus*. False orthography may also have been the cause of some variations in languages. A few centuries ago, it was considered marvellous when a gentleman or lady could either read or write. Du Guesclin, Constable of France, who died towards the close of the fourteenth century, could not sign his own name. During these periods of ignorance, many changes must have been made in the methods of spelling, and consequently of pronouncing words. Inattention and the love of novelty may also be assigned as causes of many divergences in languages.

A dialect is now in the process of formation in the West Indies, which has greatly attracted the attention of philologists, because it develops the principle upon which all languages at present existing are presumed to have been formed. It is called the *Talkee-talkee*, or Negro dialect. Its basis is the modern English, with which it combines many Dutch, Portuguese, and Spanish phrases. When a Negro attempts to speak English, he finds a difficulty in pronouncing the sound *th*, and substitutes *d*; he introduces vowels, even where they do not properly occur; and softens the language by omitting the harsh consonants, frequently substituting liquid ones. All these peculiarities are of course found in this new language; for instance, *drie* is three in Talkee-talkee; *dem* is them; *bakka* is back; *holi* is hold; *bruiloft* is bridal; *wilni* is wine; *morro* is more. The language still retains so much English, that our countrymen in the colonies can generally understand it. A version of the Scriptures in this language has been issued by the Bible Society. Many objections were made to this version. Those who contemplated the future emancipation of the Negro, contended that, by giving stability to a mere barbarous and fluctuating jargon, it was shutting up the avenue to future improvement; and that, though it might be advantageous to place the Scriptures within the comprehension of the Negro, yet that this version would render all the literature of England and of the world inaccessible to him, unless it could be possible to convey it in the barbarous Talkee-talkee. Time only can show whether the Talkee-talkee is destined to hold a higher place than it does at present in the scale of languages. A period might be mentioned when the English language was in a similar state of dissonance and incongruity. It is, as we shall hereafter require to mention, composed, like the Talkee-talkee, of a heterogeneous medley of languages; but its jarring elements are now amalgamated, and it is universally admitted to be one of the most polished languages of the world.

The political history and government of a country have considerable influence upon its language. In an enlightened community, in which a judicious attention is paid to the elementary education of the whole people on a uniform plan, varieties of dialect must in time almost cease, and a common style of speech be used. But where little attention is paid to this subject, or where no uniform principle is pursued, all kinds of jargons and dialects will abound. Great Britain is at present in the latter condition; the dialects of Yorkshire, Lancashire, Somersetshire, Cornwall, and some other counties, bear little resemblance to a pure English speech. A uniform system of education, communicated by teachers sent forth from a central institution, along with a greater intercourse by means of travelling, might be expected in time to eradicate this unseemly diversity.

CLASSIFICATION AND ANALOGIES OF LANGUAGES.

We are mainly indebted to the German critics for whatever advance may have been made in the comparative study of languages. Adelung, a German, was among the first who awakened the attention of Europe to this important study, and he has been followed by his countrymen Grimm, Bopp, and others whom it is needless to mention. It appears that the result of an extensive study of languages, is the conviction that two sorts of analogy prevail among them: first, a resemblance in words; and, secondly, in grammatical structure. Three different grammatical systems seem to prevail among languages; that is to say, the formation of parts of speech, and of the inflections from the primitives of the language, may be effected in three different ways—namely, first, by changes in the letters which compose the roots; second, by the addition of formative syllables to the root; and, third, by the use of separate words, instead of inflecting the roots. Which of these systems is the most ancient, is a question which has created much dispute. Humboldt, Bopp, and also Adam Smith, contend that the second method was the first adopted. It appears, from the history of languages, that, with the remarkable exception of the Chinese, in which the relations of syntax supply the place of inflected words, a gradual progress of simplification has been going on in all languages. Thus the Greek and most of the Oriental languages have a passive form of the verb, inflected cases of the noun, and a dual form. The Latin, which probably was partly derived from the Greek, retained the passive verb and inflected declensions, but rejected the dual form. The Italian and French, which were derived from the Latin, rejected both the passive form of the verb and the inflected cases of the noun. The remaining step of simplification was, to substitute the natural distinctions of gender for those previously in use, which were formed on arbitrary principles, depending chiefly on the termination, and to do away with the necessity of making the adjective agree with the noun in gender and number. This was effected by the English. The whole history of this process reminds us of that of many mechanical inventions, which at first were complex in the extreme, but which by degrees were made to part first with one unnecessary wheel, and then with another, thus becoming more and more simple in their structure, and perhaps more available for the purposes for which they were designed. As grammatical systems are thus found to vary in process of time, and in languages, too, which are evidently derived from the same root, languages are classified more with regard to their vocabulary than according to the structure of their grammar. In the best systems of classification, particular attention has been paid to the agreement in sound of those words which are used in the first stages of society. When terms expressive of hunger, thirst, the sun, moon, stars, are found nearly alike in several languages, it is apparent that the nations by which they are used belonged, in bygone centuries, to the same tribe, and migrated from the same district. The study of languages often enables us to trace the origin of nations, when all other avenues of information are lost in obscurity and fable, and it is hence, in other words, the study of man's history.

The number of languages and dialects, ancient and modern, has been computed by Adelung to be 3064: namely—

Belonging to Asia	987
.. .. Europe	587
.. .. Africa	276
.. .. America	1214
Total	3064

It would take more space than our limits permit, to give a tabular view of all languages: the following summary contains the principal families, and the classes in which they are generally placed:—

I. *Monosyllabic Class.*—Chinese, Siamese, Avanese, Japanese.

II. *Shemetic* or *Semetic Class.*—Aræmean (Chaldee Syriac), Hebrew, Phœnician, Arabic.

III. *Indo-European* or *Indo-Germanic Class.*—Sanscrit, Celtic, Teutonic or Gothic, Pelasgic or Greco-Latin, Sclavonic, Hungarian, Tartarian or Turkish.

IV. The *Polynesian Class*, consisting of the dialects spoken in the Indian archipelago and islands of the South Seas.

V. The *African Class.*—Remains of the ancient Lybian in the north; Soosoo and Foulah (between the rivers Senegal and Gambia); Ashantee: Amaaric, spoken in parts of Abyssinia; Hottentot, in the south; Caffre, extending from the south along the east coast as far as Delagoa Bay.

VI. *Polysynthetic Class*, extending from north to south of both continents of America, and comprising Chilian, Peruvian, Brazilian, Mexican, Western dialects of North America, Boreal dialects of North America, &c.

The contrast between the first and the last of these classes, presents an apparent anomaly. The Chinese languages have existed among a polished people from very remote antiquity, and yet are as rude and simple as if they had been just devised for the use of a nation but recently emerged from barbarism; whereas the languages in common use among the wild tribes of America, are complex and difficult in their structure, and seem as if they had been invented by a people who had made great advances in civilization. It has consequently been surmised that America was at one time the residence of a civilized people, of whom the Indian tribes are the degenerated remains.

WRITTEN LANGUAGE.

The first origin of written language may be traced to a desire, apparently natural to man, to perpetuate a record of his actions, thoughts, and feelings, beyond the narrow span of his own existence: he knows that the past is no longer his, that the present is fast fleeting away, and therefore he seeks to be in some way connected with the future. Even savages devise means of transmitting to their children's children a record of themselves. The American Indians at this day carve upon the handles of their tomahawks figures of warriors without heads, to denote how many of their enemies they have scalped. The Mexican picture-writing appears to have been equally simple. When the Spaniards first invaded Mexico, the natives painted an exact representation of the Spanish ships upon cloth, which they sent as expresses to their emperor, Montezuma. The records of their empire were delineated in the same manner. A conquered town was represented by a house, generally with some emblem annexed, to show what particular town was meant. Some of these paintings, which may well be considered as the most curious specimens of art which have yet been discovered in America, are carefully preserved in the Bodleian Library at Oxford. The representation of natural objects seems to have been the first step which was taken in the art of writing. The next step was probably the delineation of invisible ideas by symbolic representations: such, for instance, as *strength*, which was represented by the figure of a lion, on account of the great strength of that animal. As civilization advanced, more time was devoted to writing, and it was then discovered that part of an object would represent an idea as well as the whole. Thus, a sceptre was made to represent a king. Smoke ascending, symbolized fire. A battle was represented by two hands, one holding a bow and the other a shield. By degrees, these signs became conventional; that is to say, it became a matter of agreement that certain ideas should be represented by certain signs. This kind of symbolic writing was much in use among the Egyptians. It has been proved by Champollion, who devoted twenty years to the investigation of the subject, that the symbolic characters which they used were limited to 864, which he has arranged under the following eighteen classes:

Celestial bodies	10
Human figures in various positions	120
Human limbs taken separately	60
Wild quadrupeds	24
Domestic quadrupeds	19
Limbs of animals	[illegible]
Birds either whole or in parts	50
Fishes	10
Reptiles either whole or in parts	30
Insects	14
Vegetables, flowers, and fruits	60
Buildings	24
Furniture	100
Coverings for feet and legs, head-dresses, weapons, ornaments, and sceptres	80
Tools and instruments	150
Vases and cups	30
Geometrical figures	20
Fantastic forms	50
Total	864

The reason of this limitation is very obvious. As all natural objects might be used as symbols, the number of characters might have been multiplied *ad infinitum*, unless regulations had been made to restrict the number. By degrees, as these characters became universally known as fixed and permanent signs of the ideas they represented, less trouble was taken in their accurate delineation, so that they were made less like the visible object of which they were originally the image. At length, all traces of resemblance were lost, but the character, in its abridged and mutilated form, still continued to be conventionally recognised as the sign of the same idea of which it was originally the symbol. This is the exact state in which the written language of China now stands. The elementary Chinese characters are 214 in number, and are called *keys*. These keys are merely formed by the various combinations of six straight and variously curved lines. From these keys, the other characters, which are generally reckoned to be 80,000 in number, are formed. Each character represents, not a letter but a word; and though the characters have now no resemblance to any particular object, yet there is little doubt that, at some remote period, they were, like the ancient Egyptian hieroglyphics, accurate transcripts of some objects in nature.

Much labour has lately been bestowed upon the study of the Egyptian writing, particularly by Young and Champollion. It appears that three kinds of writing were common among the Egyptians.

I. The HIEROGLYPHIC, so called from ἱερος (*hièrŏs*), "sacred," and γλυφω (*gluphō*), "I carve," because it was at first believed that this kind of writing was intelligible only to the priests. It consisted of the images of visible objects, and was chiefly used in monumental inscriptions.

II. HIERATIC, also from ἱερος (*hièrŏs*), "holy," because used by the priests. Some of the manuscripts which have been found attached to mummies, consist of this kind of writing, which was merely the rude outline of images.

III. DEMOTIC, so called from δημοτικος (*dēmotikos*), "of the people," because it was in common use. It was also called *epistolographic*. Another name for it is *enchorial*, from εγχωριος (*egchoriŏs*), "of the country," because the characters were different from those of Greece. This kind of writing was a still further reduction or simplification of the others, approaching very nearly to the Chinese method.

Nothing was known in Europe respecting the meaning of the Egyptian writing, until the French, in digging a fort at Rosetta, found an irregular block of basalt. This stone, which is smooth on one side, has three inscriptions; one in hieroglyphics, the second in enchorial or demotic characters, and the third in Greek. The Greek inscription concludes with the information, that the decree it contains was to be engraved in three different characters; namely, in the sacred letters, in the letters of the country, and in the Greek. Profiting by this information, M. Champollion succeeded, by means of the Greek, in deciphering part of the other inscriptions. Other documents have recently thrown more light upon the meaning of Egyptian writings; but the Rosetta stone is still justly considered to have been the key to the whole mystery.

By degrees, as knowledge increased, and as writing became more and more resorted to, it was discovered that the labour would be greatly diminished by making each symbol represent, not a word or idea, but a simple elemental sound. This increased the number of characters in one word, and at the same time greatly diminished the number in the language; for previously only one character had represented a word, and for each word there was a distinct character; but by this arrangement the elemental sounds of the language were analyzed, and a particular character appropriated to each. This is the origin of alphabetic writing. The Hebrew is evidently the connecting link between the symbolic and the alphabetic modes of writing. It appears that each character, like the Chinese, originally represented a word. Tradition ascribes a meaning to each letter, as is shown in the following table; these words are now obsolete, and are not to be found in any lexicon:

HEBREW LETTERS	NAME.	MEANING.
א	Aleph.	Ox.
ב	Beth.	House.
ג	Gimel.	Camel.
ד	Daleth.	Hollow.
ה	He.	Hook.
ו	Vau.	Armour.
ז	Zayin.	Travelling scrip.
ח	Cheth.	Serpent.

This table might be extended throughout the whole Hebrew alphabet, but the foregoing examples will suffice to show the transition from the symbolic or hieroglyphic to our present system of alphabetic writing.

The similarity in the names and original signification of some of the Greek characters, proves that they were derived either from the Hebrew or from some of the cognate dialects. The most ancient method of reading and writing among the Greeks was that called βουστροφηδον (*bŏustrŏphēdŏn*), "ploughed by oxen," because the custom was to read backwards and forwards, in the same way that an ox draws the plough: thus, one line was read from right to left, and the next from left to right. Cadmus introduced from the East only sixteen letters, and it has long been a matter of conjecture as to when the other characters were added. The invention of four additional letters is ascribed to Palamedes, about 1164 years B. C.

The art of writing seems to have been known at a very early period, but after all the researches that have been made, it is not yet possible to say with certainty to what nation we owe the invention of this useful art; so that the poet's question still remains unsolved—

> "Whence did the wondrous mystic art arise
> Of painting speech and speaking to the eyes?
> That we by tracing magic lines are taught
> How to embody and to colour thought."

Inscriptions, of which it is impossible to fix the date, have been found at Babylon and at Persepolis, which have created much conjecture among the learned. The characters found at both places seem to be essentially the same, making due allowance for the difference of the material; the Persepolitan characters being finely sculptured on marble, while the Babylonian are rudely carved upon bricks. They are commonly known by the name of the *arrow-shaped* characters, on account of their general resemblance to arrow-heads.

The art of writing must have been discovered before the Israelites left Egypt, which was B. C. 1491, because, in the history of their journey through the wilderness, many allusions are made to writing, as if it were an art well known to them. See Exodus xvii. 14—"Write this for a memorial in a book," &c. Also, Deuteronomy chap. vi. 9; xi. 20; xvii. 18; xxiv. 1; xxvii. 3, 8. It is an established fact that Moses wrote a great part of the Pentateuch himself. Many have supposed that the book of Job was written at a still earlier period. The characters used by the Jews before the Babylonish captivity were those which we now call the Samaritan. This appears to have been the case, from some coins which were struck before the revolt of the ten tribes, of which the inscriptions are in Samaritan characters. While the Jews were in Babylon, they became accustomed to use the characters of that empire, so that their own, from disuse, became partially forgotten. It was on this account that Ezra copied out the books of the law into the square letters of the Chaldees. These are the characters which constitute what we call the *Hebrew* alphabet.

It is very difficult to ascertain at what period alphabetical writing was first practised in Europe. We are told that Cadmus introduced it into Greece about 1519 years B. C.; but it has been conjectured that it was previously known to some of the other European nations. Odin, or Woden, who lived at so remote a period that his history is almost lost in fable, is said to have introduced the Runic alphabet into Scandanavia. Tradition relates that he brought it from the East. It contained only sixteen letters, which seems to have been the number of all the primitive alphabets. The Runic characters were used by all the Gothic nations, and were applied by the priests or bards to magical incantations. They pretended to have, by means of these characters, the powe of "calling down the moon and stars from heaven, or arresting the course of the most rapid rivers, of quenching fire, of bursting asunder the gates of death, and of calling departed spirits from the deep." After the introduction of Christianity, many attempts were made to prevent the use of these characters, which had gradually become perverted to the worst of purposes. They were ordered to be suppressed by the council of Toledo in the year 1116.

There is a striking resemblance between the Welsh and the Runic alphabets. They were both evidently contrived for a people who had no materials or implements for writing but wood and a pointed flint or stone. The early events of history in England were recorded in songs by the bards or Druids, and thus handed down from father to son. Various inscriptions have been found in Ireland, which prove that the Irish were in possession of the art of writing at an earlier period than is generally supposed. Like the Romans, who, at an early period of their history, wrote upon wood, the Irish made use of the wood of the beech; hence the letters themselves received the name of *Feadha* or woods. Besides the alphabet in common use, the Irish had an occult form of writing, called *Ogam* or *Ogma*, apparently of very high antiquity. The derivation of the term *ogam* was long unknown; it has but very lately been discovered that it is a primitive Celtic word signifying the *secret of letters*. There are some letters still carefully preserved in the Harleian Library, written in these occult characters by Charles I. to the Earl of Glamorgan. The alphabet is formed of a perpendicular line, from whence lateral scratches diverge to the right and left. These scratches are never more than five on each side, answering to the number of fingers. They are very similar to those found in Egypt by Mr. Hammer, and to those which were used by the Manchew Tartars. It has been conjectured that this alphabet was originally used by the Chinese, who still write from top to bottom. The method of communication called the *Quipoz*, used by the Peruvians, was by knotted cords, each knot representing an idea or sound. The invention of printing, which took place about the middle of the fifteenth century, forms quite a new era in the history of language and of man. It is utterly impossible to estimate the effects of this invention in the diffusion of knowledge and in the development of the human mind. A written language has been devised also for the blind. The alphabet consists of embossed letters. Sometimes the Roman characters are used, but more frequently, perhaps, different modifications of triangles are found available. The sense of touch is made to compensate for the loss of sight; the idea is conveyed almost instantaneously from the written sign to the mind by the medium of the hand, and thus a vast accession of pleasure and of consolation is obtained by this afflicted portion of our race. There is another kind of writing well known in England called *stenography*, from στενος (*stenos*), "short," and γραφω (*graphô*), "I write;" it is designed to lessen the labour of writing by substituting more quickly formed characters for those in general use. Another art has lately been added to the various forms of abbreviated writing, which seems far more available than any which have hitherto been invented. It is called *phonography*, or, literally, *writing by sound*—that is, writing each word exactly as it is pronounced. It does away altogether with the tedious method of spelling, for it has distinct signs for all the sounds of the human voice. It is applicable to all languages. We have before us a book containing part of the Scriptures in English, French, German, Chinese, and Hebrew, all written in the phonographic character. Nothing has yet been invented which comes so near to the "universal character" so much desired by Bishop Wilkins. If generally introduced, it would be a very valuable acquisition to the deaf and dumb, enabling them to express their thoughts with almost as much rapidity as we can do by speech.

MONOSYLLABIC CLASS OF LANGUAGES.

The name given to this class arises from the circumstance, that every word in the languages strictly belonging to it consists only of one syllable. To express a complex idea, two of these syllables are put together, in the same way that we say, in English, *book-case*, *snuff-box*. The Chinese language, although consisting of very few radical words, appears extremely difficult to a European, on account of the different meaning given to each word by the various inflections of the voice. One word is often susceptible of five distinct meanings, according to the tone of voice in which it is uttered; so that, though there are only 328 primitives, these different intonations of voice greatly augment the number of words. It would require the labour of a whole life to become acquainted with all the words in the language, but those which are in common use are comparatively of easy acquirement. All that is required of their mandarins, or learned men, is merely to be able to read and write 2000 of their characters. The language of China has continued in a stationary state for many centuries. This may be ascribed not only to their confined and isolated position, secluded by a jealous policy from intercourse with other nations, but also to the early introduction of a singular sect among them, who inculcate that total quietism or inactivity is the only way to perfection. Another sect taught that "the nearer they approached to the perfect inaction of inanimate bodies, the more they resembled the Deity." Taking into account the influence of these pernicious maxims, and the tyrannical despotism of the government, it ceases to be a matter of surprise that the language of China should, century after century, remain unchanged and unimproved. There is no doubt but that the Chinese, at some very remote period, had intercourse with the Egyptians; this seems evident from the affinity between the written languages of the two nations. There are several reasons which might lead us to suppose that the Chinese and Egyptians originally constituted but one people; but this a subject which is much involved in conjecture. Ethnography, or the study of nations and languages, may almost be said to be yet in its infancy. As the science advances, more light will no doubt be thrown upon this most interesting subject. An analogy has already been traced between the pronominal affixes and suffixes of the Coptic or modern Egyptian and those of the Hebrew. An affinity has also been found to exist between some of the Chinese and Hebrew characters. Perhaps it may be proved that the Hebrew is a connecting link between the Chinese and Egyptian languages.

THE SHEMETIC CLASS OF LANGUAGES.

This class is usually divided into three principal branches—namely, the Aramean, the Hebrew, and the Arabic. The Median or Persian is by many classed among the Indo-European languages; but its close connection with the Arabic seems to justify its being placed in the Shemetic class. Chardin relates that the Persians study the Arabic grammar and syntax in order to make themselves acquainted with their own language; the only difference between the construction of the two languages being, that the Persians have no dual form.

Of all the Shemetic languages, the Arabic is the most widely extended. It is still the vulgar language in Egypt, Lybia, the shores of Africa, as well as in Arabia and Palestine. In Turkey, Armenia, Mesopotamia, Persia, India, and Tartary, it is extensively cultivated, and used as the vehicle of communication between different nations. Most of the other Shemetic dialects are either extinct or spoken in districts of small extent. The structure of all the Shemetic languages is very simple. They are written from right to left. Their grammatical connections are formed by prefixes and suffixes. They have no form of comparison. The nouns have two genders; no terminations or inflexions of case; but a peculiar form called the *construct*, for expressing the relation of the possessive or genitive case. Most of the radical words consist of three letters forming two syllables, though some consist of only two letters. The words are generally short, and the compounds inartificial.

The Hebrew is distinguished for its simplicity, purity, and energy. The verb is in this language the most important part of speech, and the root of most of the others. In all the western languages, such verbs as *jacère*, to throw, and *jacēre*, to lie, form separate and distinct conjugations. But in Hebrew, verbs thus connected in signification are also connected in the method of conjugation, and are regularly and analogically conjugated by varying one of the vowels or by doubling or adding letters. The inflexion of the personal pronoun, for expressing the relation of case, is also different from the inflexions of pronouns in any of the Indo-European languages. The personal pronoun never occurs as a separate word, except in the nominative case; thus, אֲנִי (*ani*) signifies I, and הוּא (*hu*) he; but to express the genitive, or other oblique cases, fragments of these pronouns are subjoined to the noun or verb, so as to form but one word; for instance, דָּבָר (*davar*) signifies a word, and דְּבָרִי (*dèvari*) my word; קָטַלְתִּי (*katalti*) signifies I have killed, and קְטַלְתִּיהוּ (*kètaltihu*) I have killed him.

When Hebrew ceased to be a spoken language, the correct mode of pronunciation was gradually forgotten. To remedy this inconvenience, the vowel points were invented, which are merely strokes or dots placed beneath the consonants, to denote what vowel sound is to be combined with the consonants under which they stand. The antiquity of the vowel points has created much dispute; but it is generally supposed that they were invented by the Jewish rabbins about five or six hundred years after Christ.

No writings in pure Hebrew are extant except the Bible. The modern or rabbinical Hebrew is so much compounded with other languages, that it has become quite a new dialect. The Chaldee language was closely allied to the Hebrew, and was early introduced into Babylon. There are 268 verses of pure Chaldee in the Bible. The ancient Syriac was another cognate dialect, and is still cultivated by the Nestorian and Maronite Christians in the East. The ancient language of Ethiopia, or, as it is now called, Abyssinia, was Chaldee. The Arabic may in some respects be called a copious language. It has 500 names for a lion, 200 for a serpent, 1000 for a sword. The multitude of synonymous words renders it so difficult, that Mahomet pretended that he had been taught by the angel Gabriel the language of Ishmael. There are many Arabic idioms in the book of Job. The country in which Job lived, if not included in Arabia, was situated on its very borders; and his three friends were Arabian. It is scarcely possible to comprehend the depth of meaning in the book of Job without a knowledge of Arabic. The language of Arabia has been much corrupted since the Koran was written, by admixture with other tongues. The unconquered tribes among the high lands of Yemen preserve it in the greatest purity, because they have had less intercourse with strangers. The language of the Koran is taught in colleges at Mecca with the same care that Latin is taught at Rome. It is now, in fact, the learned tongue of the country. The ancient Persian language was divided into two branches—Deri, which was spoken at court, and Pahlavi, the language of the learned. There was, besides, a third dialect, but so obscure and abstruse, that it was accessible only to priests and philosophers: only one book was written in this dialect: it consists of religious precepts; the letters in it are called *zend*, and the language *avesta*. Of all the Persian dialects the Deri was the most soft and harmonious; so that it became a common saying, "that God delivered his stern commands in the rapid accents of Arabic, and his milder mandates in the delicate accents of the Deri." The modern Persian is very different from the ancient, and the Arabic characters are now generally adopted.

Such were the principal languages of the Shemetic class. They all agree in grammatical structure, and in a remarkable stiffness of construction, arising from the want of particles and of forms for expressing the various relations of things. They had not sufficient scope to admit of much philosophical or metaphysical reasoning. The character of a people, as well as their literature, may be always inferred from the genius of their language; for language is but a mirror in which the ideas of the soul are reflected and made visible. Therefore, as might be expected from their language, the Shemetic nations made few advances in mathematical or philosophical science. Their attainments in the liberal arts were but limited, and they made few valuable discoveries. The invention of letters has been attributed to the Phœnicians; but this rests on very doubtful authority, and all that now remains of their language is the inscriptions on a few coins. The science of astronomy has, in the same way, been supposed to have originated with the Chaldeans; but it is evident, from all their writings, that their notions on this subject were very obscure and confused. For instance, they thought that the shape of the earth was that of a boat, and that, when all the planets meet in Cancer, it will be destroyed by fire; and when they meet in Capricorn, it will be swept away by an inundation. Several books were written about the time of the Christian era, which, the authors pretended, were the production of the ancient Chaldeans and Persians; and as it is not always very easy to detect the forgery, much caution is requisite in investigating the subject. The writings of the ancient Shemetic family, which are known to be genuine, contain but little real philosophy. The object of the so-called wise men among them was to excite wonder rather than to disseminate the truth. The little they knew was imparted only to the few, and concealed from the vulgar by studied mysticism of language.

THE INDO-EUROPEAN CLASS OF LANGUAGES.

The languages belonging to this class are spoken in the greater part of Europe and in part of Asia—from the island of Ceylon to the shores of Iceland. They still form a connecting link between nations who now resemble each other but little in form or colour, and whose religion, government, and institutions are widely different. The Sanscrit is one of the most ancient of languages. Its name imports the *language of perfection*. It contains the roots of the Latin, Greek, Celtic, German, and Slavonic languages. It is more easy in this language than in any other to analyze compound words, and reduce them to their primitive radicals. It contains many compound words; some consists of no less than twenty syllables. The grammar is complex and difficult. There are, as in Hebrew, Chaldee, Arabic, and Greek, three numbers—singular, dual, and plural. A distinguished scholar, Sir William Jones, has said, that "Sanscrit is more copious than the Latin, more perfect than the Greek, and more exquisitely refined than either; yet that it bears to each of them a stronger affinity, both in the roots of verbs and in the form of grammar, than could possibly have been produced by accicient." It appears that Sanscrit was once the current language of India; now, it is shut up in the libraries of the brahmins or priests of the country, invested with mysterious sanctity, and used alone for religious purposes. It is cultivated only by the learned, so that it now takes its place among the dead languages. The names of objects in all primitive languages are descriptive and often highly poetical. This is eminently the case in Sanscrit. The name given to

A frog, - -	signifies, literally,	The leaper.
An elephant, -	.. .	The handy one.
A bee, - -	.. ..	The flower-drinker.
A bird, - -	.. ..	The frequenter of the sky.
A serpent, -	.. ..	The mover on his breast.
Rice, - -	.. ..	Tuft-growing.
A cloud, -	.. ..	Water-giver.*

Another respect in which the Sanscrit closely resembles the Greek, is in the use of the *a* privitive. Thus, *cartum* signifies *to do*, but *acarm* signifies *a crime*, or, literally, that which should *not* be done. Almost all the languages which are spoken in India, are merely dialects of the Sanscrit, and immediately derived from it. The Sanscrit family is therefore a very large one. The dialect called Bali, or *Magudha*, that is *mixed*, is spoken beyond the Ganges; Bengalee is spoken in and about Calcutta; the Hindee or Hinduvee, about Agra; Hindustanee prevails in Lower Hindostan. The Afghan dialect contains more Hebrew words than any of the above. A Persian tradition relates, that the Afghans came from the north about two thousand years ago, and that they are the descendants of King Saul. The Multan dialect, which is spoken to the north of Sindh, contains a great many Persian words and idioms. The language spoken among the Gipsies approximates more to this dialect of the Sanscrit than to any other; so that it is probable they originally emigrated from this part of Asia. They are known in various countries by the name of Bohemians, Gitanos, Zigani, &c.; but in every part of the world, they invariably style themselves and their dialect *Romany*, from a word signifying husband. The Celtic family is also of Asiatic origin. Europe has been successively occupied by different tides of population, which poured in from the East. The Celts appear to have been the first settlers in Europe. They were compelled to move more and more westward, to make room for the other Asiatic tribes who successively invaded Europe. The Celts, or Celtæ, as they were then called, thus irresistibly impelled westward, at length reached Gaul, whence they are supposed to have crossed the sea to Britain, whose first inhabitants they are believed to have been. If this was the case, the first language spoken there was, of course, the Celtic. The Celtæ were not allowed, however, to remain in quiet possession of Britain; the successive invasions of the Romans, Saxons, and Danes, drove them to the north and western parts of the island, where their descendants are still found, and where dialects of their language are still spoken. The Celtic language now comprises the following dialects:—1. Gaelic, spoken in the Highlands of Scotland; 2. Erse or Irish, spoken in Ireland; 3. Welsh, spoken in Wales; 4. Manks, spoken in Isle of Man; 5. Cornish, spoken in Cornwall; 6. Armorican, spoken in Bretagne or Brittany. History affirms that, at a very early period, the Phœnicians traded with the first inhabitants of Britain for tin. If this be true, it may account, in some degree, for the words of Eastern origin which exist in the Celtic dialects. The affinity, however, which they still retain to the Sanscrit, although their structure has been considerably altered by the lapse of centuries, clearly proves them to be of cognate origin.

It is not known exactly at what period the Celtæ became first settled in Ireland. The Highlanders of Scotland are descended from a colony of these Irish Celts, who, about the beginning of the sixth century, migrated to the west of Scotland, bringing with them the dialect of the Celtic which was then spoken in Ireland, and the name of Scuite or Scots.

The Welsh, Cornish, and Armorican dialects, are formed from that branch of the Celtic family which was called the Cymbric. The frequent changes of the initial letters of the radical words, in the formation of cases and numbers, are the characteristics of all the Celtic dialects. In Welsh, there are nine mutable initial letters, called *literæ umbratiles*, from the Latin *umbra*, a shadow, because they change and vanish like a shadow: for instance, *tâd* is father, *ei thâd* is her father; *ei dâd* his father; and *fy nhâd*, my father. *M* also is frequently converted into *f*; this *mam* is mother, and *ei fam*, his mother.

The Basque language is a dialect of the old Spanish or Iberian. It is spoken in Biscay and Navarre in Spain, and in Lower Navarre and Soule in France. In some words it resembles the Celtic family; thus, father is *aita* in the Basque, and in Irish *aidir*. The celebrated traveller Humboldt affirmed that he discovered a strong resemblance between the Basque language and that of the American Indians.

The Teutonic or Gothic Family.

The second tide of population which poured into Europe from the East, consisted of the Germanic tribes: they are generally called the Teutons, or Goths, in history. In this family we are more especially interested, as it is from the Teutonic branch that the principal portion of the present inhabitants of Great Britain are descended

The languages of the Gothic tribes parted into two main branches. The *first*, called the GERMAN or TEUTONIC BRANCH, gave rise to two sub-branches—from one of which originated the Anglo-Saxon, Friesic, and Old Saxon; from the Anglo-Saxon came the modern English, and from the Friesic and old Saxon came the Low German or Dutch, and the Flemish, spoken in Belgium. From the other sub-branch sprang the Mœso-Gothic, the Alemannic and Frankic; and from a union of these three originated the High Dutch or German proper. The *second* great branch is comprehensively called the SCANDINAVIAN. It was the language of the ancient Scandinavians, spoken in Denmark, Norway, Sweden, Iceland, Greenland, Feroes, and the Shetland and Orkney Islands. From it have sprung two distinct branches, one of which is the modern Icelandic, and the other is that comprehending the modern Danish, Swedish, Norwegian, and the dialect called Lowland Scotch.

German Language.—The *Hoch Deutsch*, or, as it is called by us, the German language, is spoken in the various countries on the Upper Rhine (Baden, Nassau, and many other states), in Prussia, Austria, part of Switzerland, and various countries on the Baltic, including part of Russia. To an Englishman it appears harsh, and at first very disagreeable; but it improves on acquaintance, and is found to be expressive and copious. It is said to consist of at least 80,000 words, or more than double the number in the French or English languages. Originally consisting of various dialects, including those of the Mœso-Goths and Franks, it has latterly, by the progress of literature and education, been established in the distinct form in which it appears in German literature. Luther's Bible, of which the first edition was issued in 1545, was principally instrumental in the establishment and dissemination of this peculiar combination of dialects. The German language since that period has had few if any changes; the German of 1841, compared with that of 1545, will be found to differ chiefly in orthography. In German, as in Eng-

* See *Etymological Researches*, by J. Townsend, M.A. Bagster, London.

tal, there are two articles, the definite and the indefinite, but the definite article has a plural, and in all the various cases of the singular number it has distinct terminations for the three genders; so that it denotes whether the substantive before which it stands is masculine, feminine, or neuter, and also whether it is singular or plural. Both articles have four cases. One peculiarity of the German is the frequent addition of the termination *inn* to denote the feminine gender. For instance, *der löwe* signifies the lion, and *die löwinn* the lioness. This termination is also used to express a female title, it being the custom in Germany for a wife to share the title of her husband. Thus, *der rector* signifies the rector, and *die rectorinn* the *rectoress* or rector's wife. *Die professorinn* signifies the professor's wife, and *die doctorinn* the doctor's wife. The following are specimens of the mode of conjugating the two important auxiliary verbs *to have* and *to be*:—

HABEN, *TO HAVE.*

INDICATIVE.		CONJUNCTIVE.	
		PRESENT	OPTATIVE.
Ich habe,	*I have.*	Ich habe,	*I may have.*
Du hast,	*thou hast.*	Du habest,	*thou mayest have.*
Er (sie, es) hat,	*he (she, it) has.*	Er, (sie, es) habe,	*he (she, it) &c.*
Wir haben,	*we have.*	Wir haben,	*we may have.*
Ihr habet,	*you have.*	Ihr habet,	*you may have.*
Sie haben,	*they have.*	Sie haben,	*they may have.*
	IMPERFECT.	CONDITIONAL.	OPTATIVE.
Ich hatte,	*I had.*	Ich hätte,	*I might have.*
Du hattest,	*thou hadst.*	Du hättest,	*thou mightest have.*
Er hatte,	*he had.*	Er hätte.	*he might have.*
Wir hatten,	*we had.*	Wir hätten,	*we might have.*
Ihr hattet,	*you had.*	Ihr hättet,	*you might have.*
Sie hatten,	*they had.*	Sie hätten,	*they might have.*

SEIN, *TO BE.*

INDICATIVE.		CONJUNCTIVE.	
		PRESENT.	OPTATIVE.
Ich bin.	*I am.*	Ich sei,	*I may be.*
Du bist,	*thou art.*	Du seist,	*thou mayest be.*
Er (sie, es) ist,	*he (she, it) is.*	Er (sie, es) sei,	*he (she, it) may be.*
Wir sind	*we are.*	Wir seien,	*we may be.*
Ihr seid.	*you are.*	Ihr sei(e)d,	*you may be.*
Sie sind	*they are.*	Sie seien,	*they may be.*
	IMPERFECT.	CONDITIONAL.	OPTATIVE.
Ich war,	*I was.*	Ich wäre,	*I might be. I were.*
Du warest,	*thou wast*	Du wärest,	*thou mightest be.*
Er war,	*he was.*	Er wäre,	*he might be.*
Wir waren,	*we were.*	Wir wären,	*we might be.*
Ihr waret,	*you were.*	Ihr wäret,	*you might be.*
Sie waren,	*they were.*	Sie wären,	*they might be.*

It may likewise be interesting to know the names of the cardinal numbers in German, with a view to comparing them with our own Anglo-Saxon terms.

CARDINAL NUMBERS—(*Grundzahlen*).

Eine	1	Ein und zwanzig	21
Zwei	2	Zwei und zwanzig	22
Drei	3	Drei und zwanzig	23
Vier	4	Vier und zwanzig	24
Fünf	5	Fünf und zwanzig	25
Sechs	6	Sechs und zwanzig	26
Sieben	7	Sieben und zwantzig	27
Acht	8	Acht und zwantzig	28
Neun	9	Neun und Zwantzig	29
Zehn	10	Dreissig	30
Eilf (elf)	11	Ein und dreissig	31
Zwölf	12	Vierzig	40
Dreizehn	13	Ein und vierzig,	41
Vierzehn	14	Fünfzig	50
Fünfzehn	15	Hundert	100
Sechszehn	16	Hundert und eins	101
Siebzehn	17	Hundert und zwei	102
Achtzehn	18	Zwei hundert	200
Neunzehn	19	Drei hundert	300
Zwanzig	20	Tausend (ein tausend)	1,000

Unfortunately, the Germans hold with great pertinacity to an old and barbarous character in their alphabet, by which a more general study of their literature is in some measure retarded. This peculiar character is similar to the Old English,—𝔞, 𝔟, 𝔠, 𝔡, 𝔢, 𝔣, &c.; 𝔄, 𝔅, ℭ, 𝔇, 𝔈, 𝔉, &c.

Dutch Language.—This language, or Lower German, spoken only in Holland, and though used in the literature of the people of that country, has never made any progress elsewhere. In speaking of this language, in his work on Batavian Anthology, Dr. Bowring remarks, that "the Dutch is not soft or musical, but it is sonorous and emphatic. it has not the beauties of the vowelled idioms of the south, but it has beauties they can never possess; and especially in the variety and grace of its diminutives (a quality in which our own language is singularly deficient), it may be compared with the richest among them. It may be studied in its perfection, in that beautiful and emphatic version of the Bible which owes its existence to the Synod of 1618–19; to the expression of devout and dignified emotion it is particularly adapted, and a high tone of religious feeling pervades all its literature." Believing that the language is already perfect, the Dutch are most scrupulous about admitting terms from any other language; when any new word is required, as in science, they form a compound for the purpose. Thus, astronomy is called *sterrekunde*, from *ster*, a star, and *kunde*, knowledge. Another term for the same science is *hemelloopkunde*, from *hemel*, heaven, *loop*, a course, and *kunde*, knowledge. Grammar is *taalkunde*, from *taal*, language, and *kunde*, knowledge; literally signifying the knowledge or science of language. Occasionally this plan may be advantageous, but it produces inelegance, and is adverse to improvement. The Flemish language has borrowed many words from the French, but it is very similar to the Dutch. It is chiefly distinguished by a more nasal pronunciation, while the Dutch is rather a guttural language. The orthography of the two languages differs; for the Flemish writers have devised a different method of spelling those words which agree in sound but not in signification. Thus, *wagen*, is to hazard, and *waegen* to weigh; *leven* is life, and *leeven* is to live. Another language is spoken in the Netherlands, which is neither Dutch nor Flemish. It is the popular language in Hainault, Namur, Liege, and part of Limbourg, and is called the Walloon; it is a kind of corrupt French. In Brussels, the people in the lower city speak Flemish, and in the upper city Walloon. Of these languages, the Dutch most closely resembles our own. Its similarity to English is shown by the following Dutch proverb, coupled with a literal translation:—

> "Als de wyn is in de man,
> Is de wysheid in de kan."
> "When the wine is in the man,
> Is the wisdom in the can."—BOWRING.

As all classes of persons above those in the humblest ranks, both in Holland and Belgium, speak French, and as the bulk of the literature is in that language, it is not unlikely that the native vernacular will in course of time sink to the character of provincial dialects—which, indeed, they have already reached in the Flemish districts.

The English Language.—This language, as already mentioned, is based on the Anglo-Saxon, "the language of the Angles, one of the tribes of that Saxon confederacy which, about the beginning of the sixth century, supplanted the Celtic inhabitants of Britain, and drove them into the mountains of Wales and Scotland. The incursions of the Danes into England, and their settlement in several parts, made little alteration on the Anglo-Saxon, as the Danish tribes were kindred with the Saxon, being descendants of the same great Gothic or Teutonic family. In the eleventh century, the Normans, or North-men, another kindred tribe, who had, two centuries before, seized and possessed that part of France since called Normandy, subdued England. They brought with them the French language, which, in the course of time, they had adopted from the people amongst whom they had been settled. This they continued, in England, to use in common discourse, and in schools and courts of law, for more than two centuries after the Conquest. Yet as they were not so numerous as the Saxon population, the old language finally prevailed; and though many French words found their way into the English, the bulk of the language continued to be Saxon.

"The French tongue being founded on the Latin, its introduction caused the infusion of a great number of Latin words into our language; afterwards, as Roman literature was studied, a great number of other Latin terms were introduced into English. It is in some measure possible to distinguish the Latin introduced through the French, by the words being more changed in their form than the other Latin terms which were adopted directly by the learned. From the addition of so many Latin words, a species of double language has been formed—the Saxon English, which we commonly employ in conversation, and the Latinized English, which is principally employed in learned composition. Mixed, however, as the two are, each language preserves an idiomatic character; for, with few exceptions, the prefixes and affixes of the one cannot be conjoined with the words of the other.

"A further addition has been made to the English by the introduction of Greek words. This has been going on since the commencement of the study of Greek literature in the sixteenth century. As we had Latin through the French, we had unconsciously many Greek words through the Latin, which may be regarded as a variety of the Greek. The words which we have received immediately from the Greek are comparatively few, with the exception of terms of art and science, which are now extensively taken from that language.

"When we look back to the early history of our language, it may be said that we see it approaching our country in two great but unequal streams; one of which comes from the shores of the Baltic, while the other, leaving Greece, passes along the shores of the Mediterranean, and finally reaches us through France. Though the Celtic inhabitants, or Britons, are said to have been expelled by the Saxons, some of their words have been left in our language. The names of rivers, mountains, and other natural objects, in England as well as in Scotland, are generally Celtic, and the names of many places are founded on terms in the same language. As in the case of the Latin passing into the English through the French, we have words of Celtic origin through the French, France having been at one time widely inhabited by Celtic tribes. In many of the names of places in France, Spain, and Italy, the Celtic is also still discernible."*

The language of England-proper is now spoken over the whole British islands, and has been fixed at a standard by the diffusion of literature and the labours of Johnson and other lexicographers. In the common speech of the people, however, there are, as we previously noticed, numerous dialects differing less or more from pure English. The most remarkable of these dialects is that spoken by the humbler classes in the Lowlands of Scotland, of which we have specimens in the poetry of Ramsay and Burns, and the prose fictions of Scott. A controversy has existed respecting the origin of this dialect. By some it has been considered only an unimproved English, such as was spoken and written generally in England three or four centuries ago; by others, it has been defined as a distinct branch of the original Teutonic, through the Scandinavian branch; and this, in our opinion, is the true view of the matter. We now, then, have upon our island two branches of an original Gothic tongue, one of which has taken the lead in literature, while the other has continued as a local vernacular, and must in the course of time disappear.

The English language, as finally established, consists of about 38,000 words, of which about 23,000, or nearly five-eighths, are Anglo-Saxon. Many words, however, may be said to be in a state of disuse, particularly those from the Latin introduced by a fantastic mode of writing in the sixteenth and seventeenth centuries. Possessing all the force and bluntness of the Anglo-Saxon, with a due share of the polish and dignity of the Roman tongue, the English is powerful, copious, and adapted to express the most refined emotions of feeling, as well as the complex doctrines of an enlightened philosophy. For honesty and sincerity it has no equal—a peculiarity distinctly referable to the upright character of the English. One of the chief peculiarities of the language is its slight dependence on inflection, and the abundant use of articles, prepositions, &c., such as *a*, *on*, *the*, *of*, *to*, *with*, *by*; also, *shall*, *will*, *may*, *might*, *could*, *would*, *should*, &c. (all Anglo-Saxon), the meaning of which is usually provided for in languages of Latin origin by the various terminations of the verbs or main words in the sentence. The rules of English orthography are exceedingly indecisive, partly from the want of any authoritative academy to lay down a law on the subject, and partly from the diffidence of grammarians in attempting any change. This irregularity in the adaptation of spelling to pronunciation, and the constant shifting of sounds in the letters *a*, *c*, and *g*, without any apparent rule, render the language difficult of acquisition by foreigners. The sound expressed by *th*, as in *the*, *month*, *pathos*, equivalent to the sound of the letter *theta* in Greek, is also rarely mastered by natives of France or Germany who come to reside amongst us.

In writing English, some authors adhere more closely to Anglo-Saxon roots than others; but the best English is that in which no particular rule on this subject is followed. To show what difference may exist in styles, according as the Anglo-Saxon or Latin are followed, we present the following specimens; those words not Anglo-Saxon being in *Italics*. The first is from the authorized version of the Bible, which has few Latin words.

"In the beginning God *created* the heaven and the earth. And the earth was without *form*, and *void*; and darkness was upon the *face* of the deep: and the *Spirit* of God moved upon the *face* of the waters. And God said, Let there be light; and there was light. And God saw the light, that it was good: and God *divided* the light from the darkness. And God called the light Day, and the darkness he called Night. And the evening and the morning were the first day."—*Genesis*, i. 1—6.

"And it came to pass, that when Isaac was old, and his eyes were dim, so that he could not see, he called Esau his eldest son, and said unto him, My son. And he said unto him, Behold, here am I. And he said, Behold now, I am old, I know not the day of my death. Now therefore take, I pray thee, thy weapons, thy quiver and thy bow, and go out to the field, and take me some *venison*; and make me *savoury* meat, such as I love, and bring it to me, that I may eat; that my soul may bless thee before I die. And Rebekah heard when Isaac spake to Esau his son. And Esau went to the field to hunt for *venison*, and to bring it. And Rebekah spake unto Jacob her son, saying, Behold, I heard thy father speak unto Esau thy brother, saying, Bring me *venison*, and make me *savoury* meat, that I may eat, and bless thee before the Lord before my death."—*Genesis*, xxvii. 1—7.

The second specimen is from Robertson, showing an abundance of Latin roots:—

"This great *emperor*, in the *plenitude* of his *power*, and in *possession* of all the *honours* which can *flatter* the heart of man, took the *extraordinary resolution* to *resign* his kingdom, and to withdraw *entirely* from any *concern* in business or the *affairs* of this world, in *order* that he might spend the *remainder* of his days in *retirement* and *solitude*. *Diocletian* is *perhaps* the only *prince* *capable* of holding the *reins* of *government*, who ever *resigned* them from *deliberate* choice, and who *continued during* many years to *enjoy* the *tranquillity* of *retirement*, without fetching one *penitent* sigh, or *casting* back one look of *desire* towards the *power* or *dignity* which he had *abandoned*."

For further details respecting the English language, we refer to the article on ENGLISH GRAMMAR.

* Graham's English Etymology.

The Pelasgian or Graeco-Latin Family.

The first inhabitants of Greece were called the Pelasgi, and seem to have been the ancestors of the Greeks; but the early history of these nations is lost in fable.

The Greek is a most powerful and expressive language. It is divided into four dialects, which arose from the peculiar pronunciation of the inhabitants in different parts of the country, thus occasioning a change in orthography. The Attic dialect is generally considered the most polished and the most classical; it is subdivided into the old, middle, and new. Solon wrote in the old Attic, which is almost the same as the Ionic. The historian Thucydides, the tragic writers Æschylus, Sophocles, and Euripides, used the middle style, as did also Plato and Xenophon, and Aristophanes, the writer of comedy. Demosthenes, and later orators and writers of comedy, adopted the new Attic style. The name of the Attic dialect is derived from Attica, the country in which it originated; the political and literary pre-eminence of the Athenians, or people of Attica, eventually rendered it almost the universal dialect of Greece. It is distinguished by its contraction of vowels. The Ionic dialect uses the contracted inflections of nouns and verbs. It is smooth and harmonious, and was adopted by the historian Herodotus, Hippocrates the physician, and by Anacreon the poet. The Doric and Eolic dialects were more harsh and unpolished than the others. The Doric has a very broad pronunciation, and frequently substitutes *ā* for the other vowels. The Eolic has no dual form, and, in other points, resembles the Latin more strongly than the other dialects. The New Testament was originally written in Greek. We find in it instances of all the four dialects, and several Hebraisms or Hebrew idioms.

We have seen that one of the leading grammatical systems followed in the structure of all languages, consists in the addition of syllables to the root, or, as we may briefly describe it, in a variety of terminations. These are called *inflections*, because the word in this case is, as it were, *bent* or *turned*. In the Greek, we see the inflective system in its greatest extent. The noun is inflected for the expression of the various cases, genders, and numbers. The verb is inflected for active, middle, and passive voice, and all the usual variety of tenses in the first, second, and third persons. There is also a form of the verb for use with reference to two persons, called therefore the dual form. Thus, the imperfect of the indicative of the verb τύπτω (*tupto*), I strike, appears in the following variety of forms:—

	SINGULAR.	
1. ἔτυπτον	2. ἔτυπτες	3. ἔτυπτε
(*etupton*),	(*etuptes*),	(*etupte*),
I was striking.	Thou wert striking.	He was striking.
	DUAL (*two persons*).	
	2. ἐτύπτετον	3. ἐτυπτέτην
	(*etupteton*),	(*etupteten*),
	Ye two were, &c.	They two were, &c.
	PLURAL (*any number*).	
1. ἐτύπτομεν	2. ἐτύπτετε	3. ἔτυπτον
(*etuptomen*),	(*etuptete*),	(*etupton*),
We were striking.	Ye were striking.	They were striking.

The modern Greek derives most of its words from the ancient language, but a great many Italian and Turkish terms have been introduced. Perhaps the difference between the ancient and modern Greek cannot be better illustrated, than by comparing parallel passages from the same writer. The passage selected is the 1st chapter of John's Gospel, 1st verse:—

ANCIENT GREEK.	ROMAIC OR MODERN GREEK.
Εν ἀρχῇ ἦν ὁ λόγος καὶ ὁ λόγος ἦν πρὸς τὸν Θεὸν καὶ Θεὸς ἦν ὁ λόγος.	Εις τὴν ἀρχὴν ἦτον ὁ λόγος καὶ ὁ λόγος ἦτον μὲ τὸν Θεὸν καὶ Θεὸς ἦτον ὁ λόγος.
En arche en ho logos, kai ho logos en pros ton Theon, kai Theos en ho logos.	*Eis ten archen eton ho logos. kai ho logos eton me ton Theon kai Theos eton ho logos.*

The Latin, or language of ancient Rome, may be regarded as a composition of the early languages spoken in central Italy, particularly the Etrurian, and of the Greek, brought to the same country by colonists, and by the study of Greek literature among the Romans, after they had attained a certain degree of civilization. It has been remarked that the Eolian, more than any other variety of the Greek, has contributed to the formation of Latin. The Latin, in its grammatical structure, follows the Greek, but dispenses with the dual form of the verb. We shall here more particularly illustrate the inflective system, for the sake of those whose studies have not embraced any language besides their own. For example, while the Latin word for a speech, in the nominative case, is *sermo*, our ideas of *a speech, to a speech, with a speech*, are expressed respectively by the words *sermonis, sermoni, sermone*. The verb presents a great variety of terminations for the two *voices*, the various *moods, tenses*, and *persons*, &c. Thus, for example, while *I love* (active voice) is expressed by *amo*, *I am loved* (passive voice) is *amor*. While *I had loved* (pluperfect of indicative mood) is *amaveram*, *I might have loved* (pluperfect of subjunctive mood) is *amavissem*. The whole of the last tense is—

	SINGULAR.	
1. Amavissem,	*I might or could have loved.*	
2. Amavisses,	*thou mightst or couldst have loved.*	
3. Amavisset,	*he might or could have loved.*	
	PLURAL.	
1. Amavissēmus,	*we might or could have loved.*	
2. Amavissētis,	*ye might or could have loved.*	
3. Amavissent,	*they might or could have loved.*	

It may be remarked, for the sake of an unlearned class of readers, that there are various forms for the termination of nouns, called declensions. A large class, in which the nominative ends in *a* as in *penna*, a pen, *ala*, a wing, are of the first declension, and these are generally of the feminine gender. Two other large classes, in which the nominative ends either in *us* or in *um*, as *dominus*, a lord, *regnum*, a kingdom, belong to the second declension. There are in all five declensions, all including nouns of peculiar terminations. The singular of *dominus* appears as follows, under its various cases:—

Nominative.	Dominus,	*a lord.*
Genitive.	Domini,	*of a lord.*
Dative.	Domino,	*to a lord.*
Accusative.	Dominum,	*a lord.*
Vocative.	Domine,	*O lord.*
Ablative.	Domino,	*with or by a lord.*

The conjugations of verbs are analogous to the declensions of nouns. *Amo* is an example of a class in which the imperfect of the indicative always ends in *abam*, the future in *abo*, and in which all the other tenses take certain terminations in like manner. This class of verbs are said to be of the first conjugation. There is another class in which the present of the indicative always ends in *eo*: thus, *moneo*, I advise, *moveo*, I move; and in which the imperfect of the indicative always ends in *ebam*, the future in *ebo*, &c. These constitute the second conjugation. The other two conjugations, for there are four, all observe certain rules as to the formation of the various parts of the verb; in other words, all the various parts of the various verbs of the Latin language are formed after four schemes or modes, these being called conjugations.

In the syntax of the Latin language, there is one principle carried to an unusual extreme, namely, the transposition of words. Generally, the verb was among the last words placed in a sentence. The specimens of early Roman writers which are preserved, show the language in a rude state, as the English was about the thirteenth century. The language was afterwards polished, and became remarkable for its smoothness and harmony. Of the beautiful literature of which, like the Greek before it, it became the honoured vehicle, this is not the place to speak.

Italian, Spanish, and Portuguese Languages.—When the empire of Rome sank, as it were, beneath the weight of its own greatness, the different tribes by whom it was dismembered introduced a complete change into the language. Not only were new words introduced, but the very structure of the grammar was altered. The barbarians, probably finding a difficulty in remembering the various forms of the passive voice, substituted the use of an auxiliary with a participle throughout the verbs, and introduced prepositions to express the various relations of nouns, instead of the old system of declension. The language was thus rendered more simple and flexible. It is probable that many of these changes first sprang up among the Latins themselves, and that they were originally conventionally used by the vulgar in provincial districts. It would be very interesting if we could trace, step by step, the process of the conversion of the Latin language into the Italian. But this, like the history of the transmutation of the ancient into the modern Greek, is a subject upon which little satisfactory information can be gained. One characteristic in Italian, is the little use that is made of the letter *h*. "Not worth an *h*," is a familiar saying in Italy. The only office of *h* in the language, is to indicate when *c* is to be pronounced like *k*; as for instance, in such words as *cheto*, &c., which is pronounced *keto*.

Italian, says Metastasio, is "*musica stessa*" (music itself). It is a language of great compass and variety, well adapted to express passion and emotion. There are many dialects in Italy; with respect to these, a common proverb says, "Lingua Toscana in bocca Romana," meaning that the Tuscan dialect is the most classical and the Roman pronunciation the purest.

There are other languages besides the Italian which are derived from the Latin. Of these the Spanish preserves the strongest resemblance to the genius and structure of the Latin. It is almost equally pompous and solemn. The Spanish character is likewise akin to that of the ancient Romans, both nations being conspicuous for their prowess and dignity of mind. A great many Latin words may be traced in the Spanish, particularly if it be remembered that the *c* of the Latin language always becomes *g* in the Spanish; for instance, *Dico* becomes *Digo*: and that *t* is changed into *d*, so that the Latin word *totus* is discernible in the Spanish form *todo*. The Romans occupied Spain between six and eight hundred years. About 416, the Goths entered it, and effected some little change in the language, which was then called *Langue romance*, because derived from the Roman or Latin. About A. D. 741, Spain was again invaded by the Arabs, who gave an oriental tincture to the language. One peculiarity in the Spanish language, is the constant occurrence of *ll* at the commencement of a word; for instance, *llamar*, to call; *llaneza*, equality; *llave*, a key; *llegar*, to arrive; *llevar*, to carry; *lluvia*, to rain. The sound given to these double consonants is similar to the *gl* of the Italian, in *figlio*, son; to the *lh* of the Portuguese, in *filho*, son; and also to the *ll* of the French, in *fille*, daughter. There is another distinguishing sound in the Spanish, which is connected in pronunciation with the French. The Spanish *n* is pronounced like the French *gne* in Bretagne; so that such words as *senor*, sir, *mana*, dexterity, and *manana*, to-morrow, are to be read as if written *segnor*, *magna*, &c.

The Portuguese language has not so close an affinity with the Spanish as might have been expected from the geographical position of the two countries. The Portuguese attracted but little attention in the rest of Europe before the appearance of the *Lusiad*. Derivatives are in this language very numerous; thus, from the root *pedra*, a stone, we get the following derivatives:—*pedregal*, a stony place; *pedregulho*, gravel; *pedregóso*, stony; *pedreyra* or *pedréyro*, a stone-cutter; *pedrada*, a blow with a stone. By the simple addition of the termination *ada*, many words are formed, which in other languages could not be expressed without circumlocution; thus, *pancada*, a blow with a stick or club; *cutilada*, a cut with a sword; *estocada*, a stab with a sword or dagger. The Portuguese, like the French and Italians, have no adjectives of a triple form, as in Latin. Some of their adjectives mark the distinction in gender of the nouns which they qualify, as *formoso*, *formosa*, beautiful; *alto*, *alta*, high; and others are unchangeable; thus, *tempo breve*, a short time; *manhãa breve*, a short morning; *cavallo forte*, a strong horse; *egoa forte*, a strong mare.

French Language.—This language is also, in a great measure, a broken and re-organized Latin. It originated in the following manner:—"The Celtic, remnants of which were long preserved in Brittany, was the language of the Gauls. After the conquest of the country by the Romans under Julius Cæsar, Latin became the predominant language. On the overthrow of the Western Roman empire, this language was corrupted partly in its pronunciation by Teutonic organs, and partly by the mixture of words and expressions originally Frankish, Burgundian, Ostrogothic or Visigothic. This corrupt language was called the *Romance*, and was divided into two branches. They are denominated from their respective terms for expressing *yes*—the southern, or *Langue d'Oc* (dialect of Oc, Occitanic dialect), and the northern, spoken north of the Loire, or *Langue d'Oui* or *d'Oïl*, from the latter of which the modern French language is derived. In the beginning of the twelfth century, Raymond de St. Gilles, Count of Provence, united the south of France under one government, and gave the whole the name of *Provence*. From that period the two dialects were called the *Provençal* and the *French*. The former, though much changed, is still the dialect of the common people in Provence, Languedoc, Catalonia, Valencia, Majorca, Minorca, and Sardinia. In the thirteenth century, the northern, or Norman French dialect, which was much more prosaic than the former, gained the ascendency. This was partly owing to the influence of the *Conteurs*, who roamed into all parts of the country; but chiefly to the circumstance that Paris became the centre of refinement, philosophy, and literature, for all France. The *Langue d'Oui* was deficient, from its origin, in that rhythm which exists in the Italian and Spanish languages. It was formed rather by an abbreviation than by a harmonious transformation of the Latin. The Franks and Normans deprived the Latin words of their characteristic terminations, substituting in their stead the obscure German vowel, which was afterwards entirely dropped in conversation, and retained only in singing and orthography. With the exception of these differences, the French Romance dialect was formed on the same grammatical model as the Italian, Spanish, and Portuguese. A regular accentuation of syllables, according to their quantity, was at first preserved; but the metrical character of the language was gradually lost. The French thus became more accustomed to a rhetorical measure than to poetical forms. The nature of the language itself led them to eloquence rather than poetry, and their natural liveliness contributed essentially to encourage nice dialectics. Francis I. established a professorship of the French language at Paris in 1539, and banished Latin from the courts of justice and public documents. Cardinal Richelieu, by establishing the Academy in 1635, carried the language to a higher degree of perfection. The French academy became the supreme tribunal both for the language and literature. It put an end to the arbitrary power of usage, and fixed the standard of pure French; but it deprived genius of its prerogative of extending the dominion of the mind over the language. Nothing was approved by the academy unless it was received at court, and nothing was tolerated by the public which had not been sanctioned by the acatury. The language now acquired the most admirable precision, and thus recommended itself, not only as the language of science and diplomacy, but of society, capable of conveying the most discriminating observations on character and manners, and the most delicate expressions of civility, which involve no obligation. Hence its adoption, as the court language, in so many European countries."—*Conversations Lexicon*

The words in the French language are much less rounded by vowels than the other tongues founded on the Latin; they also abound in silent letters, contractions, and peculiar accents. While in the English, as other Teutonic tongues, the adjective is placed before the substantive, in French it is the reverse. This produces a degree of circumlocution which the English as a people could never tolerate; thus, while we at once go to the point in the term *steamboat*, the French express the idea in the roundabout form of *bateau à vapeur*. The French is also defective in its genders, of which it has only two; every thing is either masculine or feminine—*he* or *she*—a peculiarity which throws considerable difficulty in the way of its acquisition. Another peculiarity is the use of two words, *ne* and *pas*, to express a negative, as, *il n'est pas*—it is not, or, as we should literally translate the phrase, *it not is not*. It has been remarked by foreigners, that in speaking English the hissing sound of *s* has an unpleasant frequency of recurrence; in French, the nasal sounds *ung* and *ong* similarly predominate.

The Slavonic Family.

The Slavonians formed the third great tide of population which rolled from Central Asia into Europe, and planted their language in Russia, Servia, Croatia, Poland, Bohemia, Dalmatia, and some other countries, where it is now spoken in different dialects by the common people. The Slavonic tongue is understood to be remotely connected with the Sanscrit, and as Latin has a similar alliance with that language, it happens that a number of the Slavonic terms resemble words of Greek and Latin. The chief dialect or variety of the Slavonic is the Russian, which attained a standard in the reign of Peter the Great. In 1704, Peter invented a set of written letters, similar to the Roman alphabet, and introduced them among his countrymen in place of the cumbrous characters previously in use, in order to facilitate their intercourse with the other European nations. Of late, much attention has been paid to the old songs and traditions of Russia, for it is thought that they bear a strong resemblance to the old ballads of England, Spain, and Scandinavia, forming a connected series of popular traditions. The oldest documents in the Russian language are Oleg's treaty of peace in A. D. 912, and Igor's treaty with the Greek Emperor in 945. "The literature," says Dr. Bowring, "had its birth but yesterday, and certainly its present strength and beauty give fair hope for to-morrow: in it are elements of improvement, and buds and blossoms of future expectation." The Russian prose is at present inferior to the poetry. It is a flexible and harmonious language. The nouns have seven cases, of which five are similar to those of other languages. The sixth is called the *instrumental*, and agrees with the Latin ablative. The seventh is called *prepositive*, and is peculiar to this language.

The Polish language is characterized by the multiplicity of its consonants: it is generally considered more harmonious and flexible than the other Slavonic dialects. Upon the introduction of Christianity in 965, Latin was brought into use as the only written language. Thus the progress and improvement of the Polish language were considerably retarded; but, during the reign of Stanislaus Poniatowski, it made such rapid advances, and attained to such strength and vigour, that it has continued to flourish, uninjured, among all the storms and convulsions which have erased Poland from the map of Europe. The literature of Poland is eminently national and patriotic: it contains few philosophical or scientific treatises, but abounds in historical and poetical productions.

The Hungarian language can scarcely be called a Slavonic dialect, and yet it seems difficult to know where else to place it. Some curious affinities have lately been discovered between it and the Finnish, Laplandish, and Esthonian languages; such, for instance, as that the verb *to have* is wanting in all, so that possession is indicated by an expression equivalent to the words *to be to*. There are many different opinions respecting the origin of the Hungarians. Some have asserted that they are descended from the Egyptians. The word by which they designate themselves and their language, is *Magyar*. This is a term of Mogul extraction, and signifies *foreigner* or *stranger*. The most remarkable feature of the Hungarian language, is the division of the vowels into two genders; *a o u* are called masculine, and *e i ö* are considered feminine. A masculine or feminine affix is used according to whether the word terminates with a masculine or feminine vowel; this of course produces a singular uniformity of sound. About the thirteenth century, the Komans, a Turkish race, were compelled, by the disasters of war, to take refuge in Hungary. Here, being separated from the rest of their race, they soon forgot their language, and adopted that of the Hungarians. Hence it is that so many Turkish words are found in the language of the Magyars.

The Tartarian or Turkish Family.

The inhabitants of Central Asia are known in Europe by the general name of Tartars. They occupy the great elevated regions of Asia, from the Northern Ocean to the confines of Persia, India, and China. One language prevails throughout this vast extent of country, which is also frequently used in Egypt, Barbary, the Levant, part of Persia, and on all the shores of Africa. It comprises ten dialects, of which the principal is the Osmanlis, or that which is spoken in European Turkey. The Osmans derive their name from one of their leaders. They left Turkestan in A. D. 545, and conquered Persia. In A. D. 1543, they established themselves in Constantinople, where they still remain, and are known to the Europeans by the name of Turks. Their dialect prevails more or less in Bosnia, Illyria, Servia, Bulgaria, and in the Morea; but the purity, sweetness, and elegance of the language can only be learned at Constantinople. It has been observed of the Osmanli, that they have made the nearest approach towards uniting the genius of the two hemispheres. Situated both in Europe and in Asia, it is probable that they will one day combine in their literature the metaphysical imaginative style of the eastern hemisphere with the manly simplicity of the western. It is a very mistaken notion, that Mohammedan nations are precluded by their religion from making advances in literature or science. "Seek knowledge," said Mahomet, "were it even to China." The Turks of Europe have now many works on astronomy and mathematics, but they have little knowledge of experimental science. The best and most numerous works in the Turkish language are those on moral philosophy; this science they call "Adeb;" with them it is a system of ethics couched in a series of amusing tales and fables,* which contain many beauties of thought and of language. The nouns in the Turkish language have five declensions, which are formed by retaining the nominative throughout and adding terminations. No language contains more inversion of phraseology—not even the Latin. Prepositions are subjoined instead of being prefixed to nouns; and in all parts of speech the governed precedes the governing. The Jagatarian dialect of the Turkish is spoken in the greater part of Bokharia and of Independent Tartary. Many words, now obsolete in Constantinople, still exist in this

* Davids' Turkish Grammar.

dialect. In the same way, observes Davids, that the name Tartar has been applied indiscriminately to the nation, so the term Mongol has been given to the literature. The famous *Tezukat Timur*, or Commentaries of Timour, generally called a Mongol production, is really written in the Jagatarian dialect.

Balbi, the geographer, has given the name of Austro-Siberian to the various Turkish dialects spoken in part of Siberia. These dialects are much compounded with other languages.

THE POLYNESIAN CLASS.

It has been proved that all the languages spoken in the South Sea Islands and Indian archipelago, are but dialects of one primitive language.* This is evident from the similarity which subsists between them. It seems impossible to discover with certainty the language from which these have sprung. The difference in pronunciation is so great in various islands, that the inhabitants cannot understand one another. The change of dialect seems to correspond with the names of the islands. Thus, in Tahiti the aspirate abounds. At Ai-tu-tak-i the language has the addition of the letter *k*. At Roro-tonga the language is characterized by the nasal sound *ng*, which is also the case at New Zealand. The Tahitian vocabulary abounds with obsolete words, which was caused by the following curious circumstance: when any word had a sound similar to that which was contained in the king's name, the word was instantly changed. A similar custom prevails in China. Many of the obsolete Tahitian words are found in the language of the Sandwich Islands. In New South Wales, tribes who live within a hundred miles of each other are not able to converse together. This arises not only from the difference of pronunciation, but from several names being given to one object. Thus, they have distinct names for the kangaroo, according to its age, sex, size, and the district in which it is found.

The characteristic of all the Polynesian dialects is the frequency of the vowel sounds. The Polynesian languages have likewise a tendency to a monosyllabic form. Their modes of conjugating verbs are similar to the Hebrew. They have the dual of the Greek, and also a form of the dual peculiar to these islands, which is so constantly in use that no conversation can be carried on without it, and they have peculiar forms to express it; thus, *buli*, we two, *bula*, ye two, *bulo*, they two, &c.

The Papuas or Eastern Negroes inhabit the wild and mountainous parts of New Guinea. They are also found in the Philippines, where the Spaniards call them *Negritos del monte*. There are also mountainous regions in the continent of India inhabited by savages evidently of the same stock. Little is known concerning their language; the Malays compare it to the chattering of birds. The Malays who inhabit Malacca and the coasts of the adjacent islands, speak a language possessing some analogy to the Sanscrit; it is soft and harmonious in sound, and has on that account been called the Italian of the East. Nearly all its literature consists of poetry, which is, however, characterized by monotony and repetition.

THE AFRICAN CLASS.

Little, comparatively, is yet known respecting the languages spoken in Africa. There is a very poor Arabic dialect spoken in Abyssinia called Geez, which has been improperly confounded with the Ethiopian. The well-known version of Scripture, erroneously called the Ethiopic, is really in the Geez dialect. To the west of the river Tacazze, the language chiefly spoken is the Amaric, or Modern Abyssinian, now called *Lesan Neghus*, that is, royal idiom, because it is the language of the court at Gondar.

There are scattered tribes in the north, who are strongly suspected to be the descendants of the ancient Lybians. The old Guanchee language, once spoken in the Canary Islands, but now almost extinct, seems to belong to the same stock as the Lybian; but so little is known respecting either language, that this is mere conjecture. Turkish and Arabic idioms prevail in the sea-shores of Africa but distinct and peculiar dialects prevail in the interior, and of these the Soosoo is perhaps the most extensively used. On the Ivory or Tooth Coast, between Cape Palmas and Cape Three Points, a singular dialect is found, which is called *Quaqua*, these being the words with which the natives salute each other when they meet.

The South of Africa is occupied by two races—the Hottentots and the Caffres. The Hottentot language is immediately known from all others, by its extraordinary clipping sounds, produced by a quick action of the tongue upon the palate.

THE POLYSYNTHETIC CLASS.

The languages spoken by the Indian tribes of America, have received from Mr. Du Ponceau, an able investigator into the subject, the name of *Polysynthetic*, from the manner in which words are abbreviated and combined to express ideas. This forms a most remarkable class of languages; and we shall best convey a notion of its peculiarities by the following extract from the *Conversations Lexicon*, founded on Du Ponceau's investigations. The great distinction of these languages from those of other races of mankind is the agglutination of words. "One example, from the Delaware language, will convey a clear idea of the process of compounding; 'and I have chosen,' says Mr. Du Ponceau, 'this word for the sake of its euphony, to which even the most delicate Italian ear will not object. When a Delaware woman is playing with a little dog or cat, or some other young animal, she will often say to it, *Kuligatschis*, which I would translate into English—*Give me your pretty little paw*, or, *What a pretty little paw you have!* This word is compounded thus; *k* is the inseparable pronoun of the second person, and may be rendered *thou* or *thy*, according to the context; *uli* (pronounced *oolee*,) is part of the word *wulit*, which signifies *handsome* or *pretty*: it has also other meanings, which need not be here specified; *gat* is part of the word *wichgat*, which signifies a *leg* or *paw*; *schis* (pronounced *shees*) is a diminutive termination, and conveys the idea of *littleness*: thus, in one word, the Indian woman says *thy pretty little paw*; and, according to the gesture which she makes, either calls upon it to present its foot, or simply expresses her fondling admiration. In the same manner, *pilape*, a youth, is formed from *pilsit*, chaste, innocent, and *lenape*, a man. It is difficult to find a more elegant combination of ideas, in a single word, of any existing idiom. I do not know of any language, out of this part of the world, in which words are compounded in this manner. The process consists in putting together portions of different words, so as to awaken, at the same time, in the mind of the hearer, the various ideas which they separately express. But this is not the only manner in which the American Indians combine their ideas into words. They have also many of the forms of the languages which we so much admire—the Latin, Greek, Sanscrit, Slavonic, &c.—mixed with others peculiarly their own. Indeed, the multitude of ideas which in their languages are combined with their verbs, has justly attracted the attention of the learned in all parts of the world.

It is not their transitive conjugation, expressing, at the same time, the idea of the person acting, and that acted upon, that have excited so much astonishment. These are found also, though not with the same rich variety of forms, in the Hebrew and other Oriental languages. But when two verbs, with intermediate ideas, are combined together into one, as in the Delaware *n'schingiwipoma*, I

* Prichard's History of Man.

do not like to eat with him, which the Abbé Molina also declares to exist in the idiom of Chili—*iduanclorlavin*, I do not wish to eat with him—there is sufficient cause to wonder, particularly when we compare the complication of these languages with the simplicity of the Chinese and its kindred dialects in the ancient world. Whence can have arisen such a marked diversity in the forms of human speech? Nor is it only with the verbs that accessory ideas are so curiously combined in the Indian languages; it is so likewise with the other parts of speech. Take the adverb, for instance. The abstract idea of time is frequently annexed to it. Thus, if the Delawares mean to say, *if you do not return*, they will express it by *mattatsch gluppiwequi*, which may be thus construed: *matta* is the negative adverb *no*; *tsch* (or *tsh*) is the sign of the future, with which the adverb is inflected; *gluppiwequi* is the second person plural, present tense, subjunctive mood, of the verb *gluppiechton*, to turn about, or return. In this manner, every idea meant to be conveyed by this sentence, is clearly understood. The subjunctive mood shows the uncertainty of the action; and the sign of the future tense, coupled with the adverb, points to a time not yet come, when it may or may not take place. The Latin phrase *nisi veneris* expresses all these meanings; but the English *if you do not come*, and the French *si vous ne venez pas*, have by no means the same elegant precision. The idea which, in Delaware and Latin, the subjunctive form directly conveys, is left to be gathered, in the English and French, from the words *if* and *si*, and there is nothing else to point out the futurity of the action. And where the two former languages express every thing with two words, each of the latter requires five, which yet represent a smaller number of ideas." Mr. Du Ponceau then justly asks, to which of all these grammatical forms is the epithet *barbarous* to be applied? This very cursory view of the general structure of the Indian languages, exemplified by the Delaware, will at least convince us that a considerable degree of art and method has presided over their formation.

Mr. Du Ponceau has summed up the general results of his laborious and extensive investigations of the American languages, including the whole continent, from Greenland to Cape Horn, in three propositions—"1. That the American languages in general are rich in words and in grammatical forms, and that, in their complicated construction, the greatest order, method, and regularity prevail; 2. That these complicated forms, which I call *polysynthetic*, appear to exist in all those languages, from Greenland to Cape Horn; 3. That these forms appear to differ essentially from those of the ancient and modern languages of the old hemisphere."

These explanations of Du Ponceau surprised the philologists of Europe; and his statements were for some time controverted and ridiculed. It now, however, appears beyond a doubt that the languages of these barbarous Indian tribes are among the most expressive of any tongue dead or living, and that the principle of their construction is most ingenious and perfect. We refer readers who may be curious on the subject to the *Conversations Lexicon*, article *Indian Languages*.

BROKEN LANGUAGES.

Lingua Franca.—Along the coasts of the Levant and European Turkey, the natives of a superior class, and particularly merchants, hold intercourse with the French, English, Italians, and other foreigners, in a dialect called the *Lingua Franca*. It is a jargon composed chiefly of corrupt Italian with Turkish and other words, and cannot be said to aspire to a grammar or any regular form. As the Turks call all Europeans Franks, this language has been named from them.

Romansch Language.—In that part of Switzerland called the Grisons, and the neighbouring alpine region of Tyrol, the inhabitants of which, according to local tradition, are the descendants of some fugitives driven from Lower Italy by the Gauls, a corrupted Latin is spoken, supposed to resemble the vernacular of the Roman peasantry, and called the *Lingua Romanscha*. Of this Romansch there are several dialects, and in one of them a newspaper is published at Coire.

Chinese-English.—We have already noticed the broken English spoken by the Negroes of the British West Indies, known by the name of the Talkee-talkee. A similarly broken English is in use at Canton, in China, by which an intercourse is carried on between English and native tradesmen. This Chinese-English, composed of English words, with a few terms from the Portuguese, but altered to suit the powers of pronunciation of the Chinese, is a barbarous jargon, governed by no rules of grammar. The word "change" is pronounced *cheen-che*; "dirty" is *tah-tee*; "wife" is *wi-foo*; "three," *te-le*; "four," *faw*; "five," *fi*; "six," *sik-she*, and so on. Of the words from the Portuguese, "great" is *kah-lan-tee*, a corruption of *grande*; "orange" is *loo-lan-che*, for *laranga*; "to know" is *sha-pe*, for *sabe* (French, *savoir*), to know—a term also common in the Talkee-talkee of the West India Negroes. This Chinese gibberish also includes a few expressions from the native language of China; as, *chin-chin*, for "if you please;" *chow-chow*, for "dinner," &c. At Macao there is a similar lingo, formed principally from Portuguese and some Chinese words.

CONCLUDING OBSERVATIONS.

From what has been stated, it appears that some hundreds, if not thousands, of languages, are spoken over the globe, the whole, however, divided into certain leading classes, and by far the greater proportion being dialects or altered varieties of original roots. The predominance of any individual language by no means corresponds with either its valuable qualities or its antiquity. The Celtic, for example, the oldest language of most European countries, is now confined to a few unimportant localities; the Hebrew, following the fate of the people to whom it belonged, is not spoken as a vernacular by any nation; the ancient Greek has been modernized or altered as a spoken tongue; and the dignified and sonorous Latin, once spoken by the learned orators of ancient Rome, is also numbered with the dead languages.

Out of the wreck of ancient tongues, certain new languages, as has been observed in the preceding pages, have arisen and taken a lead in the civilized world. Of these the French was the first which attained general estimation. It was spoken at courts, became the language of diplomacy, and still is the medium of converse among all refined classes of persons throughout continental Europe. Except, however, in two or three of the Swiss cantons, and part of Belgium (also in the remains of French colonies abroad), it is nowhere the vernacular beyond the confines of France. In short, with all its superficial dissemination, it is limited in its sphere, and is not making new conquests among either barbarous or civilized races. The Italian, though rich and harmonious, is only a local tongue. The Spanish, by means of conquests in Central and South America, has been widely extended; but its progress has been arrested. The Spanish colonies, founded on the most odious oppression, and perpetuated with a disregard to any principles of rational advancement, have in every instance revolted, and the people, to all appearance incapable of civilized rule or independent support, will in all likelihood sink before the external pressure of the Anglo-Saxon republicans; if so, the Spanish tongue will disappear from the American continent.

The next great language of modern Europe is the German, which, as already mentioned, is spoken over a vast extent of country, and is distinguished for the great riches of its literature. Yet, this eloquent and copious tongue is also not making aggressions on new domains, not becoming universal—a circumstance arising from that fixity of habits in its people, which prevents them from pushing into new scenes of enterprise. The Dutch, Swedish, Norwegian, and other branches of the Teutonic, are all substantially confined each to its own little spot, from which it does not appear likely that they will ever be extended.

The English language, which, as we have seen, is little else than Saxon tinged with Latin, seems to have been reserved for a singular destiny, in no respect foreseen at the period of its formation. First spreading over the British islands, and pushing out several varieties of Celtic, it has been conducted by national enterprise to the American continent and islands, where it is now the leading form of speech of civilized men, everywhere overwhelming the native and transplanted tongues. By similar processes of colonization, it has been planted in the great Asiatic peninsula (India) and its islands, in Australia, Van Diemen's Land, New Zealand, the southern extremity and various parts of the western coast of Africa, besides other possessions of Britain in different parts of the world. Perhaps the most extraordinary incident in its eventful progress has been its plantation in Liberia, on the coast of Africa, by a society of Anglo-American colonists, and where it now forms the vernacular of a Negro race, the intelligent descendants of liberated slaves. Thus, while most tongues have been confined, by the force of circumstances, to the place of their birth, the English has gone forward in the van of civilization to almost all accessible parts of the habitable earth; and, preserved from deflection by a common standard literature, will in all probability become a universal language.

The study of languages, with a view to philosophic comparisons and conclusions, and also with the design of throwing light on man's social progress, has in recent times assumed the character of a distinct branch of learning, under the name of *Philology*, and among the patient scholars of Germany the study has been pursued to a great and honourable extent. France has likewise attained celebrity for its linguists. Except by the publication of Polyglott bibles, England has done little comprehensively in this department of letters, and few men have distinguished themselves as linguists, a facility in acquiring languages not falling apparently within the scope of the national mind and habits. The late Sir William Jones, who conquered all difficulties by his perseverance, was a remarkable exception. He was acquainted with twenty-eight languages. The method of study which he pursued, and which he recommends to others, was that which has been called *double translation*. It was his custom, after he had translated a passage into English from some foreign author, to restore his own translation to the language of the author, and then to compare this re-translation with the original. By this means, he was enabled to detect his own errors, and to acquire the peculiar style and idioms of each language. It has frequently been found highly advantageous to read the same work in different languages. By comparing the words, grammatical structure, and idioms of each language, the powers of comparison and reflection are called into active exercise, and the facts more strongly imprinted on the memory.

SPECIMENS OF LANGUAGES.

With the view of affording the unlearned reader an idea of the appearance of some of the principal languages, dead and living, we append the passages from the New Testament composing the Lord's Prayer, in Greek, Latin, Italian, Spanish, French, German, Dutch and English—for the sake of clearness, the Greek is printed in the Roman alphabet, the aspirate at the beginning of certain words being represented by the letter *h*. The reader is called on to observe the difference between the Greek and Latin words, and how evidently the Latin is the parent of the Italian, Spanish, and French, the latter, however, possessing the least resemblance in orthography and arrangement to its original. He will also have an opportunity of comparing the German with its kindred tongue the Dutch, and both with their relation to the Anglo-Saxon or English.

GREEK.

Pater hemōn ho en tois ouranois, hagiastheto to onoma sou. Eltheto he Basileia sou. Genetheto to thelema sou, hōs en ouranō, kai epi tes ges. Ton arton hemōn ton epiousion dos hemin semeron. Kai aphes hemin ta opheilemata hemōn, hōs kai hemeis aphiemen tois opheiletais hemōn. Kai me eisenegkes hemas eis peirasmon, alla rusai hemas apo tou ponerou; hoti sou estin he Basileia, kai he dunamis kai he doxa, eis tous aiōnas. Amen.

LATIN

Pater noster, qui es in cœlis, sanctificetur nomen tuum. Adveniat regnum tuum. Fiat voluntas tua, sicut in cœlo, et in terra. Panem nostrum quotidianum da nobis hodie. Et remitte nobis debita nostra, sicut et nos remittimus debitoribus nostris. Et ne nos inducas in tentationem, sed libera nos a malo. Tibi enim est regnum, et potentia, et gloria, in sempiternum. Amen.

ITALIAN.

Padre nostro, che sei ne' cieli, sia santificato il tuo nome. Il tuo regno venga. La tua volontà sia fatta in terra come in cielo. Dacci oggi il nostro pane cotidiano. E rimettici i nostri debiti, come noi ancora gli rimettiamo a' nostri debitori. E non indurci in tentazione, ma liberaci dal maligno. Perciochè tuo è il regno, e la potenza, e la gloria, in sempiterno. Amen.

SPANISH.

Padre nuestro, que estás en los cielos, sea sanctificado tu nombre. Vénga tu reyno; sea hecha tua voluntad, como en el cielo, ansi tambien en la tierra. Danos oy nuestro pan quotidiano. Y sueltanos nuestras deudas, come tambien nosotros soltamos a nuestros deudores. Y no nos metas en tentacion, mas libranos de mal. Porque tuyo es el reyno, y la potécia, y la gloria, por todos los siglos. Amen.

FRENCH.

Notre Pere qui es aux cieux, ton nom soit sanctifie. Ton règne vienne: ta volonté soit faite sur la terre, comme au ciel. Donne-nous aujourd'hui notre pain quotidien. Pardonne-nous nos péchés, comme aussi nous pardonnons à ceux qui nous ont offensés. Et ne nous abandonne point à la tentation, mais délivre nous du malin. Car à toi appartient le regne, la puissance, et la gloire, à jamais. Amen.

GERMAN.

Unser Vater in dem Himmel, dein Name werde geheiliget. Dein Reich komme. Dein Wille geschehe auf Erden wie im Himmel. Unser tägliches Brod gieb uns heute. Und vergieb uns unsere Schulden, wie wir unsern Schuldigern vergaben. Und führe uns nicht in Versuchung, sondern erlöse uns von dem Uebel. Denn dein ist das Reich, und die Kraft, und die Herrlichkeit, in Ewigkeit. Amen.

DUTCH.

Onze Vader, die in de Hemelen zijt, uw naam worde geheiligd. Uw Koningrijk kome. Uw wil geschiede, Gelijk in den hemel. Zoo ook op de aarde. Geef ons heden ons dagelijksch brood. En vergeef ons onze schulden. Gelijk ook wij vergeven onzen schuldenaren. En leid ons niet in verzoeking, Maar verlos ons van den booze. Want Uw is het koningrijk, En de kracht, en de heerlijkheid, In de eeuwigheid. Amen.

ENGLISH.

Our Father which art in heaven, hallowed be thy name. Thy kingdom come. Thy will be done in earth, as it is in heaven. Give us this day our daily bread. And forgive us our trespasses, as we forgive them that trespass against us. And lead us not into temptation, but deliver us from evil. For thine is the kingdom, the power, and the glory, for ever and ever. Amen.

ENGLISH GRAMMAR.

INTRODUCTION.

Grammar (from the Greek word *gramma*, a letter,) is, in its largest sense, that branch of knowledge which refers to the component parts of language.

The purpose of language is to express our ideas. Similar classes of ideas necessarily arise in the minds of every portion of the human family; for the mind is everywhere the same, in kind if not in degree, and the circumstances and desires of mankind are everywhere less or more alike. To express these classes of ideas, men, in all countries and in all stages of society, use corresponding classes of words, although the words may themselves be different. For example, men everywhere see tangible objects around them. To these they apply distinct *names* or *appellations*, which form, it may be said, one class of words—Nouns. They see things perform *acts*; as, for instance, they see cattle *browse* and kids *dance*. Thus arises another class of words—Verbs. They see *white* cattle and *black* cattle; hence Adjectives. These and other kinds of words, or, to use the common phrase, *parts of speech*, are found equally in the language of the North American Indian and in the refined discourse of the European philosopher. To exhibit the nature and power of words, taken singly and in combination, viewed as a vehicle of thought or a medium of communication, is the first and highest object of grammar.

In the speech of every nation there are also many peculiarities, both in the formation of words to express varieties of sense, and in the way in which words are arranged, these being partly the result of intellectual peculiarities of the people, and partly the effect of accident. Grammar also takes cognisance of such peculiarities. Hence, there is not only universal grammar, which relates to whatever is common to the structure of all language, but likewise a grammar for each particular tongue; as, for instance, the Greek grammar, the Latin grammar, the French and the English grammars. Our present business is with English grammar, or to set forth, as well as we can, within a small compass, the structure and the usages of the English language.

There are four parts in English, as in other grammars, *Orthography*, *Etymology*, *Syntax*, and *Prosody*.

Orthography, from the Greek words, *orthos*, right, and *graphe*, a writing, is that part of grammar which teaches the nature and powers of letters, and the just method of spelling words.

Prosody, from the Greek word *prosodia*, the accent of a word, treats of the pronunciation of words, and of the laws of versification.

On both these departments we mean to say nothing, principally because, as we apprehend, they can only be effectually taught by the living voice; besides, as far as relates to Orthography, so few general rules have been ascertained, that they afford little help to the young or inexperienced student. Practice alone can give facility and correctness in spelling. With regard to Prosody, we may further remark, that it relates to a mere luxury of language; because, to the effectual communication of thought, metrical arrangement of language is by no means necessary, and, in an elementary work on grammar, it may, without impropriety, be omitted.

This leaves us Etymology and Syntax, which undeniably constitute the chief parts of grammar; and of these we shall treat as fully as our limits permit.

In Etymology we shall be guided by this principle, which we hold to be established, that every word has of itself a distinct office to perform, and we shall be careful to exhibit the force and significance of words taken singly.

In Syntax we shall not attempt to lay down *rules*, as they are called, for every mode of expression, but rather to exhibit a few of the leading principles of our language, the complete understanding of which will supersede the necessity of minute observation on our part, as will enable the student to make them for himself.

We cannot approve of the exhaustive system of teaching Syntax—framing a rule for every peculiarity that the language contains; much better is it to conduct the student at once to the *principles*, which are, as it were, the fountain heads of *rules*. In the one way, we should but exhibit to him every thing *by our torch-light*; but, in the other, *we kindle his own*, and, having pointed out the road in which he is to travel, leave him to himself. When the student is familiar with the principles, it may be desirable to exercise himself on minute details, and a school-grammar should provide exercises on the minutest peculiarities of the language.

ETYMOLOGY.

Etymology, from the two Greek words, *etumon*, the root of a word, and *logos*, a discourse, is that part of grammar which treats of the various classes into which words are arranged, of the different modifications they undergo to express difference of meaning, and of their origin and history.

I. CLASSIFICATION.

Words are the symbols of ideas, and they are classified and named, not from their form, but from the nature of the idea that they represent or stand for. The class of any particular word is only to be ascertained by observing the office which it performs. What it *does*, alone indicates what it *is*.

It would be quite impossible to say, previous to actual inspection, how many sorts of words, or, as they are generally called, *parts of speech*, exist in any language; but, upon examination, it is ascertained that all words used in the English language may be arranged under eight heads.

The eight parts of speech are—Noun, Adjective, Pronoun, Verb, Adverb, Preposition, Conjunction, and Interjection.

A definition of each of these classes of words ought to point out the characteristic or specific idea by which it is distinguished from all the others; and every individual word, brought under any of the eight heads, must agree with the definition, *if it is adequate*—that is, neither too extensive nor too limited.

THE NOUN.

A Noun, from the Latin word *nomen*, a name, is the name of any person, place, thing, quantity, or principle; or, more generally, it is the name of whatever can be an object of contemplation or subject of discourse.

The characteristic of the noun is this: it gives of itself a distict idea or object of thought; thus, of the words, *to*, *pen*, *just*, *alas!* *he*, *terrify*, and *ship*, the only ones that present a picture to the "mind's eye" are *pen* and *ship*. These, therefore, we call *nouns*; but the others do not belong to this class.

It should be carefully observed, that every proposition, or sentence that asserts any thing, must contain at least a noun and a verb—the noun to express the thing spoken about, and the verb to indicate what is affirmed concerning it.

Nouns are divided into two great classes, *Proper* and *Common*.

Proper nouns are such as are applied to individual persons or things only; such as *Victoria*, *Britain*, *Edinburgh*.

Common Nouns are applicable to whole classes of persons or objects; as, *queen*, *island*, *city*. Common Nouns are by some divided into three sub-classes, called *Abstract*, *Collective*, and *Verbal*; by which arrangement the class of Common Nouns, in the limited acceptation of the term, includes only the names of things obvious to some of the five senses.

An abstract noun is the name of a quality thought of apart from all consideration of the substance in which the quality resides. The term bears reference to an act of the mind, called *abstraction*, by which we fix our attention on one property of an object, leaving the others out of view. Snow, chalk, and writing-paper, are white, and, from this quality, are oppressive to the eyes. Abstracting the quality from the substance, we say "Whiteness is oppressive to the eyes." *Whiteness* thus becomes an abstract noun.* An abstract noun may also be a name indicating the want of a quality, as *unworthiness*. Comprehensively, abstract nouns are the names of *immaterial existences, acts, or states*.

Collective Nouns are those which, though singular in form, may suggest the idea of plurality. They are such as, *army*, *clergy*, *crowd*.

The imperfect participle of a verb (which will be treated of afterwards), when used as the *name* of an action, is called a Verbal Noun. In the sentence, "The eye is not satisfied with seeing, nor the ear filled with hearing," the words *seeing* and *hearing* are called Verbal Nouns.

THE ADJECTIVE.

An Adjective is a word that qualifies a noun, that is, marks it out from other things that bear the same name.

The characteristic of the adjective is, that it limits the application of the noun: thus, the term *island* is applicable to every portion of land surrounded by water; but if the adjective *fertile* be affixed to it, all islands not distinguished by the property of fertility are excluded from our consideration.

This part of speech seems to have received its name from an accidental circumstance, and not from any thing essential to its nature. In the Latin language, it was usual to place the word modifying the noun after it, thus, *tabula longa*, while we prefix it, and say, *a long table*; the Latin grammarians, therefore, called this class of words *adjectives*, from *ad*, to, and *jectus*, thrown, and we retain the term, although our modifying word goes first. If the student has learned to recognise the *noun*, he will feel no difficulty in knowing the *adjective*, because its office is to point out some peculiarity which distinguishes the noun.

"Nouns adjective are the words which express quality considered as qualifying, or, as the schoolmen say, in concrete with some particular subject. Thus, the word *green* expresses a certain quality considered as qualifying, or as in concrete with the particular subject to which it is applied. Words of this kind, it is evident, may serve to distinguish particular objects from others comprehended under the same general appellation. The words *green tree*, for example, might serve to distinguish a particular tree from others that were withered or blasted."*

Adjectives are generally divided into two great classes, Attributive and Numeral, or those which denote quality and those which refer to number.

The words *a* or *an* (two different forms of the same word) and *the*, are reckoned by some grammarians a separate part of speech, and receive the common name of *Article*—*a* or *an* being called the *indefinite*, and *the*, the *definite* article; but, as they in all respects come under the definition of the adjective, it is unnecessary, as well as improper, to rank them as a class by themselves.

In signification, *a* or *an* is equivalent to the numeral adjective *one*, and *the* to the demonstrative adjective *that*: and the only difference between them is, that *a*, *an*, and *the*, convey the idea less emphatically than *one* and *that*. Whoever reads Dr. Crombie's remarks on the "Article," must be convinced of the absurdity of reckoning it a distinct part of speech.

Various other words, generally arranged under the head of Pronoun, seem more properly to belong to the adjective. For instance, the eight words, *my*, *thy*, *his*, *her*, *its*, *our*, *your*, *their*, corresponding exactly in office with the definition of the adjective; but as they are derived from, and answer to, the *personal pronouns*, they may be called *pronominal adjectives* with more propriety than *possessive pronouns*. If they ever stand alone, they do not exactly supply the place of a noun, but merely have it understood, and so, as will presently appear, do not come under the definition of *pronoun*. In like manner, the words *this* and *that*, with their plurals *these* and *those*, by many called *demonstrative pronouns*; and also the four words *each*, *every*, *either*, and *neither*, named *distributive pronouns*—must in strict propriety be considered as adjectives, in as much as they both precede and designate nouns, but never supply their place.

THE PRONOUN.

A Pronoun is a word that supplies the place of a noun.

Pronouns may be divided into *Personal*, *Relative*, and *Interrogative*.

The Personal Pronouns are three in number—*I*, *thou*, and *he*, *she*, or *it*.

I is used when the person speaking refers to himself; *thou*, when he refers to the person addressed; and *he*, *she*, or *it*, when he speaks of some other person or thing.

In a work equally interesting to the grammarian and the philosopher, we find the following account of the Personal Pronouns, and we confidently recommend it to the attention of our readers:—"In all speech there is a *speaker*; there is some *person spoken to*; and there is some *person* or *thing spoken of*. These objects constitute three classes, marks of which are perpetually required. Any artifice, therefore, to abridge the use of marks of such frequent occurrence, was highly to be desired. One expedient offered itself obviously, as likely to prove of the highest utility. *Speakers* constituted one class, with numerous names; *persons spoken to*, a second class; *persons* and *things spoken of*, a third. A *generical* name might be invented for each class—a name which would include all of a class, and which singly might be used as the substitute of many. For this end were the personal pronouns invented, and such is their character and office. 'I' is the generical mark which includes all marks of the class *speakers*; 'thou' is a generical mark which includes all marks of the class *persons spoken to*; 'he,' 'she,' 'it,' are marks which include all marks of the class *persons* or *things spoken of*."†

* Though we thus distinguish one class of nouns—those, namely, which come from adjectives or are closely connected with them—by the title *abstract*, we are far from wishing it to be inferred that *common nouns* are not apprehended by the same faculty. On the contrary, metaphysical propriety compels us to admit that such is the case; and if any of our readers feel an interest in the question, we request him before condemning our opinion, to peruse the third chapter of the third book of Locke's *Essay concerning Human Understanding*, and also Adam Smith's *Dissertation on the Formation of Languages*.

* Adam Smith.

† Mill's *Analysis of the Human Mind*, vol. i. p. 142

All pronouns refer to some noun, which, as it generally goes before, gets the name of *antecedent*, but as it may come after, *correlative* would appear a better term. In the case of one class of pronouns, the reference is so obvious and immediate, that they have been called Relative, by way of distinction. These are, *who*, *which*, *that*, and *as*. *Who* is used when the reference is to a person; *which*, when it is to a thing; *that* and *as* refer either to persons or to things.

The Interrogative Pronouns, so called because they are used to ask questions, are *who*, *which*, *what*, and *whether*. When *what* is not used to ask a question, it gets the name of Compound Relative Pronoun, as it includes in itself the ideas of both correlative and relative; thus, "Give me *what* is in your hand" is equivalent to "Give me *the thing which* is in your hand."

The inseparable word *self*, with its plural *selves*, is called the Reciprocal Pronoun, and denotes that the object and agent of the verb are the same.

Self is added to personal pronouns for the same purpose that *own* is affixed to pronominal adjectives; that is, to express emphasis or opposition. Thus, "I did it with my own hand;" that is, without the assistance of any other person: "He did it all *himself*;" that is, without help.

The Verb.

A Verb is a word that *affirms* something of a noun.

The characteristic of the verb is affirmation; it may, indeed, in common with the adjective, denote a *quality*; but this is accidental, and not essential to its nature. The *attribute* and the *assertion* are often conjoined in one word, as in the sentence "The man *rejoices*;" but they may be separated, and then an adjective will denote the attribute and a verb will indicate the assertion; thus, "The man is *joyful*." It is but fair to add, that this doctrine of the verb is not universally received, although, after weighing the adverse arguments of Horne Tooke and Mr. Mill, we are inclined to consider it well founded.

On attending carefully to the nature of the idea presented by verbs, we find that, while they all *assert*, they differ in this respect, that some of them express a sort of action which affects or operates upon some person or thing different from the agent, and that others either denote no action at all, or else a sort of action which is limited to the actor. The first class is called Transitive, and the second Intransitive Verbs. If the student consider with attention the state of his own mind when he repeats, with intelligence, the sentences, "James *strikes* the table," "James *walks*," he will have no difficulty in discerning the distinction that exists between a Transitive and an Intransitive Verb.

We have already stated, but the importance of the remark will justify its repetition, that as the noun denotes the thing spoken of, so the verb indicates what we affirm concerning it. Without affirmation there could be no communication of sentiment; and hence the class of words by which affirmation is made has been dignified by the appellation of verb, or *the word*. "Verbs must necessarily have been coeval with the very first attempts towards the formation of language. No affirmation can be expressed without the assistance of some verb. We never speak but in order to express our opinion that something either is or is not. But the word denoting this event, or this matter of fact, which is the subject of our affirmation, must always be a verb."*

The Adverb.

An Adverb is a word that qualifies a verb, adjective, or another adverb.

As a *description* of a fact in grammar, this is unobjectionable; but it cannot be received as a *definition*, since the word defined is made use of in the definition. Its application may be thus explained. If we wish to modify the noun or *subject* of a sentence, we must use an adjective; but if the *predicate* is to be modified, or any additional modification to be put on a word already qualifying it, the verb then used must be an adverb: thus, in the sentence, "The sun shines," we have a simple subject, "sun," and a simple predicate "shines." If we wish to express any quality of the subject, we must use an adjective; and if the predicate is to be modified, we must bring in an adverb: thus, "The *bounteous* sun shines," and "The sun shines *equally* on all."

Adverbs may be divided into four great classes:—

1. Adverbs of *Manner*; as well, ill, justly, wisely.
2. Adverbs of *Time*; as now, then, soon, when.
3. Adverbs of *Place*; as here, hence, there, where.
4. Adverbs of *Quantity*; as much, considerably.

The adverb, it may be observed, is an abbreviated mode of expression, and the idea could in all cases be conveyed by the use of two or more words. They have a close affinity to adjectives, not only in English, but in most other tongues. Ruddiman justly says, "That adverbs seem originally to have been contrived to express compendiously in one word what must otherwise have required two or more." The truth of this doctrine will appear by an inspection of the following table of Adverbs of Place:—

	In.	To.	From.
This place	Here	Hither	Hence
That place	There	Thither	Thence
What place	Where	Whither	Whence

The Preposition.

A Preposition is a word that connects two words together, in such a manner as to indicate the relation which the things or ideas signified by them bear to each other.

This part of speech, like the adjective, which it resembles in other respects, has received its name from an accidental circumstance. It generally goes immediately before the object related to the other thing named; but the essence of the preposition, it should be carefully observed, is to signify *relative position*.

We subjoin a list of the prepositions in most common use, and we recommend the student to exercise himself in putting them all, one after the other, into sentences. In this way he will learn to apprehend their real significancy; and, instead of calling a word a preposition because it is so named in a compendium of grammar, he will recognise it from its function. Doubtless, by committing the list to memory, a practice as common as it is mischievous, he might be soon able to parse; but his knowledge would be mere deception, and he himself would be but "as sounding brass and a tinkling cymbal."

LIST OF PREPOSITIONS.

Above	Between }	In	Till }
About	Betwixt }	Into	Until }
After	Beyond	Near	To }
Against	Before	Nigh	Unto }
Among }	Behind	Of	Toward }
Amongst }	Beneath	Off	Towards }
Amid }	Below	Over	Under }
Amidst }	Besides	On }	Underneath }
Around }	By	Upon }	Up
Round }	Down	Since	With
At	For	Through }	Within
	From	Throughout }	Without

The following remarks on this part of speech by Adam Smith, and his scarcely less illustrious disciple, Mr. Mill will amply repay an attentive examination:—

"Prepositions are the words which express relation considered in concrete with the correlative object. Thus, the prepositions *of*, *to*, *for*, *with*, *by*, *above*, *below*, &c., denote some relation subsisting between the objects expressed by the words between which the prepositions are placed; and they denote that this relation is considered in concrete with the correlative object. Words of this kind serve to distinguish particular objects from others of the same species, when those particular objects

* Adam Smith.

cannot be so properly marked out by any peculiar qualities of their own. When we say 'The green tree of the meadow,' for example, we distinguish a particular tree, not only by the quality which belongs to it, but by the relation which it stands in to another object." And again, "Every preposition denotes some relation considered in concrete with the correlative object. The preposition *above*, for example, denotes the relation of superiority—not in abstract, as it is expressed by the word *superiority*, but in concrete with some correlative object. In this phrase, for example, 'The tree above the cave,' the word *above* expresses a certain relation between the *tree* and the *cave*, and it expresses this relation in concrete with the correlative object, *the cave*. A preposition always requires, in order to complete the sense, some other word to come after it, as may be observed in this particular instance."*

To the same purpose Mill says—"It is easy to see in what manner prepositions are employed to abridge the process of discourse. They render us the same service which, we have seen, is rendered by adjectives, in affording the means of naming minor classes, taken out of larger, with a great economy of names. * * * Prepositions always stand before some word of the class called by grammarians nouns substantive. And these nouns substantive they connect with other nouns substantive, with adjectives, or with verbs."†

The Conjunction.

A CONJUNCTION is a word used to join words and propositions together.

Conjunctions are of two sorts, *Copulative* and *Disjunctive*. The Copulative not only join the words, but indicate that the things are to be united; while it is the office of the Disjunctive to unite the words but keep separate the things. The youngest child cannot fail to perceive the difference between these two sentences: "Will you have an apple *and* an orange?" and "Will you have an apple *or* an orange?" In the first case, he is to get both things—we therefore use a copulative conjunction; in the second, he is to have one only—we therefore use a disjunctive conjunction.

In one respect the preposition and conjunction agree—they both connect words; but each class does something not done by the other. The preposition indicates the nature of the connection, which the conjunction does not; and, on the other hand, the conjunction can connect not merely single words but clauses or sentences. If I say, "Give me a knife *and* the book," you may present the objects named separately or together—the knife being *under* the book, *in* the book, or *on* it, and in each case my request will have been complied with: but if I say, "Give me a knife *in* the book," the *relative position* of the objects is fixed, and there is only one way of complying with my demand.

We have asserted that the conjunction couples individual words as well as propositions; but, as in this we go against authorities so respectable as Ruddiman, Harris, and Mill, we must take some pains to make good our position. Ruddiman says, "A conjunction is an indeclinable word, that joins sentences together, and thereby shows their dependence upon one another;" and, in a note to his rule of syntax—"Conjunctions couple like cases and moods"—he tells us, that "the reason of this construction is, because the words so coupled depend all upon the same word, which is expressed to one of them and understood to the other." To much the same purpose Mr. Mill says—"The conjunctions are distinguished from the prepositions by connecting predications, while the prepositions connect only words. There are seeming exceptions, however, to this description, the nature of which ought to be understood. They are all of one kind; they all belong to those cases of predication in which either the subject or predicate consists of enumerated particulars, and in which the conjunction is employed to mark the enumeration. Thus, we say, 'Four and four, and two, are ten.' Here the subject of the predication consists of three enumerated particulars, and the conjunction *seems* to connect words and not predications." We do not think that Mr. Mill's argument is conclusive. There is no *seeming* about the matter. We wish it, however, to be distinctly understood that we do not charge his doctrine with being altogether erroneous; it is only not complete. It is right so far as it goes; what we maintain is, that it is too limited.

Ruddiman is correct in maintaining, that in the example, "Honour thy father and thy mother," the word "honour" is again understood before mother; but this will not do in every case. The sentence, "Charles and John rode to town," may certainly be resolved into two clauses, "Charles rode to town" and "John rode to town." But can the sentence "Charles and John carried fifty pounds," be resolved into the two, "Charles carried fifty pounds," and "John carried fifty pounds?" Obviously not. The conjunction *and*, in that case, connects the two words "Charles" and "John," and shows that conjointly they are the *subject* of the *predicate* "carried." In like manner, in the sentence, "The man of piety and virtue secures the favour of God," it is not implied that "the man of piety" secures the favour of God, and that "the man of virtue" secures the same; but that the man uniting the two qualities, the *marks* of which are united by the conjunction *and*, secures it. Mr. Mill himself, indeed, would appear not to have felt quite satisfied as to the conclusiveness of the mode of reasoning which we have been animadverting on, for he immediately shifts his ground, and argues that, because in such a sentence as "His bag was full of hares and pheasants and partridges," we may substitute the preposition *with*, and read, "His bag was full of hares, with pheasants, with partridges," the word *and* is properly to be considered a preposition. To this extraordinary specimen of reasoning it is sufficient to say, that by a similar process we might conclude, to use a homely illustration brought forward by Dugald Stewart on a like occasion, that because people can "supply the want of forks by their fingers, that therefore a finger and a fork are the same thing." On the whole, we consider that nothing can well be clearer than that these great grammarians have taken up a wrong position; but perhaps we have said as much already as the importance of the subject warrants.

The Interjection.

AN INTERJECTION is a word used to express emotion or excitement of mind.

Pure interjections are mere instinctive emissions of the voice, few in number and unimportant in character; and, as to other parts of speech used *interjectively*, the expression is, we apprehend, elliptical; but this circumstance cannot properly change the nature and character of a word. Horne Tooke considers that "interjections have no more claim to be called parts of speech than the neighing of a horse or the lowing of a cow;" but as there are words in the language which express mental emotion and nothing else, we must have a name for them, and it would be difficult to find a better than the one in universal use.

PARSING.

The student should now be able to analyze, or *parse*, as it is generally called by English grammarians, any sentence submitted to him. Various artificial rules have been devised to enable one to know what part of speech any word belongs to; but these we mean not to mention, being fully persuaded that such *helps* are altogether "from the purpose" of grammar, inasmuch as they ren-

* Adam Smith

† *Analysis*, &c., vol. i. p. 148.

der thought first unnecessary and then impossible. No person can parse a sentence which he does not understand, and, when he does so understand it, he can have no difficulty in referring each individual word to the class to which it belongs. All he has to do is to compare the idea suggested in his mind by the word to be parsed with the definitions of the various classes with which he must be familiar; and by this mental effort it will soon be ascertained to what class the word belongs. The idea suggested by any word, and the characteristic idea of a class, being brought before the mind at the same time, their identity or difference must be at once apparent. But not to deal in general reasoning more, we shall present the *analysis* of a short sentence by way of example:—

"A man that is young in years may be old in hours, if he has lost no time; but that happeneth rarely."—*Bacon's Essays.*

A is an adjective, because it limits the signification of the noun *man*.

Man is a noun, because it is the name of a class of beings.

That is a relative pronoun; its correlative is *man*.

Is is a verb, because it asserts something (existence.)

Young is an adjective, qualifying the noun *man* understood. Every adjective must have a noun understood or expressed.

In is a preposition, inasmuch as it points out the *relation* that "years" has to "young man."*

Years is a noun, being the name of a portion of time.

May is a verb, asserting something (power) of the noun *man*.

Be is a verb, asserting or denoting existence.

Old is an adjective, qualifying the noun *man* understood.

In is a preposition, as above.

Hours is a noun, being the name of a division of time.

If is a conjunction, connecting the clause, "A man that is young in years may be old in hours," to the following clause, "he has lost no time." As *if* in such cases points out the *condition* on which the assertion going before it is to be received, it is called by many grammarians a conditional conjunction.

He is a personal pronoun, standing instead of the noun *man*.

Has is a verb, asserting something (possession.)

Lost is a verb indicating an act. On the nature of this part of the verb we shall have more to say afterwards.

No is an adjective, qualifying the noun *time*.

But is a conjunction. It connects the two clauses, and at the same time indicates, or, to adopt the apt expression of which Mr. Mill frequently makes use, *connotes* that the clause coming after it is in opposition to the one going before, and therefore it is called a disjunctive conjunction.

That is a demonstrative adjective, qualifying the noun *thing* understood.

Happeneth is a verb, asserting something of its subject, "that thing."

Rarely is an adverb of time, modifying the verb *happeneth*.

As an additional exercise in *parsing*, we shall transcribe a stanza from Campbell's beautiful ode, "Farewell to Love," containing, according to our view, ten of each of the three classes, nouns, adjectives, and verbs; five of the two, pronouns and prepositions; two conjunctions, and three adverbs. The student is requested to make a careful analysis for himself, and see how far our enumeration be consistent with his own:—

"Hail! welcome tide of life, when no tumultuous billows roll;
How wondrous to myself appears this halcyon calm of soul!
The wearied bird blown o'er the deep would sooner quit its shore,
Than I would cross the gulf again that time has brought me o'er."

To the subject of parsing we shall return before we quit Etymology; but for the present we wish to direct the attention of the reader to the various modifications put on words to express a difference of meaning.

II. INFLECTION.

Any change made upon the termination of a word is called its *accident* or *inflection*; thus, the words, *boy's*, *harder*, *its*, *loved*, and *sooner*, are said to be inflected forms, or simply inflections of the words *boy*, *hard*, *it*, *love*, and *soon*. Of the eight parts of speech, five only—the noun, adjective, pronoun, verb, and adverb—are declinable, that is, capable of being inflected; while the remaining three—preposition, conjunction, and interjection—are indeclinable, that is, cannot be varied in such a way as to express any modification in meaning.

Inflection of Nouns.

The noun is varied in three ways—Number, Gender, and Case.

NUMBER shows whether one or more than one thing is meant by the noun.

There are two Numbers, the Singular and the Plural. The singular expresses one of a class; as river, horse. The plural denotes more than one; as rivers, horses. The plural is generally formed from the singular, by adding the letter *s*; thus, table, table*s*; book, book*s*; pen, pen*s*. But nouns ending in any of the five following terminations, *s*, *sh*, *ch* (when pronounced soft), *x*, and *o* (*impure*, that is, preceded by a consonant), form their plural by adding *es* to the singular; thus, brush, brush*es*, church, church*es*; box, box*es*; hero, hero*es*.

When *ch* is pronounced hard, and when *o* is preceded by a vowel, the plural is formed by adding *s*; thus, monarch, monarch*s*; folio, folio*s*.

When a noun ending in *y* is to be formed into the plural, *s* is added if the *y* is preceded by a vowel; but if a consonant goes before the *y*, then the *y* is changed into *ies*; thus, in boy, there is a vowel before the *y*, we therefore add *s*, boy*s*; but in duty there is a consonant before the *y*, the plural therefore is dut*ies*.

Nouns ending in *f* or *fe*, generally form the plural by changing the *f* or *fe* into *ves*; thus, loaf, loa*ves*; knife, kni*ves*.

Nouns derived from dead or foreign tongues, for the most part retain their original plurals; thus,

From the Latin we have—

SINGULAR.	PLURAL.
Effluvium	Effluvia
Radius	Radii
Larva	Larvæ
Vortex	Vortices
Axis	Axes
Genus	Genera
Magus	Magi
Medium	Media
Oasis	Oases
Nebula	Nebulæ
Stratum	Strata

From the Greek come—

SINGULAR.	PLURAL.
Phenomenon	Phenomena
Crisis	Crises
Hypothesis	Hypotheses
Criterion	Criteria
Automaton	Automata
Thesis	Theses
Elipsis	Elipses
Metamorphosis	Metamorphoses
Basis.	Bases.

The Hebrew words *cherub* and *seraph* form their plurals *cherubim* and *seraphim*; and the French *beau* and *monsieur* form their plurals *beaux* and *messieurs*, which last is contracted into *messrs.*

A few nouns, in very common use, form their plurals quite anomalously; thus,

SINGULAR.	PLURAL.
Man	Men
Foot	Feet
Tooth.	Teeth.

GENDER.—Gender is that accident of a noun which points out the sex or the absence of sex. Every existence is either male or female, or neither the one nor the other. The Masculine Gender includes all males, the Feminine, all females; and the Neuter, all things destitute of sex, or animals when the sex is not regarded.

Adam Smith remarks, that, "in many languages, the qualities both of sex and of the want of sex are expressed by different terminations in the substantive which denote objects so qualified." After showing that, in Latin, certain *terminations* were appropriated to expressing certain genders, he adds, "The quality [of sex] appears in nature as a modification of the substance and as it is thus expressed in language by a modification of the noun substantive which denotes that substance, the quality and the subject are, in this case, blended together, if I may say so, in the expression, in the same manner as they appear to be in the object and the idea

*It must be confessed that it is not in all cases easy for the mind to apprehend the nature of the relation pointed out by a preposition. The student will do well to familiarize his mind with *physical relations* in the first place, and moral will afterwards become more easily recognisable. In the following sentence it is at once perceived what relation the first *in* expresses, but much more difficult to get the distinct idea meant to be conveyed by the second:—"Diogenes sat *in* a tub, but he was generally *in* good humour."

Hence the origin of the masculine, feminine, and neuter genders, in all the ancient languages."

Admitting the truth as well as the ingenuity of this speculation, as far as regards ancient languages, it does not appear to be the *genius* of the English language to assign any particular termination (as we find in the Latin) to the different genders; there, are, however, some cases in which gender may be recognised, from the mere termination of the noun, as will appear from the following table:—

MASCULINE.	FEMININE.
Actor	Actress
Governor	Governess
Heir	Heiress
Lion	Lioness
Master	Mistress.

In some cases, difference of sex is expressed by a totally different word, and the gender cannot be known but by knowing the exact idea attached to the word. Of this sort are the following:—

MASCULINE.	FEMININE.
Boy	Girl
Father	Mother
Brother	Sister.

Sometimes the same word is applied to males and females indiscriminately; and when we wish to distinguish the sex, we prefix another word. Thus, the word *servant* signifies either a male or female; but if we desire to notify which, we can use the compound words *man-servant* or *maid-servant*. Of the same kind are *he-goat* and *she-goat*, *cock-sparrow* and *hen-sparrow*, and many others.

CASE.—Case is that accident of a noun which points out the relation which it bears to other parts of the sentence.

Nouns have three Cases—Nominative, Possessive, and Objective.

The noun is said to be in the Nominative, when it is the subject of discourse, and represents the person or thing of whom or which some assertion is made. Thus, in the sentence, "John reads," the proper noun *John* is said to be in the nominative, because it names the person of whom the assertion *reads* is made.

The possessive represents a vast variety of relations, but the principal one is that of ownership or possession. Thus, "John's book is lost," where *John's* is in the possessive, because it names the owner of the *book*.*

The inflection of the Possessive Case (the only case in English that has an inflection) corresponds exactly in import to the preposition *of*. In the line,

"An angel's virtues and a woman's love,"

we could easily dispense with the possessive, and introduce the preposition, where the whole meaning would be preserved; thus,

The virtues *of* an angel and the love *of* a woman.

Adam Smith asserts that inflections would probably be made before *prepositions* were invented; observing very justly, that it requires much less *abstraction* to express the nature of the relation that subsists between two objects *by a change on the name denoting one of them*, than to call into use a class of words expressing relation and nothing else. "To express relation by a variation in the name of the correlative object, requiring neither abstraction nor generalization, nor comparison of any kind, would at first be much more natural and easy than to express it by those general words called prepositions, of which the first invention must have demanded some degree of all these operations."

This speculation is exceedingly ingenious; but whether it be true in general is, to say the least, doubtful; and as far as the possessive of the English noun goes, it must be allowed, we think, to be wide of the truth.

The noun is in the Objective Case—1st, when it names the *object* on which the action expressed *by* a transitive verb operates; and, 2d, when it names the thing *shown* to be related to something else by a preposition. In the sentence, "John destroyed his book," *book* is expressing the *object* on which the verbal action operates; it is therefore said to be in the objective case. Again, in the sentence, "The cloud rises over the hill," *hill* is in the objective, because it is the word shown to be related to *cloud* by the preposition *over*.

The Nominative and Objective of nouns are alike in form; and it is only by observing how the noun stands related to other words that we can say when it is in the one and when in the other. To decide on the case of a noun, we must "look before and after." The Possessive, however, may be recognised by its form, as well as by its function, as it for the most part ends with 's in the singular, and ' after the *s* in the plural.

A noun is thus declined:—

	SINGULAR.	PLURAL.
Nominative.	Brother	Brothers.
Possessive.	Brother's	Brothers'.
Objective.	Brother	Brothers.

When the plural does not end in *s*, the Possessive is formed in the same way as the singular; thus,

	SINGULAR.	PLURAL.
Nominative.	Man	Men
Possessive.	Man's	Men's
Objective.	Man.	Men.

Inflection of Adjectives.

In many languages, the Adjective is changed in termination to correspond with the noun which it qualifies; but in the English tongue there is no such modification; and here, as in many other respects, our language seems superior in metaphysical propriety to most others, because the accident of gender cannot properly belong to a quality which is itself but an accident and no self-existing thing. "Gender, it is to be observed, cannot properly belong to a noun adjective, the signification of which is always precisely the same, to whatever species of substantives it is applied. When we say 'a great man,' 'a great woman,' the word *great* has precisely the same meaning in both cases, and the difference of the sex in the subjects to which it may be applied makes no sort of difference in its signification. *Magnus, magna, magnum*, in the same manner, are words which express precisely the same quality, and the change of the termination is accompanied with no sort of variation in the meaning. Sex and gender are qualities that belong to substances, but cannot belong to the qualities of substances."*

But while the nature of the thing which the adjective is employed to express cannot be varied, yet it may exist in different proportions; and hence the adjective is varied to express different degrees of the quality indicated by it, and these variations are called Degrees of Comparison.

When the simple quality is denoted, the adjective is said to be in the Positive Degree. When a higher

* Concerning the origin of the possessive case, English grammarians and critics are not agreed. Some maintain that it is what we may call indigenous to the language, corresponding, they affirm, to an inflection of the Saxon noun; but we rather incline to the opinion of Addison, who thinks that the possessive termination is only a contraction for the pronoun *his*. Had the *possessive* case been native to our tongue, it is hardly conceivable that the translators of the Bible would have used such an expression as "Asa his heart was perfect." It has been ingeniously objected to Addison's explanation, that while it is very easy to see how "the king his crown" might have been contracted or corrupted into "the king's crown," it is impossible to imagine that "the queen her crown" or "the children their bread" could have been subjected to the same contraction. But surely this objection is not unanswerable; for when the convenience of the contraction was seen in the case of singular nouns masculine, it might very easily be transferred to nouns feminine and plural. We would not be understood, however, to speak confidently on the point; and in whatever way the possessive was introduced, it is now impossible, supposing it were desirable, to displace it.

* Adam Smith.

degree is signified, the adjective is in the Comparative; and when the highest degree is expressed, it is said to be in the Superlative. Logically considered, indeed, the *positive* involves the idea of comparison as much as the comparative: thus, when we affirm of a mountain that it is *lofty*, we must have a tacit reference to other mountains; when we affirm of any particular river that it is *rapid*, we (unconsciously, perhaps, but yet actually) make a comparison between it and some other rivers. We consider it, therefore, impossible to state any essential difference between the *degrees of comparison*; but, in addition to what we have already said, we may mention that the *comparative degree* denotes that the quality expressed by it belongs to one of two objects in a greater degree than to the other; and the superlative, that it belongs to one of several in a greater degree than to any of the rest. For example, when we say that the line A—— is longer than the line B——, the meaning is, that both lines have a certain quality—length, but that A has more of it than B. When the comparison is drawn between more things than two, we use the *superlative*. Thus, we say of the lines A——, B———, C———, D——, that C is the longest. In the same way, speaking of stone and wood, we might say, "Stone is the *harder* body of the two;" but if we are discoursing of iron, stone, and wood, we must use the superlative, and say, "Iron is the *hardest* body of the three."

The whole class of Numeral Adjectives, from their very nature, cannot be in any other degree than the positive; and, with respect to Attributive Adjectives, it is to be observed that those only which express a quality which may exist in greater or less proportions, can be compared: for instance, if the exact *ideas* represented by the words, *circular*, *square*, *triangular*, and also such words as *chief*, *extreme*, *universal*, and *eternal*, be apprehended by the mind, by the very act of apprehension it will be seen that it would be contradictory to their nature to admit of any increase. Let the student reflect on this, and then he will be able to dispense with rules about the use of *chief*, *perpendicular*, &c., because he will see at once, from the nature of the idea suggested by the word, whether it admits of increase or diminution.

The Comparative is formed by adding *er* to the Positive, if it end with a consonant, and *r* simply, if it end in the vowel *e*; thus, hard, harder; large, larger.

Adjectives compared in this manner are called Regular; but some adjectives follow no rule in forming their degrees of comparison, and these are called Irregular. The following are those most commonly in use:—

POSITIVE.	COMPARATIVE.	SUPERLATIVE.
Good	Better	Best
Bad	Worse	Worst
Little	Less	Least
Much *or* many.	More.	Most.

Sometimes the same idea is conveyed by prefixing an adverb to the adjective in its simple state: thus, instead of saying *juster*, we might say *more just*: but it is not therefore to be inferred that *more just* is the comparison of *just*. Were this principle admitted, we should soon be in inextricable confusion. In such cases *more* is an adverb in the comparative, qualifying the adjective *just*, and the two words should be parsed separately. The prefixing of an adverb cannot, with any justice, be called a variation of the adjective.

A few adjectives have a plural form, particularly the demonstrative, *this* and *that*: in the plural, *these* and *those*: *one other*, and *another*, are also sometimes varied by number or case.

Inflection of Pronouns.

The Pronoun is varied by Gender, Number, Person, and Case.

The Personal Pronouns are thus declined:

SINGULAR NUMBER.

	NOMINATIVE.	POSSESSIVE.	OBJECTIVE.
1st *Person*,	I	Mine	Me
2d "	Thou	Thine	Thee
3d "	He, she, it.	His, hers, its.	Him, her, it.

PLURAL NUMBER.

	NOMINATIVE.	POSSESSIVE.	OBJECTIVE.
1st *Person*,	We	Ours	Us
2d "	Ye *or* you	Yours	You
3d "	They	Theirs	Them.

By inspecting the two following lines, the student will understand what we meant by saying, that the Possessive Pronouns, or, as we prefer calling them, Pronominal Adjectives, were derived from, and corresponded with, the Personal Pronouns.

I	thou	he	she	it	we	you	they.
mine	thine	his	hers	its	ours	yours	theirs.

The Relative and Interrogative Pronouns, *who* and *which*, are alike in both numbers, and are thus declined:—

	Who.	*Which.*
Nominative.	Who	Which
Possessive.	Whose	Whose
Objective.	Whom.	Which.

That and *as* are indeclinable.

Inflection of Verbs.

The Verb is varied in *four* ways—Number, Person, Mood, and Tense.

There are two Numbers, Singular and Plural, as in the case of the noun; and three persons, as in the pronouns.

The Moods are generally reckoned *five* in number—the Indicative, the Subjunctive, the Potential, the Imperative, and the Infinitive. But it may well be questioned if there is any real ground for such distinction, as far at least as the Subjunctive and Potential are concerned. The Subjunctive, as it is called, is merely an elliptical mode of expression, and the Potential is made up of two or more verbs, and therefore it can with no propriety be called an *inflection* of any one of them.

This leaves us the Indicative, by which simple assertions are made; the Imperative, by which commands are issued; and the Infinitive, which is neither more nor less than the name of the verb, and in use corresponds exactly to a noun.

The Tenses are two in number—the Present and the Past: the Future is not expressed by any *inflection* of the verb in English, as it is in Latin, French, and other languages, but by the help of another verb; and it is surely absurd to force a distinction upon the English verb, merely because it exists in Latin.*

The Participles of the verb are likewise two in number—the Perfect and the Imperfect. They are often called the Present and Past, but in themselves they have no reference to time, and merely indicate the *completion* or *non-completion* of an action.

According to this view of the verb—the only consistent one—it has no such thing as a passive voice. What is called the passive voice is not formed by any variety of termination, and so cannot be acknowledged as an *inflection*, without opening a door to all manner of confusion.

"The English verb," says Crombie, "has only one voice, namely, the active. Dr. Lowth, and most other grammarians, have assigned it two voices—active and

* "A little reflection may, I think, suffice to convince any person, that we have no more business with *a future tense* in our language than we have with the whole system of Latin moods and tenses: because we have no modification of our verbs to correspond to it: and if we had never heard of a future tense in some other language, we should no more have given a particular name to the combination of the verb with the auxiliary *shall* or *will*, than to those that are made with the auxiliaries *do*, *have*, *can*, *must*, or any other."—PRIESTLEY'S *Rudiments of English Grammar.*

passive. Lowth has, in this instance, not only violated the simplicity of our language, but has also advanced an opinion inconsistent with his own principles. For, if he has justly excluded from the number of cases in nouns, and moods in verbs, those which are not formed by inflection, but by the addition of prepositions and auxiliary verbs, there is equal reason for rejecting a passive voice, if it be not formed by variety of termination. Were I to ask him why he denies *from a king* to be an ablative case, or *I may love* to be the potential mood, he would answer, and very truly, that those only can be justly regarded as cases or moods which, by a different form of the noun or verb, express a different relation or a different mode of existence. If this answer be satisfactory, there can be no good reason for assigning to our language a passive voice, when that voice is formed not by inflection but by an auxiliary verb. *Doceor* [being an inflection of the word *doceo*] is truly a passive voice; but *I am taught* cannot, without impropriety, be considered as such."*

By *conjugating* a verb, is meant mentioning the present and past tenses and the perfect participle.

The past tense and perfect participle are formed from the present tense by adding *ed*, if it end in a consonant, as *rain, rained*, and simply *d* if it end in a vowel, as *change, changed*.

If these parts are formed in any other way, the verb is called Irregular; and if it wants any of these, it is said to be Defective.

We subjoin a few of the Irregular Verbs in most frequent use, or in which mistakes are apt to arise:—

PRESENT.	PAST.	PERFECT PARTICIPLE.
Am	was	been
Awake	awoke	awaked
Bear	bore	born
Beseech	besought	besought
Bereave	bereft	bereft
Bid	bade	bid
Choose	chose	chosen
Cleave	cleft, clave	cleft, cloven
Clothe	clothed	clothed, clad
Crow	crew	crowed
Deal	dealt	dealt
Drink	drank	drunk, drunken
Eat	ate	eaten
Fly	flew	flown
Hang	hung	hung
Lay (to deposit)	laid	laid
Lie (as on a bed)	lay	lain
Rive	rived	riven
Run	ran	run
Shrink	shrunk	shrunk
Shoe	shod	shod
Slink	slunk	slunk
Spit	spit	spit
Tread	trod	trodden
Win	won	won

The Regular Verb is thus inflected:—

To Love.

Present Tense.	*Past Tense.*	*Perfect Participle.*
Love.	Loved.	Loved.

PRESENT TENSE.

SINGULAR.		PLURAL.	
1st *Person,*	I love	1st *Person,*	We love
2d "	Thou lovest	2d "	Ye *or* you love
3d "	He loves.	3d "	They love.

PAST TENSE.

SINGULAR.	PLURAL.
1. I loved	1. We loved
2. Thou lovedst	2. Ye *or* you loved
3. He loved.	3. They loved.

Imperative, Love. *Infinitive,* To love.

PARTICIPLES.

Imperfect, Loving. *Perfect,* Loved.

The verb *To Write* is irregular, and is thus conjugated and declined:—

To Write.

Present Tense.	*Past Tense.*	*Perfect Participle.*
Write.	Wrote.	Written.

PRESENT TENSE.

SINGULAR.	PLURAL.
1. I write	1. We write
2. Thou writest	2. Ye *or* you write
3. He writes.	3. They write

PAST TENSE.

SINGULAR.	PLURAL.
1. I wrote	1. We wrote
2. Thou wrotest	2. Ye *or* you wrote
3. He wrote.	3. They wrote.

Imperative, Write. *Infinitive,* To write.

PARTICIPLES.

Imperfect, Writing. *Perfect.* Written.

The Irregular Verbs, *Be, Do, Have*, and the Defective Verbs, *Shall, Will, May, Can*, from their frequent occurrence, ought to be carefully examined. Tables of them are here presented:—

To Be.

Present Tense.	*Past Tense.*	*Perfect Participle.*
Am.	Was.	Been.

PRESENT TENSE.

SINGULAR.	PLURAL.
1. I am	1. We are
2. Thou art	2. Ye *or* you are
3. He is.	3. They are.

PAST TENSE.

SINGULAR.	PLURAL.
1. I was	1. We were
2. Thou wast	2. Ye *or* you were
3. He was.	3. They were.

Imperative, Be. *Infinitive,* To Be.

PARTICIPLES.

Imperfect, Being. *Perfect,* Been.

The verb To Be has a peculiar inflection, to express contingency or conditionality, which we here subjoin. It may be called the Conditional or Subjunctive Mood. In the case of other verbs, this form is elliptical.

CONDITIONAL TENSE OF THE VERB TO BE.

SINGULAR.	PLURAL.
1. I were	1. We were
2. Thou wert	2. Ye were
3. He were.	3. They were.

To Do.

Present Tense.	*Past Tense.*	*Perfect Participle.*
Do.	Did.	Done.

PRESENT TENSE.

SINGULAR.	PLURAL.
1. I do	1. We do
2. Thou doest *or* dost	2. Ye do
3. He does *or* doth.	3. They do.

PAST TENSE.

SINGULAR.	PLURAL.
1. I did	1. We did
2. Thou didst	2. Ye did
3. He did.	3. They did.

Imperative, Do. *Infinitive,* To Do.

PARTICIPLES.

Imperfect, Doing. *Perfect,* Done.

To Have.

Present Tense.	*Past Tense.*	*Perfect Participle.*
Have.	Had.	Had.

PRESENT TENSE.		PAST TENSE.	
SINGULAR.	PLURAL.	SINGULAR.	PLURAL.
1. I have	1. We have	1. I had	1. We had
2. Thou hast	2. Ye have	2. Thou hadst	2. Ye had
3. He has.	3. They have.	3. He had	3. They had

Imperative, Have. *Infinitive,* To have.

PARTICIPLES.

Imperfect, Having. *Perfect,* Had.

Shall.

PRESENT TENSE.		PAST TENSE.	
SINGULAR.	PLURAL.	SINGULAR.	PLURAL.
1. I shall	1. We shall	1. I should	1. We should
2. Thou shalt	2. Ye shall	2. Thou shouldst	2. Ye should
3. He shall.	3. They shall.	3. He should.	3. They should

* The Etymology and Syntax of the English Language, p. 94

WILL.

PRESENT TENSE.		PAST TENSE.	
SINGULAR.	PLURAL.	SINGULAR.	PLURAL.
1. I will	1. We will	1. I would	1. We would
2. Thou wilt	2. Ye will	2. Thou wouldst	2. Ye would
3. He will.	3. They will.	3. He would.	3. They would.

MAY.

PRESENT TENSE.		PAST TENSE.	
SINGULAR.	PLURAL.	SINGULAR.	PLURAL.
1. I may	1. We may	1. I might	1. We might
2. Thou mayst	2. Ye may	2. Thou mightst	2. Ye might
3. He may.	3. They may.	3. He might.	3. They might.

CAN.

PRESENT TENSE.		PAST TENSE.	
SINGULAR.	PLURAL.	SINGULAR.	PLURAL.
1. I can	1. We can	1. I could	1. We could
2. Thou canst	2. Ye can	2. Thou couldst	2. Ye could
3. He can.	3. They can.	3. He could.	3. They could.

INFLECTION OF ADVERBS.

Adverbs, for the most part, admit no modification or inflection: a few, however, are compared, like adjectives.

Some are Regular, as—

POSITIVE.	COMPARATIVE.	SUPERLATIVE.
Soon	Sooner	Soonest
Often	Oftener	Oftenest
Seldom	Seldomer	Seldomest.

Others are Irregular, as—

POSITIVE.	COMPARATIVE.	SUPERLATIVE.
Well	Better	Best
Badly *or* ill	Worse	Worst
Little	Less	Least
Much	More	Most.

The student will now be able to *parse* a sentence, mentioning not merely what part of speech any word is, but what *inflection* it has undergone, and how it stands related to other words. By way of example, we shall parse one sentence from Bacon.

"A single life doth well with churchmen; for charity will hardly water the ground where it must first fill a pool."

A, a numeral adjective, qualifying the noun *life*. It is commonly called the indefinite article.

Single, an attributive adjective, designating the noun life. It cannot be compared.

Life, a noun, singular in number, neuter gender, and the nominative case, because it is the thing of which something is asserted. The plural of *life* is *lives*.

Doth, a verb, because it asserts something of the noun *life*: it is in the present tense, indicative mood, and the third person singular, to agree with its noun *life*. *Doth* is now almost obsolete, *does* being the word in common use. The verb to do is conjugated thus: *Present Tense*, Do; *Past*, Did; *Perfect Participle*, Done.

Well, an adverb, expressing how "a single life doth." *Well* is in the positive degree, and is compared thus:—*Positive*, Well; *Comparative*, Better; *Superlative*, Best.

With, a preposition, used in a metaphorical sense, to connect *churchmen* with *single life*.

Churchmen, a noun plural, masculine, and the objective; being the object shown to be related to something else by the preposition *with*. The singular is *churchman*. All nouns, it should be remembered, are of the third person.

For, a conjunction, connecting the clause that follows with the one which went before.

Charity, a noun, being *primarily* the name of a disposition of mind, and *secondarily* of the course of action resulting from that disposition; singular, neuter, and the nominative to the verb *will*.

Will, a verb, present tense, singular number, and third person, to agree with *charity*.

Hardly is an adverb of degree, qualifying the verb *water*.

Water is a verb in the infinitive mood. *To*, the sign of the infinitive, is suppressed after a great number of verbs, and *will* is one of them. *Will* is a defective verb, and is conjugated thus:—*Present Tense*, Will; *Past Tense*, Would.

The, numeral adjective, or definite article, qualifying the noun *ground*.

Ground, a noun, singular, neuter, and the objective, being the *thing* which is affected by the verb *water*.

Where is of the nature of a conjunction, since it unites the two members of the last clause; but it also has in it the force of an adverb, being equivalent to *in the case in which*. We may therefore call it a conjunctive adverb.

It is a personal pronoun, singular, neuter, and the third person, supplying the place of the noun *charity*. *It* is the nominative to the verb *must*.

Must is a verb, asserting something of the pronoun *it*. It is in the present tense, and third person singular.

First is an adverb of time, qualifying the verb *fill*.

Fill is a verb in the *infinitive*, *to* being understood after *must*, in the same way as it was after *will*, in the former part of the sentence.

A, numeral adjective, or indefinite article, designating the noun *pool*.

Pool, a noun, singular, neuter, and objective case, being the thing affected by the transitive verb *fill*.

Additional Remarks.—Before quitting this division of our subject, we must inform the reader, that the same word is frequently used in different ways, and consequently belongs to different parts of speech. Nothing can be more certain that every word must have been originally significant of only one idea; but in the progress of language other ideas attach themselves to it, and the grammarian must not resist this extension of meaning, but carefully observe it. To discover, then, what class of words any word belongs to, we must "look before and after;" but a few examples will illustrate our meaning best.

"Come out of the *wet*." Here *wet* is a noun, because it is a name expressive of a certain state of the elements. "John threw off his *wet* clothes." Here *wet* is an adjective, because it qualifies the noun *clothes*. "A shower came on and *wet* the ground." Here *wet* is a verb, because it expresses an action. The shower did something—"wet the ground."

On the following examples let the student exercise himself, in satisfying himself as to the justness of our assertions with regard to the *class* of those words which may belong to one or more.

1. The sun is the great source of *light* (noun). Feathers are *light* (adjec.)

2. Beloved, let us *love* (verb) one another; for *love* (noun) is of God.

3. Then he arose and rebuked the winds and the sea, and there was a great *calm* (noun).

> Thy brow is *calm* (adjec.) and bright,
> Wearing no trace of sorrow or of sin.
>
> To still the pang that conscience can impart,
> And *calm* (verb) the restless pulses of the heart.

4. How often have I loitered o'er thy *green* (noun),
Where humble happiness endear'd each scene.

> Yet wandering, I found, on my ruinous walk
> By the dial-stone aged and *green* (adjec.)

5. Thy *nightly* (adjec.) visits to my chamber made.

> When the blue wave rolls *nightly* (adverb)
> On deep Galilee

6. Yes! there are charms *that* (rel. pron.) scorn the spoiler time.

> Blessed are those,
> Whose blood and judgment are so well commingled,
> *That* (conjunc.) they are not a pipe for fortune's finger
> To sound what stop she pleases. Give me *that* (demon. adjec.) man
> *That* (rel. pron.) is not passion's slave, and I will wear him
> In my heart's core.

7. The common *still* (noun) can only be employed, &c.

> Hope quickens the *still* (adjec.) parts of life.
>
> Is this the Talbot so much feared abroad,
> That with his name the mothers *still* (verb) their babes?

It hath been anciently reported, and is *still* (adverb) received, &c.

John has been very foolish, *still* (conjunc.) I will not dismiss him.

Let the student further exercise himself in what respects one part of speech resembles another, and wherein it differs. He will find that the noun and pronoun, adjective and adverb, preposition and conjunction, resemble each other in some respects, but that they yet are quite distinct.

We conclude this subject with two brief extracts from Locke:—"Besides words which are names of ideas in the mind, there are a great many others that are made use of to signify the connection that the mind gives to ideas or propositions one with another. The mind, in communicating its thought to others, does not only need signs of the ideas it has then before it, but others also, to show or intimate some particular action of its own, at that time, relating to those ideas. This it does several ways; as *is* and *is not* are the general marks of the mind affirming or denying. But, besides affirmation or negation, without which there is in words no truth or falsehood, the mind does, in declaring its sentiments to others, connect not only the parts of propositions, but whole sentences, one to another, with their several relations and dependencies, to make a coherent discourse."

"Though prepositions and conjunctions are names well known in grammar, and the particles contained under them carefully ranked into their distinct subdivisions, yet he who would show the right use of particles, and what significancy and force they have, must take a little more pains, enter into his own thoughts, and observe nicely the several postures of his mind in discoursing."—*Human Understanding*, book iii. chap. 7.

Whoever wishes really to understand the nature and use of words, should study carefully the third book of Locke's invaluable essay.

III.—DERIVATION.

Derivation is that part of Etymology which traces words to their original form and signification.

The ideas attached to words are purely arbitrary and conventional; there being no reason, for instance, why the sound represented by the combination of letters f i r e, should suggest the idea of heat, while that of i c e, should give the notion of cold. From this principle it follows that the real import of any word can be ascertained only by induction, that is, by observing the common idea which it suggests in every different position that it may occupy. Some, indeed, have affirmed, that in order to ascertain with precision the philosophical import of a word, it is necessary to trace its progress historically, through all the successive meanings it has been employed to convey, from the moment that it was first introduced into the language; and others, not content with this, prosecute their etymological research till they arrive at the literal and primitive sense of the root from which it springs. But it may well be doubted if such a course of procedure is followed by any substantial benefit at all proportionate to the labour which it imposes on the student; and one thing is certain, that an appeal to etymology from use is altogether nugatory, and displays an utter ignorance of the nature and function of words. The derivation or pedigree of a word will by no means universally lead to its real meaning. Horne Tooke and his followers have employed themselves in tracing words to their sources, and with wonderful success; but their speculations, however interesting in some respects, are almost useless, as far as the grammar of our language is concerned; and, certainly, though that school of philologists should succeed to their utmost desire in chasing every word now in use up to some Icelandic or Gothic origin, it would in no way interfere with the present structure of the English tongue. It may be very interesting to trace our language from the period when it was only the rude jargon of wandering hordes of savages, down to the present time, when it is capable of expressing with precision the minutest distinctions of the metaphysician or the most glowing conceptions of the poet; but it belongs rather to the philologist to enter on such investigations than the grammarian. Still, some ground is common to both, and it is necessary to say a few words on the subject.

Words are divided into two classes, *Primitive* and *Derivative*.

A Primitive word is one not derived from any other word in the language: as, *man*, *school*.

A Derivative word is either compounded of two significant words in the language, or of one significant word and some termination that modifies its meaning as, *schoolman*, *scholar*.

The bulk of the English language is Anglo-Saxon, and so are the forms of its grammar. A considerable number of its words, however, are from the Latin, and not a few from the Greek, both as entire words, and as parts of words or prefixes.* The following is a list of these Prefixes, together with examples of the manner in which they enter into combination with other words.

LATIN PREFIXES.

A, *ab*, or *abs*, from; as *avert*, to turn from; *absolve*, to loose from; *abstract*, to draw from.
Ad, to; as, *adhere*, to stick to.
Am, round about; as, *ambition*, literally, a going round about.
Ante, before; as, *antecedent*.
Circum, round; as *circumnavigate*.
Con, together; as, *conjoin*, *convoke*.
Contra, against; as, *contradict*.
De, down; as, *destroy*, *demolish*.
Di or *dis*, asunder; as *divert*, *dissolve*.
E or *ex*, out of; as, *evolve*, *extract*.
Extra, beyond; as, *extraordinary*.
In, in, or into; as, *inject*.
Inter, between; as, *intervene*.
Intro, within; as, *introduce*.
Juxta, nigh to; as, *juxtaposition*.
Ob, in the way of; as, *obstacle*.
Per, through; as, *perforate*.
Post, after; as, *postpone*.
Pre, before; as, *prefix*.
Pro, instead of; as, *pronoun*.
Preter, beyond; as, *preternatural*.
Re, back; as, *replace*.
Retro, backward (implying motion); as *retrograde*.
Se, aside; as, *secede*.
Sub, under; as, *sublunary*.
Super, above; as, *superinduce*, *superfluous*.
Trans, across; as, *transport*, *transatlantic*.

GREEK PREFIXES.

A, without; as, *anomalous*, *amorphous*.
Amphi, both; as, *amphibious*.
Ana, up, through; as, *anatomy*.
Anti, against; as, *Antichrist*.
Apo, from, away; as, *apostate*.
Cata, down; as, *catastrophe*.
Dia, through; as, *diagonal*.
Epi, upon; as, *epilogue*, *epidemic*.
Hyper, overmuch; as *hypercritical*.
Hypo, under; as, *hypocrite*.
Meta, change; as, *metamorphosis*.
Para, near to; as, *paraphrase*.
Peri, round about; as *perimeter*.
Syn, together; as, *synod*, *synagogue*.

Affixes.

It is not so easy to trace the Affixes to their original meaning, as they now seldom retain any signification when taken by themselves, but are used merely to modify other words. We shall present a few of them, with examples, but we are far from thinking that the list is complete.

AFFIXES FORMING NOUNS.

an *ant* *ar* *ard* *ary* *eer* *ent* *er* *ist* *or* *ster*	denoting the agent or doer of a thing; as,	Tragedian, historian. Claimant, combatant. Scholar, liar. Drunkard, dotard. Adversary, actuary. Engineer, auctioneer. Adherent, correspondent. Accuser, believer. Apologist, chartist. Actor, creator. Punster, spinster.

AFFIXES FORMING VERBS.

en *fy* *ise* or *ize* *ate*	denoting to make or cause; as,	Harden, strengthen. Purify, clarify. Civilise, equalize. Alienate, assassinate.

AFFIXES FORMING ADJECTIVES.

ful *ous* *ly* *some* *y* *ical* *ive*	denoting full of, or [illegible]	Artful, beautiful. Bounteous, plenteous. Fatherly, homely. Troublesome, toilsome. Wealthy, mighty. Democratical, methodical. Expensive, instructive.

* The reader [illegible] to the article LANGUAGE, in this work for more inf[illegible] this point.

AFFIXES FORMING ABSTRACT NOUNS.

ment		Amusement, abatement.
ness		Goodness, hardness.
sion		Convulsion, expansion.
tion	denoting	Production, vindication.
ty	state of,	Piety, probity.
hood	considered	Childhood, manhood.
ship	abstractedly.	Friendship, courtship.
dom		Christendom, kingdom.
ric		Bishopric.
tude		Lassitude, fortitude.

All words must originally have had only one meaning, but subsequently they come to have various secondary significations. These are attached to them according to fixed laws of the association of ideas; but in the case of each individual word, the signification must be inferred from the relation which it bears to the other words with which it stands connected.

A very large and important class of words, whose primary signification refers to the operation of sensible things, are applied secondarily to modes of thinking; as, imagine, apprehend, comprehend, adhere, conceive, instil, disgust, disturbance, tranquillity, abstraction, sincere, foresight, penetration, acuteness, inclination, aversion, deliberation, sagacity, attention, &c. But the prosecution of this subject falls more within the province of the logician than the grammarian, and here we may draw our observations on derivation to a close.

SYNTAX.

Syntax, from two Greek words, *syn*, together, and *taxis*, a putting or placing, is that part of grammar which shows how words are connected and arranged.

Etymology, we have seen, treats of the materials of language, *individual words;* but it is the business of Syntax to point out by what rules these words are put together, so as to form *sentences*. By a *sentence*, is meant a number of words so united as to make sense; that is, to declare or affirm something: thus, the words, "The city of Edinburgh," do not form a sentence, because they declare nothing; but if we say, "The city of Edinburgh is the capital of Scotland," a distinct assertion is made, and therefore the words form a sentence.

We must here remind the reader, that every sentence must contain at least a subject and a predicate, the subject being the thing spoken of, and the predicate the action or state of being affirmed of it.

When the verb forming the predicate is transitive, the word which it affects is called the *object:* thus, in the sentence, "John learns his lesson," *John*, being the subject of discourse, is in the nominative, and *lesson*, being the thing affected by the predicate *learns*, is in the objective case.

RULES OF SYNTAX.

Rule I.—Nominative and Verb:

A verb agrees with its nominative in number and person; as, *I read, he learns.*

This rule is of very extensive application, and if understood in its full import, it will render useless many others that are commonly set down by grammarians. It may be expressed in more general terms, thus: "The number and person of the subject of a sentence determine the number and person of the verb. For example, in the sentence, 'John runs,' *John*, the subject, is singular, and, like all nouns, of the third person; we therefore use the third person singular of the verb, *runs*. Again, in the sentence "John and James read," the subject, *John* and *James*, expresses an idea of more than one, and so the verb must be plural, *read*, not *reads*, as it would have been had only one name been mentioned. In this sentence, "John or James intends to accompany me," it is obvious, from the very nature of the conjunction *or*, that *intention* is predicated or asserted only of one of the persons, and therefore the verb is in the singular, *intends*.

As collective nouns, though singular in form, may yet suggest the idea of plurality, they are joined either to a singular or a plural verb, according as the idea suggested is that of unity or plurality. Thus, when we say, "The army *is* on its march," we seem to lose sight of the individuals composing the idea represented by the word *army*, and speak of it as one mass; but if we say, "The peasantry *go* barefooted," this mode of expression seems to give us an idea of a number of people existing separately, and we therefore put the verb in the plural. With respect to the collective noun, the only thing further to be observed is, that if in one part of a sentence it is made to stand as singular, it ought not in another to be used as plural.

A noun is sometimes put in the nominative, even when it is not the *subject* of the sentence, but merely stands connected with a participle; thus, in these lines of Cowper—

> "Thou, as a gallant bark from Albion's coast
> (The *storms* all weather'd and the *ocean* cross'd)
> Shoots into port," &c.

The words *storms* and *ocean*, joined to the participles *weathered* and *crossed*, are neither the nominatives to any verb, nor are they the *object* affected by a transitive verb or a preposition. Still they are in the nominative; and this construction is known among grammarians as the nominative absolute. Some grammarians, indeed, contend, and not without reason, that there is an absolute case, quite distinct from the nominative; and that to speak of the "nominative absolute" involves a contradiction of ideas. It must at once be conceded, that the noun conveys very different ideas in the two cases referred to, and we cannot well deny that they ought to have separate names, in the same manner as we give different names to the nominative and objective, although they are the same in form.

In every case, the *idea* represented by the *subject* must be carefully noticed, and then the *predicate* be conformed to it.

To each rule, we shall subjoin a few examples of erroneous construction, being persuaded, in common with Crombie, of the truth of Lowth's remark, that a good way "of teaching right, is to show what is wrong."

1. This *course* of lectures *were* delivered last spring.
2. In the human species, the *influence* of reason and instinct *are* generally assisted by the lessons of experience.
3. *Was you* present at the meeting?
4. There *are abundance* of treatises on that subject.
5. At this time *the House of Commons were* of little weight.
6. *Every one* of these theories *are* unfounded.
7. *Was* the *master and his scholars* there?

Rule II.—Possessive Case.

When the relation of ownership is to be pointed out the Possessive Case of the noun denoting the owner is used: thus, "This is John's hat." Here the relation of ownership is to be declared as existing between the person *John* and the thing *hat*, and consequently the name of the possessor is put in the possessive case.

If the name of the owner be a compound name, the last of the component parts only receives the sign of the possessive: thus, "The Queen of Great Britain's prerogative; also when there are two separate names, as, "Robertson and Reid's office."

1. This is John Thompson *his* book.
2. James is in *Walker's and Son's* office.
3. Charles is a member of the *Mechanic's* Institution.
4. Have you read *Chamber's* Journal.

Rule III.—Objective Case.

Active transitive verbs and prepositions take the Objective Case after them: thus, "Do justice love *mercy* and walk humbly with *God*." In this sentence, *justice* and *mercy* are in the objective, being affected by the verbs *do* and *love* respectively; and *God* is also in the objective, being the object of the relation pointed out by the preposition *with*.

Some active transitive verbs appear to take two objective cases after them; but it is much more consistent with the analogy of the language to understand a preposition: thus, "He sent me the book," where *me* and *book* are both in the objective. It is quite clear that *book* is the thing immediately affected by the verb *sent*, it therefore must be in the objective; but as to *me*, it seems most natural to understand the preposition *to*, when the sentence would be, "He sent the book to me." Ellipses of this sort are quite common, and it is altogether unnecessary to bring in any new rule or principle to account for idiomatic expressions thus produced.

Under this rule we may further observe, that all words denoting *measure*, whether of time or space, are capable of being put in the objective, a preposition being understood. Thus, in the sentences, "The wall is seven *feet* high," "I was three *days* in the country," the words *feet* and *days* are in the objective, the preposition *for* or *during* being understood. As, however, the nominative and objective of all nouns in English are alike, this remark must be allowed to be of limited utility.

1. I *told ye* that I would come.
2. *Who* should I *love*, if not my father?
3. Do you know *who* you speak *to?*
4. *He* that can doubt whether he be any thing or not, I speak *not to*.—LOCKE.

Rule IV.—Pronouns.

Pronouns agree in gender, number, person, and case with the nouns for which they stand, and are in all respects to be treated as the nouns would have been had they been used. In the sentence, "The master instructs *his* pupils," the pronoun supplies the place of the possessive case of the noun, *master*, which is of the singular number, third person, and masculine gender; we therefore use *his*, which corresponds to all this. Again, "John and James learn *their* lesson:" here *their* stands for two nouns, and so must be plural.

1.—Thou shalt also make a *laver* of brass, and *his* foot also of brass.
2. For my *name and memory*, I leave *it* to men's charitable speeches, and to foreign nations, and to the next age.—BACON.
3. Rebekah took goodly *raiment* that was in the house, and put *them* on Jacob.
4. I saw the whole *species* delivered from *their* sorrows.—ADDISON.
5. Those are the *birds whom* we call gregarious.

Rule V.—The Infinitive.

One verb governs another in the Infinitive: as, "He loves to study," where *to study* is the object of the verb *loves*.

Before the verb denoting the object of the predicating verb, the preposition *to* is generally put; and it is in this case called the *sign of the infinitive*. But as we already saw that the infinitive is nothing but a noun, the utility of this rule may well be questioned.

The sign *to* is omitted after the following verbs:—Bid, can, dare, feel, hear, let, make, may, must, need, shall, see, and will. We do not say, "He bade me to go," but, "He bade me go." The infinitive of a verb may also come after a noun or an adjective, as well as after another verb.

1. Sylla *obliged* them *submit* to such terms as the *senate were* pleased to impose. (See also Rule I.)
2. The king *caused* them *feel* the weight of his displeasure.
3. I *desired* him *call* in the evening.
4. You *need* not *to trouble* yourself on my account.
5. God *maketh* the sun *to rise* on the evil and on the good.

Rule VI.—Apposition.

Nouns and pronouns added to other nouns and pronouns to explain them, are put in the same case; thus, "Edinburgh, the capital of Scotland, is celebrated for its university." Here *Edinburgh*, being the subject of the sentence, is in the nominative; and the noun *capital*, with its adjunct *of Scotland*, being added to explain it, is in the nominative also. The two words in cases of this kind, are said by grammarians to be in apposition.

"Brutus killed Cæsar in the Capitol; him who had been his friend." Here *Cæsar* is in the objective, governed by the verb *killed;* and as the succeeding pronoun refers to it, it must be in the objective too. If it were *he*, there would be no violation of any rule in grammar, but a misrepresentation of a historical fact, as it would lead us to believe that Brutus befriended Cæsar, whereas it was Cæsar that had befriended Brutus.

There seems to be an exception to this rule in such expressions as "I called at Smith's the bookseller," where *Smith's* and *bookseller* are evidently marks of the same idea, but yet the one has the sign of the possessive ('s), which the other has not. As far as the possessive case (so called) is concerned, it is in most instances awkward to add any explanatory word to it; and the sentence runs much more smoothly if we use the preposition *of;* thus, "I called at the shop of Smith the bookseller," where both words are obviously in the objective.

1. Your *friend, him* whom you introduced to me yesterday, very soon departed.
2. Why do you treat *Mary Ann* so harshly, *she* who has always been so affectionate?
3. The *leader* was taken, *him* who defied the law.
4. I am going to see my *friends* in the country; *they* whom we met at the ferry.

Rule VII.—The Verb To Be.

The verb To Be has the same case after it as it has before it: thus, "*Alfred* was a good *king*." Here the work *king*, coming after the verb *was*, is in the nominative, because it is descriptive of *Alfred*, the subject of the sentence. "She, supposing *him* to be the *gardener*, saith unto him." Here *gardener* is to be considered in the objective, because *him*, going before the verb *to be*, is in the objective, governed by the verb *supposing*.

It requires very little penetration to perceive that this seventh rule is included in the sixth, for the verb *to be* does nothing more, in such cases, than mark that the two nouns between which it is put are different names for the same thing. On this subject, Mr. Mill reasons with his usual acuteness. In showing how the name of a class comes to be used for the name of an individual, he says, "I have the name of the individual, *John*, and the name of the class *man;* and I can set down my two names *John*, *man*, in juxtaposition. But this is not sufficient to effect the communication I desire, namely, that the word *man* is a mark of the same idea of which *John* is a mark, and a mark of other ideas along with it; those, to wit, of which James, Thomas, &c., are marks. To complete my contrivance, I invent a mark which, placed between my marks *John* and *man*, fixes the idea, I mean to convey, that *man* is another mark to that idea of which *John* is a mark, while it is a mark of other ideas of which James, Thomas, &c., are marks. For this purpose, we use in English the mark *is*. By help of this, my object is immediately attained."*

Those capable of understanding this dissertation, will immediately see the virtual identity of our sixth and seventh rules; but here, as in other cases, we have been anxious not to depart from the common doctrine, and a repetition of the rule, while it may be useful to some, can do harm to none.

1. You believe *it* to be *he*.
2. *It* was not *me* who said so.
3. *It* appeared to be — who carried on the business
4. Though I was blamed, *it* could not have been *me*.

* Analysis [illegible] I. p. 117.

These we take to be the great leading principles on which the Syntax of the English language is founded, and by the thorough understanding of which, the student will be enabled to see the construction of almost any sentence. Many grammarians, some of whom—particularly Crombie and McCulloch—we highly respect, have given many more; but we adhere to the decision of the dictator of English literature, who says, that "our language has so little inflection or variety of terminations that its construction neither requires nor admits any rules."*

A few miscellaneous remarks (we cannot dignify them with the name of rules) will conclude this part of our subject.

1. Every adjective must qualify a noun, either expressed or understood: thus, in the lines—

> "*Auspicious* Hope! in thy *sweet* garden grow
> Wreaths for *each* toil, a charm for *every* wo,"

every adjective is immediately followed by its noun. But in this,

> "*Few* shall part where *many* meet,"

the noun *men* is obviously understood.

We have already seen that *a* and *an* (commonly called the indefinite article) are identical in meaning; but there is this difference in their application, that *a* is prefixed to words beginning with the sound of a consonant, the long sound of *u*, and vowels sounding like *w*; and *an*, to words which begin with the sound of a vowel. Thus, we say, *a* man, but *an* ox; *a* house, but *an* hospital; *a* one-horse coach; *a* unicorn; *an* easterly wind, &c.

2. The exact import of the four words, *each*, *every*, *either*, and *neither*, which are known by the name of Distributive Adjectives, ought to be carefully attended to, and, from their very meaning, it will appear that they must always be joined to a noun in the singular.

Each means the one and the other of two: thus, Cowper, in his ode, "The Lily and the Rose," says properly—

> "Until a third [flower] surpass you both,
> Let *each* be deemed a queen."

Every refers to any number more than two, considered individually: thus, Byron, referring to the unfortunate separation of himself and Lady Byron, says—

> "Both shall live, but *every* morrow
> Wake us from a widow'd bed."

Either means the one *or* the other of two; *neither*, not either, not the one *nor* the other of two. The use of both words is seen in these lines—

> ——"Lepidus flatters both,
> Of both is flattered: but he *neither* loves,
> Nor *either* cares for him."—SHAKSPEARE.

Milton makes a wrong use of *either* in these lines—

> ——"She was cheer'd,
> But silently a gentle tear let fall
> From *either* eye."

3. In English, as already noticed, the adjective is not generally inflected for any purpose except to express degrees of comparison; but to this remark there are two exceptions. These are the Demonstrative Adjectives *this* and *that*, which have corresponding plurals, *these* and *those*: thus, we say, *this* man, but *these* men; *that* map, but *those* maps.

4. It is not the office of an adjective to qualify either a verb or another adjective; this must be done by an adverb. We do not say, "James reads *good*," but "James reads *well*." "I am myself *indifferent* honest," should be, "I am myself *indifferently* honest."

"In general, no quality, when considered in concrete, or as qualifying some particular subject, can itself be conceived as the subject of any other quality, though, when considered in abstract it may. No adjective, therefore, can qualify any other adjective. A *great good man*, means a man who is both *great* and *good*. Both the adjectives qualify the substantive; they do not qualify one another."—*Adam Smith.*

That this is the *genius* of our language, admits not of reasonable doubt; but there are several exceptions. We speak of a thing as being of a *florid red* colour, and of iron as being *red hot*. We say, "a *great many* were present;" "the doors were *wide open*;" Byron speaks of the "*pale blue* sky;"—in all which cases it is quite clear that the first adjective, in some degree, modifies the second. Whether this idiom is capable of being *metaphysically* defended against the reasoning of Smith, or whether such expressions are to be regarded as, to use the words of Johnson, "spots impressed so deep in the English language, that criticism can never wash them away," is a question into the discussion of which we shall not enter. About the *authority* of the expressions there can be no dispute.

It was already pointed out that certain adjectives, from their very nature, do not admit of comparison; and it should now be observed that, for the same reason, many of them, such as *universal*, *omnipotent*, and others, whose signification cannot be increased, ought not to be qualified by any adverb.

5. Tautological expressions ought to be avoided, and no word should be introduced into a sentence which has not some distinct function to perform.

"From whence came he?" should be, "Whence came he?" because, as we already saw, *whence*, in itself, means "*from* what place." Again, in the sentence, "I doubt not but that he will come," it is obvious, on a little reflection, that the idea intended would be completely conveyed by this form of expression—"I doubt not that he will come," and the insertion of *but* serves no useful purpose. By reversing the sentence, this may be more obvious—"He will come, I doubt not that (*thing*)."

In this sentence, taken from Goldsmith's *History of England*—"The New Englanders were determined to attack the royal forces as soon as *ever* they should march out of Boston"—the word *ever* is of no use, and consequently should be omitted.

Perhaps under the same remark might be included the following, which, however, from its extensive application, we shall keep separate.

6. Two negatives ought not to be used, unless affirmation is meant.

In this respect Bacon, Shakspeare, and Locke, and indeed all our early writers, frequently offend. Usage was in their times divided; but it has now become fixed, and that on the side of metaphysical propriety.

Bacon says—"The joys of parents are secret, and so are their griefs and fears; they cannot utter the one, *nor* will they *not* utter the other." Shakspeare says—

> "Be *not* too tame neither."

And again,

> "*Nor* do *not* saw the air too much."

Goldsmith, too, has violated the idiom of the English tongue in this respect, although he has offended in good company: "Never was a fleet more completely equipped, *nor never* had the nation more sanguine hopes of success." *Never* should be *ever*. "He is *not unjust*" is right, if we mean to express much the same idea as is conveyed by the words, "He is just." By some it is maintained that this mode of expression strengthens the affirmation, and certainly it may do so in spoken language; but in writing it serves only to introduce ambiguity, and so ought to be avoided.

7. Certain conjunctions go in pairs: thus, both, and; either, or; neither, nor; though *or* although, yet; whether, or; so, that; not only *or* not merely, but also; so, as; as, as; such, as. Most of these words are conjunctions, but not all.

"I will *neither* come or send" is wrong; because *or* is not the correlative of neither: it ought to be, "I will *either* come *or* send," or, "I will *neither* come *nor* send."

* Dr. Johnson. Preface to Dictionary.

8. Derivative words generally take the same prepositions after them as their primitives.

Goldsmith offends again in saying, "Catiline was insatiable *of* wealth;" because we do not say to satiate (the primitive of insatiable) a person *of* wealth, but *with* wealth.

9. Certain prepositions are appropriated to certain words and phrases

We do not say, "To have faith *to* a person," but "*in* a person;" "To find a difficulty *with* doing a thing," but "*in* doing it;" "To differ *with* a person," but "*from* a person."

Such idiomatic expressions are only to be made familiar by an extensive and well-directed course of study; or, as Milton has it, "by a well-continued and judicious conversing among pure authors."

10. After the comparative degree, whether of adjectives or adverbs, and the adjective *other*, the conjunction *than* is used: thus, "*Better* is a little with righteousness, *than* great revenues without right;" "This is none *other than* the house of God." Shakspeare has offended against this idiom—

> "The sun no *sooner* shalt the mountains touch,
> *But* we will ship him hence."

But ought to be *than*. "Scarcely had Austria been crushed, *than* it was announced," &c.—GOLDSMITH. *Than* ought to be *when*.

11. The Perfect Participle, and not the Past Tense, is used after the verbs *have* and *be*.

This remark requires to be attended to in using irregular verbs, but in verbs that are regular, no mistake can arise, as both parts are the same. In nothing, we venture to remark, does defective scholarship sooner betray itself than in a wrong conjugation of the irregular verbs.

"They *had* from the beginning *begun* to embrace opposite systems."—GOLDSMITH. *Began* ought to be *begun*.

> "You must not think,
> That we are made of stuff so flat and dull,
> That we can let our beard *be shook* with danger."
> —SHAKSPEARE.

Shook should be *shaken*.

12. Adverbs ought to be placed so as to leave no doubt what word is affected by them.

"The negroes are to appear at church *only* in boots." By this position of *only*, it appears that the negroes were not to come to church unless "in boots," or with nothing else but boots; but the meaning intended was that they should appear at church, and no where else, in boots. The sentence should therefore have stood thus:—"The negroes are to appear only at church in boots." "Pompey played a despicable part *enough* betwixt them." *Enough* ought to be immediately after *despicable*. "Cæsar so turned the fate of the day, that the barbarians were *almost* cut off to a man." It ought to be, "were cut off *almost* to a man."

EXERCISES.

To all these remarks, we shall adjoin a few miscellaneous examples, on which the student may exercise himself. We shall refer to the Rule or Remark violated as we go on.

1. Are either of us to blame? (Rule I. Remark 2.)
2. Those kind of things give most satisfaction. (Rule I. Remark 3.)
3. I acted in compliance to his request. (Remark 8 and 9.)
4. Let such teach others who themselves excel.—POPE. (Remark 7.)
5. These new divines offered salvation upon easier terms, substituting practice to belief and a man's own efforts to a vicarious satisfaction.—AIKEN'S *Letters*. (Remark 9.)
6. There is nothing more pleases us as to have our performances praised. (Remark 10.)
7. Antony led the way direct to Italy. (Remark 4.)
8. Neither of them appealed to impotent laws which could afford them no protection.—ROBERTSON. (Rule IV. Remark 2.)
9. It is wonderful how preposterous the affairs of this world are managed.—FRANKLIN. (Remark 4.)
10. During the rest of his consular year, Bibulus could only escape outrage by not only avoiding all assemblies of the people, but every solemn and important meeting of the senate.—*History of Rome, Cabinet Cyclopædia*. (Remark 12.)
11. I never did repent for doing good,
    Nor shall not now.—SHAKSPEARE. (Remarks 6 and 9.)
12. The wisest princes need not think it any diminution to their greatness, or derogation to their sufficiency, to rely upon counsel.—BACON'S *Essays*. (Remark 9.)
13. The hostilities which twice interrupted the progress of the community, neither seemed to originate in any imperative claim of national honour or advantage.—WADE'S *British History*. (Remarks 12 and 7.)
14. It was observed to me, that in this country no man who is able to work need to go supperless to bed. This far he stated the fact.—COMBE'S *Notes on America*. (Rule V. Remark 4.)
15. When a nation forms a government, it is not wisdom but power which they place in the hands of the magistrate.—ROBERT HALL. (Rule IV.)
16. The leaders of the fleet and the army began mutually to accuse each other.—GOLDSMITH. (Remark 5.)
17. Royal proclamations continued as omnipotent as in the preceding reign.—WADE.
18. There have been three riots in England of late, each of which have been levelled against dissenters.—ROBERT HALL. (Remark 12.)

The student should now be so familiar with the *Rules of Syntax*, which are nothing but generalized facts regarding the customary modes of uniting words and sentences together, that he will be able to commit his thoughts to appropriate language; that is such as shall convey to others the exact meaning he has in his own mind. To do this, however, not merely with accuracy but with ease, besides attending to the rules of syntax, he must take care, first, that all the words he uses belong to the English tongue; and, secondly, that they be employed in their usual and recognised acceptation.

A word *not English* is termed a *barbarism*, and when used in a sense different from its established one, an *impropriety*; both should be equally avoided, either in writing or speaking.

PUNCTUATION.

Punctuation, or the insertion of *points* in written language, is usually considered a part of grammar, and a knowledge of its principles is desirable for correct literary composition. The introduction of points is said to be useful to mark places at which a pause of a lesser or greater length should be made in reading. This definition is not altogether wrong, but punctuation has much higher objects in view. Points are necessary for marking the parts or sections into which sentences and paragraphs are divided, so that the exact meaning or sense may be apprehended, and perfect regularity preserved. The real use of points, therefore, is to cut off and separate single words, or groups of words, from each other. Sometimes the separation need only be slight, and for this the point called the *comma* , is sufficient. For instance, "Providence has, I think, displayed a tenderness for mankind." Here there is a comma before and after "I think," because these two words express something thrust into the sentence, which should be kept in some measure distinct. The *semicolon* ; is used to mark a more perfect separation of words. In general, it cuts a sentence into two or more parts, one of which has a reference to the other. Thus, "Economy is no disgrace; for it is better to live on a little than to outlive a great deal." Here the sentence is in two sections, the semicolon marking the boundary of separation. The *colon* : signifies a still wider separation in the words of a sentence; but its qualifications are so indistinct, and so liable to misconception, that in practice it is now almost entirely disused, and the *period* or full stop . is employed in its stead.

The other marks used in written language are as follows:—The *mark of interrogation* ?, which is put after words asking a question; the *mark of admiration* !, put after any exclamation of surprise, lamentation, or scorn; the *dash* —, which is sometimes employed instead of a semicolon, or for any kindred purpose; and the *parenthesis* ( ), for enclosing a word or portion of a sentence foreign to the tenor of the sense. Good writers endeavour to avoid requiring either parenthetic marks or dashes, both of which indicate irregularities of thought and expression.

CONCLUSION.

We have now explained the Etymology and Syntax of the English tongue, so far as our limits permit; and, in drawing to a close, we may be allowed to impress on our readers the value of the science which we have been endeavouring to expound. If they have intelligently gone along with us in our various remarks, they will not be surprised when we assert that this department of human knowledge, if skilfully cultivated, will be productive of very valuable results. To understand the grammar of a sentence, is nothing more or less than to understand its sense, and to see clearly how its various parts are connected; while in learning to recognise the different modifications that words undergo, and the different arrangements of which they are susceptible, to express difference of thought, we have exercised many of the mental faculties, and in so far laid the foundation of what is much wanted, a just system of Logic.

The sources whence the student will derive effectual aid in the prosecution of this interesting subject, we have already pointed out incidentally; but let no one lament too much though he should not have access to them. Rather let him, by additional thought on his own part, make up for the deficiency, and he may rest assured that, by accustoming himself to mark the different modes of expression he meets with in reputable authors, *a system of grammar will evolve itself*, which will be all the more valued—if we may not say valuable—that it has been wrought out by his own exertions, and not received by tradition or passively from the hands of another. Following this plan, the real method of induction, he will either reproduce the rules which we have set before him, or else see their erroneousness. So that, in either case, we shall deserve well of him; for, if we are right in any thing, we shall have served as a guide to him; and in those points where we have erred, we shall have put him on the way to find out our errors. We know very well that the pupil cannot see with our eyes, and we have, therefore, only endeavoured to direct his attention to such objects as he may see with his own. So far as he sees, he should believe, and no farther. To dogmatize is the method of a grammatist, but our ambition has been to act the part of a philosophical grammarian, and, as such, we cannot conclude without warning our readers never to forget that words in themselves are nothing, and that they are only valuable in so far as they are the symbols of ideas. Beautifully and justly has Johnson said, "Words are the daughters of earth, and things only are the sons of heaven." Language is but a vehicle of thought, or, at best, its instrument, and to view it as an "end unto itself," is the vain humour of a pedant. Let none be so taken up with words as to forget solid things.

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COMMON ERRORS CORRECTED

The remaining space of the present article could scarcely, we think, be better employed than in enumerating some examples of the most common errors in the pronunciation and selection of words. In every part of the country there are some peculiar vices of speech, which have been handed down from one generation to another, and are generally so inveterate in most minds, from the effect of early habit, that no cultivation which the mind may receive in mature life altogether obliterates them. For any one who has occasion to mix in refined society to be thus liable at every moment to the use of some barbarism of speech, is a misfortune of some magnitude; for nothing tends so much to convey a mean impression of his education and habits of life. The most beautiful young female, who, silent, appears a kind of divinity, is reduced at once to common earth when we hear a few inelegant words fall from her mouth. Coleridge somewhere tells that he was once much prepossessed in favour of an individual whom he met at a dinner-table, and who appeared a dignified and respectable person, until, some kind of fruit being introduced, he heard him exclaim, "Oh, them's the jockies for me!" Words are the exponents of conditions of mind, and, when mean ones are used, we unavoidably suppose the condition of mind to be mean.

ERRORS IN PRONUNCIATION.

The interchange of *w* for *v* and *v* for *w*, and the putting of the sound of *h* before words where it is inappropriate, and taking it away where it ought to be. *Examples*—Vill you vait to get some vine and wictuals? An 'ard boiled *hegg*.

The sound *k* instead of *g* at the ends of words. *Examples*—Somethin*k*, nothin*k*.

The addition of *r* at the ends of words ending in vowels. *Examples*—Idear, windor, Elizar.

Changing the termination *en* or *ain* into *ing*; as gar*ding* for garden, fount*ing* for fountain.

UNGRAMMATICAL FORMS.

Between you and *I*, there is a great want of conscientiousness in most partisans. *Correction*—Between you and me, &c.

I am not so proud as *him*. *Cor.*—As he.

You will do it better than *her*. *Cor.*—Than she.

May thou as well as me, be meek, patient, and forgiving. *Cor.*—As well as I, &c.

While the house *was being* built. *Cor.*—While the house was in the course of being built.

He *don't* go to town to-day. *Cor.*—He does not go to town to-day.

I *rather think* he is out of town. *Cor.*—I believe he is out of town.

I *had better* go myself. *Cor.*—It were better that I should go myself.

I *had oblige* to go. *Cor.*—I was obliged to go.

John is tall in comparison *to* James. *Cor.*—John is tall in comparison with James.

He is a *very rising* man. *Cor.*—He is rising very rapidly.

She *readied* a dish for us. *Cor.*—She cooked, or prepared, a dish for us.

She was a *superior* woman, or, She was a *most superior* woman. *Cor.*—Superior can only be used with regard to something else which is at the same time expressed; thus, She was a woman much superior to the generality of her sex.

Short-lived, long-lived. *Cor.*—Short-lifed, long-lifed.

The *then* Earl of Winchelsea; the *then* Mrs. Bennet. *Cor.*—The Earl of Winchelsea of that time; the Mrs. Bennet then living.

He *lays* asleep in the cabin. *Cor.*—He lies asleep in the cabin.

His health was *drank*. *Cor.*—His health was drunk. The dinner was all *eat* up. *Cor.*—The dinner was all eaten up.

I went to table and *eat* very heartily. *Cor.*—I went to table and ate very heartily.

A *couple of shillings*. *Cor.*—Couple can only be properly applied to objects in connection; as, a married couple, a couple of pointers.

John, James, and Robert, were sober workmen, the *latter* particularly so. *Cor.*—The last particularly so (the objects enumerated being more than two).

The Manchester Guardian is a *well-advertised* paper—meaning a paper which usually contains many advertisements. *Cor.*—The Manchester Guardian usually contains many advertisements, or—enjoys a large share of the patronage of advertisers.

I could not give him credit, *without* he changes his behaviour. *Cor.*—I could not give him credit, unless he changes his behaviour.

I will go, *except* I should be ill. *Cor.*—Unless I should be ill.

I saw them all, *unless* two or three. *Cor.*—I saw them all, except two or three.

I took some cream *into* a bowl. *Cor.*—I took some cream in a bowl.

I am going *for* to do it. *Cor.*—I am going to do it.

He was a devoted *antiquarian* all his days. *Cor.*—He was a devoted antiquary all his days. (*Antiquarian* is the adjective.)

James is going to be a *medical* man. *Cor.*—James is going to be a physician, surgeon, or medical practitioner.

He is *oftener* wrong than right. *Cor.*—He is more frequently wrong than right.

I have *no right* to pay this tax. I have *no right* to be distressed by that man's conduct. *Cor.*—I am under no obligation to pay this tax. I am not obliged to suffer from that man's conduct.

You will be *necessitated* to submit. *Cor.*—You will be obliged to submit.

Don't talk of *those* sort of things to me. *Cor.*—Don't talk of that sort of things to me. *Sort of things* is a mean and objectionable expression. "Things of that kind" is more elegant as well as correct.

The castle is seated *by* the Garonne. *Cor.*—The castle is seated beside the Garonne.

Lord Byron was born *at* London. There have been destructive fires *at* Edinburgh. *Cor.*—Lord Byron was born in London. There have been destructive fires in Edinburgh. (*At* is only proper with respect to a small town.)

I met him *on* the street. *Cor.*—I met him in the street.

I don't know, but I will inquire *at* my friend. *Cor.*—Of my friend.

Oh, I *will* fall, and nobody *shall* help me. *Cor.*—Oh, I shall fall, and nobody will help me.

I have been *to* London, and am now going *for* Liverpool. *Cor.*—I have been in London, and am now going to Liverpool.

They were some distance from home when the accident happened. *Cor.*—At some distance, &c.

He lives opposite the Royal Exchange. *Cor.*—Opposite to, &c.

The performance was approved *of* by all who understood it. *Cor.*—The performance was approved by all.

They attacked Northumberland's house, whom they put to death. *Cor.*—They attacked the house of Northumberland (or the Duke of Northumberland), whom they put to death.

It is true what he says, but it is not applicable to the point. *Cor.*—What he says is true, &c.

Together with the national debt, the greatest national advantages are *also* transmitted to succeeding generations. *Cor.*—*Also* is superfluous.

Failing in his effort, he *again* repeated it. *Cor.*—*Again* is superfluous.

He is *no way* thy inferior, and in this instance is *no ways* to blame. *Cor.*—He is in no wise thy inferior, and in this instance is not at all to blame.

He charged me with want of resolution, in which he was greatly mistaken. *Cor.*—He charged me with want of resolution, but in this censure he was greatly mistaken.

No *less* than two hundred scholars have been educated in that school. *Cor.*—No fewer, &c.

It is above a year since the time that I left school. *Cor.*—It is more than a year since I left school.

He was guilty of such atrocious conduct, that he was deserted by his friends for good and all. *Cor.*—He was guilty of conduct so atrocious, that he was entirely deserted by his friends.

OBSOLETE, AWKWARD, AND MEAN FORMS.

I had *as lief* do it myself as persuade another to do it. *Cor.*—I would as readily, &c.

He convinced his opponent by *sheer dint* of argument. *Cor.*—Entirely by force of argument.

He is *not a whit* better than those whom he so liberally condemns. *Cor.*—He is not in any degree, &c.

He *stands upon the bond*, and will not abate *a jot* of his claim. *Cor.*—He insists on the strict terms of the bond, and will not in the least abate his claim.

Good satin, *I take it*, is considerably superior to common silk. *Cor.*—I presume.

Politics too often *sets men by the ears*. When they *come to words*, and *fall out*, reason is generally lost sight of. I should not wonder but on this occasion there might be *broken heads going*. *Cor.*—Politics too often causes quarrels. When men enter into controversy and differ violently, reason is generally lost sight of. I should not wonder but on this occasion they might commit some violence on each other.

We shall have a *regular break-up* in the ministry. *Cor.*—We shall have a dissolution of the ministry.

He was very dexterous in *smelling out* the designs of his neighbours. *Cor.*—In penetrating, &c.

He is a *thorough-paced* knave. *Cor.*—He is a great knave.

Heretofore Hannibal had carried all before him; *wherefore* he had become very proud, listening to no advice *whatsoever*; *whereas* Scipio invariably took counsel from the most sagacious of his officers.—The words in Italics are all obsolete and objectionable.

He *wist* not what to do. *Cor.*—He knew not what to do.

He little *wots* of the storm that is brewing. *Cor.*—He is not aware, &c.

Topsy-turvy, *pell-mell*, *hurly-burly*, having a *month's mind* for a thing, *currying favour* with a person, *dancing attendance* on customers.—All objectionable, from their meanness.

We are *at one* on the slave question.

I happen to have a little leisure *upon my hands*.

He might have perceived it with *half an eye*.

We should always be glad to *put ourselves about* for our neighbours. *Cor.*—To put ourselves to a little inconvenience.

My father *left* this morning by the mail. *Cor.*—My father went away this morning, &c. "When are you to *leave?*" is, in like manner, vicious. The place or thing left should always be stated.

Slang phrases of all kinds should be received warily. The least objectionable are those which merely suggest comical ideas; those which tend to present light and jocular views of moral error are particularly detestable. It will be the aim of a well-bred and judicious person to make his discourse neither too nice and formal, nor too loose and homely, but as far as possible to preserve a medium between the select language employed in literature, and the familiar and perhaps temporary phraseology which prevails in ordinary society.

LOGIC.

INTRODUCTORY

It is generally observable that some men form clearer and more rational ideas upon most subjects than others. In a miscellaneous company, should any complicated question arise, a considerable number of the party will probably be found to treat it in a confused or partial manner, so as to have no effect in convincing each other; but after a great deal of wrangling, and perhaps some anger, it may be that some one who has not as yet opened his mouth, rises up and sets the whole matter in so clear a light, showing so well the whole of its bearings, that all the consequences likely to arise from what is involved in it, that the storm is silenced at once—all, or at least a large portion, of the company, being convinced that a correct and just view of the matter has at length been placed before them. Such is exactly the history of many questions that come before deliberative assemblies: all is confusion, until some leader stands up and gives a more than usually comprehensive and lucid view of the case, which carries the conviction of so many, that clear resolutions are formed, a measure is arranged, and the business of the house is allowed to advance. What is it that enables particular men thus to make all appear order where others could bring forth nothing but confusion? It is simply their possessing minds which, seeing many parts of a subject at once, detect the order in which they lie, the bearing they have upon each other, the truth of this, the fallacy of that, what effect such a thing will have, how far there is justice in such another thing, and so forth; while others, when called to consider such a subject, are, to use a common phrase, quite at sea in it, seeing nothing of it but some of its external parts, which they may fasten upon and discuss till they are tired, without ever advancing one step towards a wise conclusion.

It has been found, by attentive observation, that the mind in all these operations goes through certain defined courses, leading either to truth or error. It has, we may say, certain established modes of action, which are natural to it, and which must accordingly have characterized it always. To all of these modes of action appropriate terms have been given, in order that they may be recognisable—just as such words as noun, verb, case, tense, have been given to certain forms of speech which are the same in all languages. The operations of the mind, as far as reasoning is concerned, have thus been reduced into a science; in other words, methodically described as a part of the great scheme of nature. Logic is the name applied to this science.

The use of this science is easily shown. It is readily allowed that many men reason very clearly, in ordinary circumstances, without having been much instructed. They enjoy a natural sagacity which enables them to take a pretty large view of most subjects, and to consider their various parts with a good deal of precision. The same power enables them to steer clear of the ordinary sources of error. This class of men would be the first, in an early state of society, to make advances towards Logic as a scientific system. But even these men are obviously liable to derive great advantage, in their reasoning processes, from a knowledge of distinct terms for those processes, as well as for all the kinds and modes of error which lie along their way. The *thing* and the *term* together, once implanted in their minds, they know in an instant what to embrace and what to avoid on their own part, and also how to detect and render apparent the error in others, when it occurs. It is clear that, under favour of such knowledge, argument must be greatly facilitated, and much tedious contention avoided. With those who are not naturally powerful or clear reasoners, the same knowledge is calculated to be of infinitely greater use. We may fairly presume that, if such men were so well acquainted with the science of logic, that of any course their minds were taking they could say at once to themselves whether it was one of a legitimate kind, or one notorious for leading to error, they would be enabled, almost mechanically, to keep in right intellectual paths.

Thus Logic is, in the first place, a science, or the description of a department of nature. In the second place, it becomes an art, or means of teaching right modes of reasoning. For its value in the latter character, we have a good argument in the preface to the masterly work of Archbishop Whately. "Many," he says, "who allow the use of systematic principles in other things, are accustomed to cry up common sense as the sufficient and only safe guide in reasoning. Now, by common sense is meant, I apprehend (when the term is used with any distinct meaning), an exercise of the judgment unaided by art or any system of rules—such an exercise as we must necessarily employ in numberless cases of daily occurrence, which, having no established principles to guide us—no line of procedure, as it were, distinctly chalked out—we must needs act on the best extemporaneous conjectures we can form. He who is eminently skilful in doing this, is said to possess a superior degree of common sense. But that common sense is only our *second-best* guide—that the rules of art, if judiciously framed, are always desirable when they can be had—is an assertion for the truth of which I may appeal to the testimony of mankind in general; which is so much the more valuable, inasmuch as it may be accounted the testimony of *adversaries*. For the generality have a strong predilection in favour of common sense, except in those points in which they respectively possess the knowledge of a system of rules; but in those points they deride any one who trusts to unaided common sense. A sailor, for example, will perhaps despise the pretensions of medical men, and prefer treating a disease by common sense; but he would ridicule the proposal of navigating a ship by common sense, without regard to the maxims of nautical art. A physician, again, will perhaps contemn systems of political economy, of logic, or metaphysics, and insist on the superior wisdom of trusting to common sense in such matters; but he would never approve of trusting to common sense in the treatment of diseases. Neither, again, would the architect recommend a reliance on common sense alone in building, nor the musician in music, to the neglect of those systems of rules which, in their respective arts, have been deduced from scientific reasoning, aided by experience. And the induction might be extended to every department of practice. Since, therefore, each gives the preference to unassisted common sense only in those cases where he himself has nothing else to trust to, and invariably resorts to the rules of art wherever he possesses the knowledge of them, it is plain that mankind universally bear their testimony, though unconsciously and often unwillingly, to the preference of systematic knowledge to conjectural judgments."

INVESTIGATION.

Investigation, or the art of inquiring into the nature of causes and their operation, is a leading characteristic of reason, and may be defined as one of the essential distinctions between man and the lower animals. Investigation implies three things—*Observation*, *Hypothesis*, and *Experiment*. Observation is the act of noticing circumstances evident to the senses, for the purpose of acquiring a knowledge respecting them and their causes. Hypothesis is a supposition or conjecture relating to the cause of an effect. Experiment is putting in operation, or trying what will be the result of certain supposed causes.

The first step in the process, it will be perceived, is to *observe*. Powers of observation lie at the foundation of all excellence in art or science. All men who have attained eminence in literature have been close observers. They have noticed circumstances and treasured remembrances which common minds would have neglected. The late Sir Walter Scott observed all that passed under his eye; no expression escaped him, if it bore on the illustration of character. Reasoning from the first efforts of observation may be exemplified as follows:—

An agriculturist *observed* that a certain spot in one of his fields produced more grass than any other portion. He recollected that a certain quantity of rubbish had lain for some time on that spot; and *supposed* that the rubbish had been the cause of the greater fertility. To ascertain whether his *hypothesis* or conjecture was correct, he covered another spot with sand, but no such effect followed. He inferred, therefore, that the mere covering of the spot had not been the cause. He then *supposed* that some portion of the rubbish had possessed peculiar qualities, the nature of which he wished to discover. A portion of each ingredient of the rubbish was therefore deposited in separate places; and after some time it was found that in one of the places a similar degree of fertility prevailed. This *experiment* determined his hypothesis. He acquired a knowledge of what ingredient is useful in conferring fertility. This may be called following out a train of reasoning on observed circumstances to its proper results.

POWER, CAUSE, AND EFFECT.

In Logic, *Power* is the relation of circumstances to each other in time. *Cause* is the invariable antecedent or thing going before. *Effect* is the immediate invariable consequent, or the change produced by power. No effect can take place without a cause.

There are immediate or proximate causes, and also remote or final causes. It is of great importance that these should not be confounded with each other: neglect on this point has led to all manner of superstitions and errors. First, of proximate causes: When we pour water on salt, the salt melts. Water is therefore the *cause* of the melting; in other words, water possesses the *power* of causing salt to melt. The melting is the *effect*. Again: Atmospheric air is necessary for the growth of plants; it is one of the essential causes of the vegetation. Such are instances of the action of *immediate* causes, quite undeniable, for they have been determined by experiment. But the existence of immediate causes does not preclude the existence of remote causes. Thus, a remote cause of vegetable growth from atmospheric air is the nature of the air, and a more remote cause still, is the Being who made the air—the Great First Cause of all created things. Pursuing an inquiry of this kind is called tracing events or circumstances to their final causes—going back, step by step, till we reach, as we must invariably do, that Being who not only designed but sustains all by his Providence.

The Sign.—We must guard against the error of confounding signs with causes. Smoke accompanies the combustion of moist wood. The smoke is not the *cause* of the combustion; it is only a *sign* that there is combustion. The falling of mercury in the barometer does not cause rain; it is only a sign the atmosphere is in that condition which is likely to lead to rain.

Imaginary Causes.—In determining what are the causes of events, it is of importance, in the first place, to ascertain that the supposed causes exist. A king once called a number of men of science around him, and said, "How should it be, that when I fit up a balance with two scales, each of which bears a basin of water of equal weight, and I put a live fish into the basin in one of the scales, that scale does not preponderate?" The cause of this seeming wonder was immediately sought for, and created some little altercation, till one of the men, more ready-witted than the others, said boldly out that he disputed the fact; and the king, laughing, owned that he was in the right, and that his question was a joke. Here we have an instance of trying to discover the cause of a thing which was not founded in truth. It is clear that causes assigned for any such unproved and improbable circumstances must be imaginary.

Imaginary causes may also be such as persons are willing to consider true without investigation. A storm rises at sea and wrecks several vessels. Witches raise storms. An aged and poor woman is residing in a lonely cottage at no great distance on the shore. That old woman is a witch. She caused the storm which wrecked the vessels. Here we have a train of reasoning, such as has sent hundreds of aged females to the stake, but which rests on no solid foundation. Before proceeding to accuse the woman of witchcraft, it would be necessary to settle whether there were such beings as witches at all. Having proved this, which would be impossible, the next step would consist in determining whether this old woman, in particular, was a witch. And, last of all, whether she actually was concerned in raising the storm in question.

Confounding Cause with Effect.—Causes and effects are sometimes mistaken for each other, for want of a close examination of facts. It is not unusual to hear a person say that a shower brings a change of wind, whereas the wind is the cause of the shower. The appearance of small-pox on the outer surface of the body is by ignorant persons supposed to be the cause of the illness in that disease, whereas the external marks are an effect of an internal cause. The richness of certain soils is not an effect of the flourishing of certain vegetables upon them, but the cause of the flourishing. Much money circulating in a country is not the *cause* but the *effect* of wealth. In common speech, the mistaking of effect for cause is called "putting the cart before the horse."

Induction.

Having established the reality of a cause, and that, if certain circumstances be given, certain results will follow, we have furnished the mind with a sufficient degree of experience to know that when the same cause and circumstances are again produced, the same consequences will ensue. This is drawing an inference from ascertained truths, and in Logic is known by the term *induction*, which signifies the bringing in of valid conclusions. We have learned, by indisputable experience, that when a spark of fire falls on gunpowder, the gunpowder will explode. Therefore, when we see a spark is about to fall on any quantity of gunpowder near us, we infer, and justly, that an explosion will be the consequence.

Thus, induction is an inference from facts that have been established by observation, hypothesis, and experiment. If the observation has been defective, or not sufficiently extensive, the subsequent hypothesis will, in all probability, be defective also, and we may arrive at wrong conclusions. Should a traveller, on visiting a foreign country, see only a few people, and these have red hair, he would not be warranted, on returning home, to say that all the people of that country were red-haired. His induction would not be fair; it would be founded on limited observation, and liable to be disputed by others better acquainted with the country.

In some subjects, it is much easier to draw a just inference than in others; but in all cases, judgment and caution are required. A physician saw a case of fever last year; he saw another last month; and when he sees a third similar case, he infers that another person is about to have the same fever. The skill of the physician consists in judging whether he has examined a sufficient number of cases of fever to justify such a conclusion.

General Principles.

In reference to inanimate substances and the lower animals, two or three cases are generally sufficient to justify conclusions; but, in regard to mankind, who differ so much from one another, and are under the influence of so many external and various circumstances, a very extensive collection of facts is necessary. When a person draws conclusions from a large array of facts, he is said to deduce *general principles*, and these are often of great importance in regulating social life. Pains-taking men, by collecting a record of all the deaths which occur year after year in a country, and the ages of the persons at death, are able to form a correct inference as to the number per hundred out of the population who will die per annum, and also the ratio of deaths as respects the ages of the individuals. This affords an instance of fair induction. If the facts had been collected only from a single town or parish, and only for one or two years, the inference would have rested on too narrow a foundation, and consequently would not have been fair. The rules to be observed in deducing general principles are—1st, that the cases be true; and, 2d, that the facts be universal.

Theory.

A theory is a precise system of rules, intended to explain certain facts. The theory, to be correct, must rest on rules founded on a rigorous induction of things true or probable. In some instances, in forming theories, we require to take truths as being proved, although we cannot actually measure these truths by the evidence of the senses. The Newtonian theory of the planetary system, as sustained by contending forces, explains the phenomena and movements of the heavenly bodies, including our earth. But this theory, after all, is only conjectural. For instance, it is stated that all bodies let fall on the surface of our earth are attracted by gravitation in the direction of its centre; and that, if a body could get to the centre, there it would remain, even though unsupported by any tangible object. Now nobody ever was at the centre of the earth to see that this would be the case. We can only, in this as in many other cases in which personal experience is limited, accept of the reasonable inferences of learned men, founded on their examination of a wide array of facts, and reconcilable with all known phenomena. Hence, experience cannot stand in opposition to well-established theory. Without theory or general principles, experience is but a feeble guide.

ANALYSIS AND SYNTHESIS.

Analysis is taking any subject, first as a whole, and then taking it to pieces and viewing each part separately; in other words, proceeding from the complex to the simple. *Synthesis* is the reverse of this, and implies taking, first the separate parts, and after treating each individually, proceeding to the whole in combination.

When a chemist takes a quantity of mineral water for the purpose of discovering its ingredients, he separates the different elements, and is thus said to analyze the contents of the water. When, knowing the different ingredients, he forms each artificially, and puts them together to form a whole, he may be said to proceed synthetically. We may speak of the British constitution as a whole, and then analyze its component parts to prove the truth of our assertions; or we may first speak of each part separately, and then refer to them all in a united form. When a clergyman illustrates a doctrine by separate texts, he treats his subject analytically; when he reassembles the texts or heads of his discourse into an aggregate form, he treats the subject synthetically. The analysis and synthesis must agree. The same conclusion must be arrived at in both cases.

In delineating human character, general notions are resolved into individual parts. We begin with the more conspicuous traits of the character, and gradually descend to the more hidden principles of action and passion, and we may afterwards present the character synthetically, with a unity of appearance. In all subjects the mind follows the same plan. Analysis should be carried to that point at which the truth of the general principle we wish to find is ascertained.

Philosophical Arrangement.—The memory derives aid from philosophical arrangement; because knowledge so arranged is easily applied to use, in the same manner as goods put up in small parcels are more readily and advantageously handled than if their contents were lying in a state of confusion. It enables us also to ascertain the truths which may be deduced from general principles. For instance, lives are insured by fair inferences from philosophically arranged facts.

DISCOVERY AND INVENTION.

Discovery is finding out something already existing. *Invention* expresses the analogies of objects considered as means in reference to a particular end. Finding out the polarity of the magnet was a *discovery*; but the application of that discovery to the purposes of navigation was an *invention*. The mechanical powers are beautiful instances of invention. The lower animals do not invent; they betake themselves to the shelter of rocks during a storm, but they are never found to construct a building for shelter. Newton is said to have *discovered* the binomial theorem, because he only brought to light a truth formerly unknown; but he is said to have *invented* the method of fluxions, because he contrived a new method of *discovering* truth.

Invention facilitated.—Invention is facilitated by referring particular truths to general principles, or concentrating the attention to one subject.

ART AND SCIENCE.

Art is a knowledge convertible to practical purposes. *Science* is a knowledge of the principles of art. The object of art is to produce certain effects by the action of bodies upon each other; that of the latter is to ascertain the uniform relations of substances. All art must be founded upon science, because art implies knowledge acquired. The man who prescribes for disease, without having made a *fair induction*, is a mere empiric.

Difference of the Sciences.—The sciences differ only in their matter, or the nature of their truths. In the physical sciences, the relations we trace are uniform. Polarity, or turning towards the north, is a universal property of the magnet. But in those sciences in which we have to deal with the powers of living bodies, or mental operations, the true relations are not only difficult to discover, but even after we know them we may frequently be disappointed in the result we wish to produce. New causes intervene which sometimes elude observation. The constitutions and habits of human beings are different. A motive which influences one person fails to influence another.

But, by extensive observation, we can trace a remarkable uniformity in the great operations of nature. The changes of the moon seem to be irregular to one whose observation is limited. Human life is *uncertain* as regards individuals, but *certain* as regards a number. Men, too, are possessed of certain uniform principles, which can be acted upon by certain moral truths, when they are brought into circumstances necessary for the due operation of those truths.

The Object of all Science.—It is the object of all science to ascertain facts, and to trace their relations. We know, for example, that a certain substance is a medicine, and we know that it acts upon the skin. These are two facts. With this knowledge, if nothing more can be ascertained, we must be satisfied. It is sufficient for all practical purposes.

EVIDENCE.

Demonstrative evidence is employed about all subjects which can be expressed by numbers; but the subjects of moral evidence are matters of fact.

Proof.—The term *proof* should not be confined to demonstration; because a proposition for which sufficient probable evidence has been advanced is considered to be *fairly proved*. It cannot be *demonstrated* that the Romans had been in this island; but it is *proved* by the testimony of historians, the Roman camps and roads, the remains of Roman buildings, the coins, urns, &c.

Two kinds of Moral Evidence.—The two kinds of moral evidence are *Experience* and *Testimony.* We have the evidence of certainty for personal experience.

In reference to things that are various, as the direction of the wind and the effects of medicine, conclusions are drawn from general experience by collecting all those instances in which we have found them to exist in one way, and all those in which we have perceived them to exist in another, and then determining the ratio which those instances bear to each other. Thus if the number of instances in which a certain fruit had proved harmless were equal to those in which it had proved hurtful, it would be *uncertain* whether it would hurt a person that was going to eat of it. If more had been hurt by it than not, it would *probably* hurt him; if very few who had eaten of it escaped injury, it is *highly probable* that it would hurt him.

Testimony.—*Direct* testimony is that which is professedly given. *Incidental* testimony is that which is casually introduced on one subject in the course of an evidence delivered on another. The latter has greater weight than the former, because it is less susceptible of deliberate intention to deceive.

When all the persons through whom the information passes are known, the testimony is *remote;* but when they are not known, the evidence is termed *report.*

Mixed Evidence.

Mixed testimony is that by which we learn from others the general conclusions which they have drawn. It is termed *mixed*, because it possesses partly the nature of *personal observation*, and partly the nature of *testimony.* The *degree* of evidence to be attributed to mixed subjects depends, 1st, On the nature of the subject—some subjects are capable of more accurate observation than others; 2d, On the character of the observer—his *ability* must be considered in scientific subjects—his *honesty* in common matters; 3d, On the number of our informers—*several persons* are less likely to be mistaken in the conclusions they have drawn than *one person.*

A thing believed by all men, as far as we can know, is a matter of *general notoriety.*

Tradition is the relation of a fact or event which was not committed to writing by any person who observed it, but was communicated from one to another for a certain period of time. It is very uncertain, because the defects of memory are supplied by invention.

Internal Evidence.

The preceding species of evidence are termed *external*, because they are drawn from some external source. The following are named *internal*, because they arise from the subjects themselves:—

Analogical.—When it is inferred from the resemblance which the subject in question bears to some other known subject, that they are likely to produce similar effects, the evidence is termed *analogical.* From the resemblance which a disease in a certain patient bears to other diseases which he has observed, the physician ascertains its nature, and prescribes for its cure. The credit due to this species of evidence is ascertained by finding whether the resemblance holds good in regard to the point under consideration.

Presumptions.—*Positive* proof is the evidence of men on oath, or of writings or records. *Presumptions* are *probable inferences.* These inferences are of greater or less weight according as it is more or less probable that the facts established would not have existed unless the fact which is inferred had existed also. Thus, James was found dead, with a bleeding wound, in a house; Thomas was observed running out of the house, and there was no other person found on the spot; *therefore, he was the murderer.*

The Degree of Probability.—The *degree of probability* is calculated as follows:—Of 100 persons who had eaten of a certain fruit, 75 were hurt by it; and of every 16 who had eaten of it, 4 died. Hence the probability of safety in eating of it is $\frac{1}{4}$, and the probability of surviving the eating of it is $\frac{3}{4}$.

DIRECT AND INDIRECT BELIEF.

Belief is ascent produced by apparent credibility. It is *direct* when a proposition, without regard to any former proposition, is admitted; but *indirect* when a proposition is admitted in consequence of the admission of some former proposition.

The *intuitive* principles of belief are—1st, A conviction of our own existence; 2d, A confidence in the evidence of our senses; 3d, In our mental operations; 4th In our mental identity; 5th, In the conformity of th operations of nature.

In judging of the credibility of a statement, we must often extend our views beyond *our own experience.* The King of Siam would not believe that water froze in Britain, because he had never seen water become solid. If the king had proceeded upon the knowledge which he had acquired of the properties of bodies, he would have recollected that he had seen various fluids rendered solid by the abstraction of heat, and hence inferred that water might become solid in a low temperature.

TRUTH.

Truth is that which admits of proof. It may be proved to be true by the evidence of the senses, by investigation, hypothesis, and experiment, or by a fair train of induction founded on these preliminaries. Some persons are so incredulous, that they will believe in the truth of nothing which they cannot prove by the evidence of the senses and a certain degree of experience. But, under the head of *theory*, we have seen that it is perfectly reasonable to accept of inferences founded on the investigation and experience of others, provided the inferences are reconcilable with known phenomena.

Too great credulity is as erroneous as too great incredulity. A person may make himself ridiculous by believing even that which the senses seem to prove to be true. An ignorant person sees a juggler, as he thinks, catch a bullet fired from a gun, and believes that the juggler actually performed this feat; whereas the bullet is not fired at all, but is held in the juggler's hand. To judge of truth, therefore, the mind must be cultivated, the experience extensive, and the induction just. In Logic, Truth is said to be the agreement of propositions with the notions concerning which an affirmation is made. Truth does not exist unless the terms employed are understood in the same sense by the speaker and the person addressed. The chief causes that preven the discovery of truth are—1st, *Ambiguous language*; 2d *Hasty inductions*; 3d, *Prejudice*

GENERALIZATION.

Generalization is that process by which the mind arrives at a whole class, expressed by a *general* term. It may be defined as the notion of partial resemblance. A horse, a sheep, and a stag, are named *quadrupeds*, because *they resemble one another in having four legs*, though they differ in many other respects.

A marble, an apple, an orange, agree in *form*—they are *round*: but the first is hard, the second is pulpy, and the third is fragrant.

India-rubber, steel, air, the gases, are *elastic*, that is, they have the power to resume their former shape when the force that diminished it is withdrawn.

Generalization, then, is *tracing certain points of resemblance*. Abstraction is fixing the mind on the point of resemblance in one body. Generalization implies *three* things: 1st, An object that gives rise to the notion of resemblance in the mind; 2d, The rise of that notion in the mind; and, 3d, The name to express that notion of partial resemblance.

ANALYSIS OF TERMS.

A *general term* expresses a notion of *partial similarity*. Thus, the general term *quadruped* expresses the partial notion of resemblance that is felt when we regard a horse, sheep, stag, &c.

To *analyze* a general term is to mention every notion which it embraces.

Passion embraces two notions: that of displeasure and haste.

Peevishness is transferring displeasure from the guilty to the innocent.

Manslaughter is killing accidentally, or without malice.

Murder is killing with malice aforethought.

The analysis of complex terms is indispensable to accuracy of thought. Many hot disputes arise from men not being able to analyze the language they employ. A gentleman lately related the following anecdote to show that Sheridan was a wit. Sheridan was walking one day with a friend, when he observed a person coming towards him who was very affected in his pronunciation. As soon as he met Sheridan, he asked him if he had seen a certain great curosity which was then exhibiting. Sheridan walked on, and his friend observed, "That gentleman does murder the English language." "Not so bad," answered Sheridan, "he has only knocked an i (eye) out." Some of the company who heard this anecdote related, pronounced it witty, others affirmed that there was no wit in it. They disputed more than two hours, and seemed then farther from agreement than when they began. Fortunately, just as they were about to part, a gentleman requested to know whether all the disputants would admit that *a feeling of light mirth, occasioned by the unexpected discovery of resemblance with difference*, constituted *wit*. All agreed that it did. He then asked them if there was not in this instance a resemblance in the sound—i—eye, with a difference in the meaning—i, a letter of the alphabet. To this, too, all assented, and wondered how they could possibly have disputed so long about a matter that was so simple.

Importance of General Terms.—The progress of society is greatly owing to the introduction of general terms. The process of study is abridged more and more in proportion as the truths to be acquired increase in number. Hence the elementary truths of science, which were at one time occult, become the subjects of common education. A short period employed at the present time, under a skilful teacher, will carry the student beyond the conclusions which limited the inquiries of those who were deservedly reputed eminent philosophers an age or two ago.

Men are apt to fall into two great extremes. The one arises from too minute an attention to *particulars*, the other from habits of *generalization* carried to an excess. When theoretical knowledge and practical skill are happily combined in the same person, then the intellectual power of man appears in its full perfection.

PREDICABLES.

A term is said to be *common* when it belongs to a whole class alike; as, Horses are *quadrupeds*.

The horse is a *quadruped*. A term is named a *predicable* when it may be affirmed of the class, or of any one of the class.

Predicables have been reduced to *five* classes—*genus, species, difference, property, accident.*

The *genus* expresses the common part of the essence of several objects.

The *specific* expresses that which is essential to the notion of an object.

The *difference* expresses the distinguishing part, or characteristic.

The *property* expresses what belongs to every individual of the species.

The *accident* expresses what belongs to some individuals only of the species.

The following are examples of predicables:—

Man is an *animal*. Animal is the *genus*.

Man is a *rational being*. Rational is the *difference*.

Man *possesses the property of speech*. The *property*.

Man is *tall, learned, ignorant, &c. Accidents.*

Rational being, or animal, is the *species*. The species with the difference is equivalent to the *genus*.

The qualities necessary to the existence of a subject constitute its *essence*.

Man is also distinguished from other animals by the *capacity of religion, making exchanges, using fire to dress his food.*

A logical or universal whole is termed a genus when its parts are also wholes or species; as *man, beast, bird, fish, insect*, are *species of animal*.

A whole is termed a *species* when its parts are individuals; as *John, James, &c.*, are *men*.

A genus that is not considered as a species of any thing is termed the *summum* or the *highest genus*.

The *proximum genus* is the *lowest genus* that can be predicated of a subject.

Man is an animal. Here *animal* is a *genus* in relation to *man*. An animal is a substance. *Animal* is a *species* in relation to *substance*. *Genus* and *species* are only notions of resemblance. We may, therefore, generalize differently, and refer the same individual to any of several different species, and the same species to several genera, as suits our purpose.

Man may be classed *politically, physiologically, theoretically*, or *geographically*; as—

The man is a farmer, a merchant, a manufacturer, &c.

The man is a negro, a white man, &c.

The man is a pagan, a Christian, a Mohammedan, &c.

The man is a European, an American, an African, &c.

And the *property* of an object may appear differently to different men; for the notion which is most important in reference to one art may not be regarded so in another. The sailor considers *polarity* the property of the magnet; but those manufacturers who use magnets for shielding their faces in grinding needles, fix on the notion of attraction.

The predicables are *relative*, because the same notion or quality may be considered in various relations. Thus

Red is a *genus* in relation to *scarlet*.

Red is a *property* in relation to *blood*.

Red is the *difference* in relation to a *rose*.

Red is an *accident* in relation to a *cup*.

The term *species* in natural history is applied to animals which "resemble one another as much as those of the same stock do." Hence it is said that the African elephant is of the same species as the Asiatic one

DIVISION.

Logical divison is the distinct enumeration of several things by one common name. The *highest genus* is the *whole*, the *species* is the *parts* into which it is divided. Thus,

An *oak* is a *tree*. An *elm* is a *tree*. A *fir* is a *tree*.

Physical division is separating the constituent parts of any thing; but in a *logical* division each of the parts expresses the *difference* as well as the general notion. A tree is divided physically into *trunk*, *branches*, *leaves*, &c.

The rules of division are *three*:—

1. Each of the parts, or any of them less than the whole, must contain less than the thing divided. To divide bird into *vertebrated*, *wading*, *rapacious*, would violate this rule, for all birds are vertebrated.

2. All the parts together must be exactly equal to the thing divided. To divide bird into the *sparrow tribe*, *rapacious*, and *wading*, would be erroneous, because some birds are *climbing*, &c.

3. The members must not be contained in one another. Book cannot be divided into *quarto*, *French*, *Latin*, for the same book may be both quarto and French.

The principle of division with which we begin must be kept in view. To divide book partly according to size, partly according to language, would be a *cross division*. One mode of dividing may be most suitable for one purpose, and another mode for another. A bookseller would divide book into octavo, quarto, &c.; but a philologist would divide book into Latin, French, &c.

Classification.—In classifying, we separate objects according to certain differences, or continue to generalize until a difference can no longer be found. In classification, one act of generalization follows another. Thus, according to Linnæus, animals that suckle their young form the class *mammalia*; birds form a second class; amphibious animals a third class; fishes a fourth; insects a fifth; worms a sixth. The mammalia are classified into *seven orders*. Each order is divided into *four genera*. Each genus has *different species*, of which there are *many varieties*. Cuvier classifies thus: Individual, species, kind, family, order, class, division.

DEFINITIONS.

Definition is fixing in a single word or phrase the particular circumstance of resemblance of various objects. A sheep is a ruminating animal; it resembles those animals which chew their food twice. The attribute which we obtain, common to all the objects, is the definition. The proximate genus with the specific difference is the logical definition. *Rational animal* is the logical definition of man.

Definitions are divided into *nominal* and *real*; because the object in view may be either to explain the *meaning* of the term or the *nature* of the thing.

The *nominal* explains the *meaning* of the term; as, decalogue, the ten commandments. The *real* defintion explains the nature of the thing; as, gold is that metal which is yellow, fusible, malleable, heavy, precious, &c.

And real definitions have been divided into *physical*, *accidental*, and *logicol* because a definition may be employed to enumerate the *properties* and *accidents*, or the *physical* or *metaphysical parts* of the essence.

An accidental definition or description enumerates the properties and accidents; as, Bonaparte was a native of Corsica, who was conquered at Waterloo.

The *nominal* and *real* definitions are the same in all strict sciences; because in them the meaning of the word and the nature of the thing are the same. Gold may possess many qualities not implied in the meaning of the term; but all the properties of a triangle, or of a circle, may be deduced from its definition.

Such terms, too, as virtue, vice, obligation, right, &c., are capable of a real definition as well as of a logical; and the nominal definition coincides with the real. "Virtue is that benevolence which springs from love to God and man."

Rules for Definition.

The rules for definition are *three*:—

1. The definition must be adequate. To define *fish* as an animal that has an air-bladder, is too narrow, for many fish have not an air-bladder.

2. The definition must be plainer than the thing defined. Dr. Johnson's definition of *network* is not so.

3. The definition must be neither too brief nor too prolix. When it is tautological, we are left to suppose what is not true. Circumstances must not be introduced which are true generally, but not always; because accidental circumstances may be mistaken for real. Clouds are *gloomy vapours*. This definition is true only in certain circumstances.

Importance of Definition.

1. To guard our meaning against mistake, we must define the terms we employ, if we do not use them in their common acceptation. If we employ, without definition, the term *virtue* to express *fortitude*, some persons may suppose that we mean *justice*.

2. We must understand the terms used by others in the sense in which they define them; and if a definition has not been given, we must understand them according to common use.

3. We must distinguish *verbal* from *real* differences. John affirms that the ancient Germans were *savages*. James denies the assertion. They dispute long and violently. They are asked to define the term *savage*. John defines it, "a person unacquainted with agriculture." James defines it, "an illiterate person." Hence the dispute is *verbal*, for James admits all that John contends for. John does not include in his definition the notion illiterate. James does not deny that the ancient Germans were unacquainted with agriculture. If he had denied this, the dispute would have been *real*. The one would have denied that which the other affirmed to be true.

PROPOSITION.

A *proposition* is an act of judgment expressed in language. Judgment is the notion of relation which arises upon the perception or conception of two or more objects, or of two or more affections of our mind. We perceive the distant mountain, we consider its relation in position to the hill that is nearer. A notion of relation arises in the mind; the hill is judged to be nearer than the mountain.

Every proposition expresses the relation of a whole to its parts. Snow is white, cold, &c.; that is, each of those qualities forms a part of the subject snow.

Terms of a Proposition.

Every proposition has *two* terms: the *subject*, or that which is spoken of; and the *predicate*, or that which is said of the subject.

Subject.	Copula.	Predicate.
Snow	is	white
Snow	is not	black.

The *copula* affirms or denies the *predicate* of the *subject*.

It is probable that some ships have been lost. *That some ships have been lost* is the subject; *probable* is the predicate. Kings reign. *Kings* is the subject; (are) *reigning* is the predicate.

When the predicate is emphatic, it is placed before the subject; as, *Great* is Diana of the Ephesians.

A Qualified Subject or Predicate.

The man is wise who speaks little. The subject is not *man* only, but man limited by the words *who speaks little*; *wise* is the predicate.

The sailor is happy in having reached the shore. The predicate is not *happy*, but *happy* limited or qualified by the words *in having reached the shore*.

Compound Propositions.

In *compound* propositions there is either more than one subject or *one* predicate.

Life and death are in his hand. *Life* and *death* are the two subjects. Holy and reverend is his name. *Holy* and *reverend* are the two predicates.

Compound propositions are distinguished by the language in which they are clothed. Life *and* death are in his hand, is named a *conjunctive* or *copulative* proposition; because *and* is a copulative conjunction.

Neither Cæsar *nor* Pompey loved his country, is equivalent to—Cæsar did not love; Pompey did not love. A conjunctive proposition is false when one or both of the propositions into which it is resolvable is false. Virtue and riches are necessary to salvation. Virtue is necessary to salvation, but riches are not.

Disjunctive Propositions.

It is *either* day *or* night, is resolvable into four propositions. 1. It is day. 2. It is not night. 3. It is night. 4. It is not day. A disjunctive is false when it does not contain the true member or proposition. It is *either* summer or winter. It may be spring or autumn.

Comparative and Causal Propositions.

A comparative proposition is false when the higher degree is false, or the positive is not true in both propositions, as, Riches are *better than* virtue.

A causal proposition is also false when either of the propositions is false, or the cause is falsely assigned; as, All events are necessary, *because* they were decreed by fate; Tamerlane was cruel, *because* he was born under Scorpio.

Definitive and Conditional Propositions.

A definitive is false when any of the propositions is false; as, Cæsar was put to death in the 610th year of Rome, by those whose lives he spared when conquered. Cæsar was put to death in the 710th year of Rome.

If this man is sick, he has a fever. This proposition is false; it is not true that whoever is sick has a fever.

The Property of a Proposition.

Propositions are divided, according to their *property*, into *true* and *false*.

Propositions are divided, according to their *substance*, into categorical and hypothetical.

Propositions are divided, according to their *quality*, into affirmative and negative.

Propositions are divided, according to their *quantity*, into universal and particular, or partial.

A categorical proposition is a *simple* proposition; as, Snow is white.

A hypothetical proposition is either a *disjunctive* or a *conditional*.

The following may be taken as illustrations:—

Dogs are *rational*. The *property* of the proposition. It is *false*.

Dogs are *faithful*. The *substance* of the proposition. It is *categorical*.

Horses are *quadrupeds*. The quantity of the subject. It is *universal*.

Horses are quadrupeds. The quantity of the predicate. It is *partial*; because there are other quadrupeds than horses.

Horses are quadrupeds, is *universal*; because all horses are quadrupeds.

Some men are not virtuous, is partial; because the sign *some* indicates that the proposition is particular.

Circles are round, is *indefinite*; because the sign *all* is not expressed.

Opposition of Propositions.

Two propositions are said to be opposed to each other, when, having the same subject and predicate, they differ in quantity or quality, or both.

A universal negative and a universal affirmative are termed *contraries*; as, *All* horses are quadrupeds; *no* horse is rational.

A universal affirmative and a particular affirmative are termed *subalterns*, and also a universal negative and a particular negative; as, *All* horses are quadrupeds; *some* horses are quadrupeds, *No* horse is rational; *some* horses are not rational.

A particular affirmative and a particular negative, are termed *subcontraries*; as, Some horses are black; some horses are not black.

A universal affirmative and a particular negative, or a universal negative and a particular affirmative, are termed *contradictories*; as, *All* horses are quadrupeds; *some* horses are not black: *No* horse is rational; *some* horses are black.

Contraries differ in *quality*. Subalterns differ in *quantity*. Subcontraries differ in *quality*. Contradictories differ in both *quantity* and *quality*.

Contraries cannot be both true; for if it is true that *all* men are mortal, it must be false that *no* man is mortal. Subcontraries cannot be both false; for it must either be true that some men are white, or that some men are not white.

Subalterns may be both true or both false. *All* men are liable to mistakes, *Some* men are liable to mistakes, are both *true*. *No* man is liable to mistakes, *Some* men are not liable to mistakes, are both *false*.

In contradictories, if the one is true the other is false, and *vice versa*. If it is *true* that *some* men are not white, it is *false* that *all* men are white.

Conversion of Propositions.

A proposition is said to be converted when its terms are transposed; as, *Some cowards* are *boasters*; *some boasters* are *cowards*.

A universal negative and a particular affirmative are converted simply; as, *No* Christian is *impious*; *no impious man* is a *Christian*.

In converting a universal affirmative, we must limit its *quantity*; as, *All* birds are *animals*; *some* animals are birds.

In converting a particular negative, we must regard it as a particular affirmative; as, *Some* members of the university are not learned; *some not learned* are members of the university.

REASONING.

Reason is a series of consecutive judgments, and *reasoning* is a series of related propositions, or a continued analysis of our thought. Thus, Man is fallible; he who is fallible may err; he who may err ought not to wonder at others differing from him in opinion; therefore, man ought not to wonder at others differing from him in opinion. The last proposition is contained in the first as much as of the intervening propositions; but the relation between the first proposition and the last is not seen till the unfolding of proposition after proposition.

Logical Inference.

Logical inference is of *two* kinds: it proceeds either from the parts to the whole, or from the whole to the parts. Thus, A cow, a deer, a sheep, ruminate; a cow, a deer, a sheep, represent all horned animals; therefore, all horned animals ruminate. This is *inductive* reasoning.

Deductive reasoning is proceeding from the whole to the parts; as, All horned animals ruminate; a cow is a horned animal; therefore a cow ruminates.

All horned animals is the *class* or *whole*; the parts are, a cow, a deer, a sheep; what is affirmed of the *whole* may be affirmed of *each of the parts*, or of all the parts. The rule for *inductive* reasoning is—What is affirmed of the *parts* may be affirmed of the *whole*. The property which belongs to the *parts* is admitted to belong to the *whole*, or *class*.

What is denied of the *whole* may be denied of the *parts*.

Analysis of Reasoning.

Every *conclusion* is deduced from other *two propositions*, termed *premises*; as—Premiss 1, or *major* proposition, *All* horned animals ruminate; Premiss 2, or *minor* proposition, A sheep is a horned animal; *Conclusion*, Therefore, a sheep ruminates. *Sheep* is named the *minor* term, because it is less extensive than *ruminating*, which is therefore termed the *major*. Horned animals is the *middle* or *mean* term, or *proof*. It is also the *whole*.

In the major proposition we find the *middle* and *major* terms; and in the minor proposition, the middle and minor terms.

The third proposition is named the conclusion, because it *concludes*, or *shuts up in one*, the major and minor propositions. The first two propositions are termed the *premises*, because they *premise*, or go *before*, the conclusion.

Enthymeme.

Enthymeme is reasoning from signs (language) or probabilities, because it has one of the premises suppressed. Thus, He is an industrious man; therefore, he will acquire wealth. The *major* proposition is here suppressed—Every industrious man acquires wealth, which is false. Therefore, the conclusion is only probable—he *may* acquire wealth. All good men are happy; therefore, John is happy. The minor premiss, John is a good man, is suppressed.

Hypothetical Reasoning.

A disjunctive proposition states an alternative, or implies that some one of the categorical propositions is true. Wealth must *either* be spent *or* hoarded; it is not hoarded; therefore, it is spent. The reason is not conclusive, because a proposition or member is wanting; for wealth may be neither spent nor hoarded; it may be laid out or employed in producing more wealth.

Dilemma.

The *dilemma* is a complex conditional reasoning, in which either one of the *antecedents* must be admitted, or one of the *consequents* must be denied.

If Eschines joined in the public rejoicings, he is inconsistent; if he did not join, he is unpatriotic; but he either joined or did not join; therefore (one of the consequents must follow), he is either inconsistent or unpatriotic.

We speak of the *horns* of a dilemma, because the name implies a taking hold of both ways; if a person is not caught by the one antecedent or consequent, he must be caught by the other.

If it is spring, you are to blame for not sowing; if it is autumn, you are to blame for not reaping; but it is either spring or autumn; therefore, you are to blame for either not sowing or not reaping. It is not conclusive. The enumeration of the parts is not complete; it may be summer or winter.

Sorites.

The *sorites* consists of a number of dependent propositions, in which the predicate of every preceding proposition becomes the subject of every succeeding proposition, till the subject of the first is found to agree in the conclusion with the predicate of the last. Thus, A miser covets much; he that covets much wants much; he that wants much is miserable; therefore, a miser is miserable. There are here as many acts of reasoning as there are intermediate propositions.

Figure.

The *figures* of reasoning are only *different forms* of stating it. We have seen that the same act of reasoning may be expressed either *categorically* or *hypothetically*. It will now be shown that the same act of reasoning may be expressed in each of the *four* figures.

First Figure.

No lover of pleasure is a true philosopher;
The Epicureans were lovers of pleasure;
They were not true philosophers.

Second Figure.

No true philosopher is a lover of pleasure;
The Epicureans were lovers of pleasure;
They were not true philosophers.

Third Figure.

No lover of pleasure is a true philosopher;
Lovers of pleasure were Epicureans;
The Epicureans were not true philosophers.

Fourth Figure.

No true philosopher is a lover of pleasure;
Lovers of pleasure were Epicureans;
The Epicureans were not true philosophers.

In the first figure, the middle term is the subject and the predicate of the minor. In the second figure, the middle term is the predicate of both premises. In the third figure, the middle term is the subject of both premises. In the fourth figure, the middle term is the predicate of the major, and the subject of the minor. The fourth is the opposite of the first, and the third of the second. The first figure is used when we are reasoning with a person who wishes instruction; the second in proving to one who objects; the third in showing that a universal conclusion has been drawn when a partial conclusion is the legitimate one.

Reductio ad Impossibile.

In *reductio ad impossibile* or *ad absurdum*, it is proved, not that the original conclusion is true, but that an absurdity would follow from the supposition of its being false. Thus, All gold is yellow; some metal is not yellow; some metal is not gold. If this conclusion is not true, the contradictory—All metal is yellow, must be true: All gold is yellow; All metal is gold; all metal is yellow. The major premiss is true, being originally granted; therefore the falsity must be in the minor premiss, which is the contradictory of the original conclusion; therefore the original conclusion must be true.

Fallacy.

Fallacy is false or inconclusive reasoning. When the fallacy is in the form of expression, it is termed *formal*. Otherwise it is named *material*.

Money is wealth; corn is not money; therefore it is not wealth. Whatever is affirmed or denied of the *whole* may be affirmed or denied of any of the parts. But here nothing is mentioned as belonging to the class, money; corn is excluded from it. Now, though we may affirm of *gold* or *silver*, or of any part of the term *money*, what was affirmed of the class itself, we are not authorized to deny that what was affirmed of it can be affirmed of nothing else. The following is a similar fallacy:—Horses are animals; sheep are not horses; therefore, sheep are not animals. Sheep are animals as well as horses: corn is wealth as well as money. The terms *animal* and *wealth* have been used *partially* in the premises, but *universally* in the conclusion.

Fallacy of Equivocation.—In this fallacy, the middle term is used in two senses, or there are *two* classes, not *one*. Thus, Wicked men abound in repentance; therefore they abound in what is good.

This act of reasoning or fallacy is analyzed as follows:
Repentance is a good thing;

Wicked men abound in repentance;
They abound in what is good.

In the major premiss *repentance* signifies *genuine sorrow*, but in the minor it signifies *regret arising from pain or loss*.

Fallacy of Division and Composition.—5 is *one* number; 3 and 2 are 5; therefore, 3 and 2 are *one* number. 3 and 2 are two numbers; 5 is 3 and 2; therefore, 5 is two numbers. The former is the fallacy of *division*, because the middle term 5, is used *collectively* in the major premiss, but dividedly, 3 and 2, in the minor. The fallacy of *composition* is the reverse. In both there are *two* wholes or classes.

The miracle of curing the man sick of the palsy might have been the result of chance; therefore, all miracles might have been the result of chance. This is an instance of the fallacy of *composition*.

Fallacy of Accidents.—In this fallacy, the middle term is used simply in one of the premises, but conjoined with certain accidents in the other; as, What we eat grew in the fields; loaves of bread are what we eat; therefore, loaves of bread grew in the fields. In the major premiss *we eat* is taken *simply*, but in the minor it is taken with its accidents, *baked*, *cooked*, &c.

A certain medicine, when taken improperly, hurts; therefore it is a bad medicine. It is bad when taken with its accidents, that is, *improperly*.

Reasoning in a Circle.

This occurs when a person pretends to determine the truth of a proposition by instancing the conclusion. The English language, by being composed of words from the Saxon and Latin languages, admits of this fallacy to a great extent. A person says, A thing is *hateful*. Why is it hateful? Because it is *odious*. Now, *hateful* and *odious* mean the same thing; *odious* being a Latin synonym for the Saxon word *hateful*. Reasoning in this way is just as bad as saying a thing is hateful because it is hateful, or it is true because it is true. Why did you go to such a place? says one man to another; Because I went, is the reply. This is no answer at all.

Whately gives an instance of this fallacy in the following sentiment. "To allow every man an unbounded freedom of speech must always be, on the whole, advantageous to the state; for it is highly conducive to the interests of the community, that each individual should enjoy liberty, perfectly unlimited, of expressing his sentiments." This kind of rant often passes for sound reasoning.

Petitio Principii.

When any one reasons on the supposition of a fact which is neither proved nor granted, he is said to *beg the question*, or, in the language of Logic, to resort to the *petitio principii*. A proposition cannot be proved to be true from something which is equally uncertain and disputed.

Self-Contradiction.

Some persons advance arguments which bear their own contradiction, and therefore come to nothing. A partisan will be heard to say, "The removal of the laws which prevent the free importation of foreign corn would injure the home agriculturists; but it is well known, from the most ample investigation, that foreign countries possess so little overplus of corn, or the means of sending it, that any expectation of supplies from abroad is little better than a delusion." Here the second proposition, in effect, contradicts the first. This fallacious kind of reasoning is only surpassed by the following legal *jeu d'esprit*:—"There are three points in this case," says the defendant's counsel. "In the first place, we contend that the kettle was cracked when we borrowed it; secondly that it was whole when we returned it; and, thirdly, that we never had it at all."

Ignoratio Elenchi.

Ignoratio elenchi, or irrelevant conclusion, is when various kinds of propositions are substituted, according to the occasion, for the one that ought to be proved. The fine arts please the imagination, and adorn and polish life. But the fine arts are the parents of luxury. This does not prove the original conclusion, namely, that the fine arts are a frivolous amusement; besides, it mistakes the effect for the cause. The fine arts are the offspring of wealth, not the parent of luxury, for they can be encouraged only by a people who possess as much wealth, at least, as enables them to devote a portion of their time to the cultivation of the mind.

Argumentum ad Hominem.

This signifies the argument directed point blank to the person spoken to, or a reference to something in the person's own condition which proves the truth of the argument. There is a fine instance of the legitimate use of the *argumentum ad hominem* in Luke's Gospel, chap. xiv. v. 5. The Pharisees, affecting to be scandalized by Christ doing works of mercy on the Sabbath, he addressed them as follows:—"Which of you shall have an ass or an ox fallen into a pit, and will not straightway pull him out on the Sabbath day?" This direct appeal was unanswerable.

The *argumentum ad hominem* is always used fairly when the conclusion established is not considered general but particular; that is to say, when it applies to the conduct or principles of the person reasoned with, not with the principles of all mankind. No man is entitled to have his argument overturned by the doings of others.

Fallacies of the Feelings.

The feelings may be said to be always lying in wait to set aside the efforts of judgment. The class of fallacies of this nature are intimately connected with interest, caprice, self-esteem, envy, jealousy, disputation, complaisance, outward appearance, long-sounding words, inferring the motive from the effect, authority, manner, awe of rank, fear, &c. Bacon terms the fallacies or prejudices which militate against the discovery of truth *idols*, because men are apt to pay homage to them instead of regarding truth. He classes them as follows:—

The 1st class are called Idols of the *Tribe*, because they are common to the whole race or *tribe* of mankind; the 2d are termed Idols of the *Den*, because every man has his own particular den or character; the 3d class, Idols of the *Market*, because they are accommodated to *common notions*; and the 4th, Idols of the *Theatre*, because many systems of philosophy are but *stage-plays*, which exhibit nothing but *theatrical worlds* or *visionary hypotheses*.

The first class are those prejudices which men entertain from their early notions, and from a love of hypothesis. Thus an old woman who may have recommended some nostrum, which has been successful in curing one disease, will consider it a remedy for all other diseases.

The second are those prejudices which arise from habits of thinking, the dispositions or the passions of men. A theologian who is of a violent temper, will represent the Deity as implacable. The pedantic mathematician, who reasons on a subject, will not be convinced by probable conclusive reasoning, because it is not demonstrative.

The third are those which arise from the relations of human society, from the condition of men, from their different stations. The man of wit laughs at the philosopher of whose speculations he is ignorant.

The fourth are those prejudices which men entertain upon the authority of others. The zealous abettor of some favourite theory will never listen to any arguments against it.

The following are illustrations of these various fallacies, drawn from different circumstances.

Of Caprice.—There are persons who will not admit that those individuals whom they happen to dislike are in any respect worthy of esteem. They seem to reason thus:—I like that man; therefore, he is the best person in the world. I dislike that one; therefore, he is a worthless fellow.

Of Self-Love and Self-Conceit.—Some individuals regard all men as irrational who differ from them in opinion: all who do not agree with them are opinionative. I am a man of common sense; therefore, it is so. I have a right to be displeased with you for not succumbing.

Of Envy and Jealousy.—Some men contradict with a mean malignity those of whom they are jealous. Their envy of a person begets hatred of his opinions. I did not say that; therefore, it is false. I did not write that article; therefore, it is contemptible.

Of Disputation.—Disputation, or maintaining an assertion for the sake of contradiction, renders conviction difficult, if not impossible. When some disputants find that a position is not to be defended, they trust to equivocation; some affect contempt or modesty, so reproach themselves in order to get rid of an adversary; others defend themselves with the only weapons they can use to advantage—the strength of their voice and lungs.

Of Interest.—A difference of judgment not unfrequently proceeds from interested motives. I am a native of this country: therefore, I must believe that every interesting event recorded in its early history actually occurred. My interest is apparently damaged by a certain public measure; therefore, I must oppose it. I have nothing to do with the effect which it may have on the country generally.

Of Complaisance.—Some persons either commend what is reprehensible, or more than is just, and therefore delude those that are so commended, and wrong those that really merit praise.

Of Outward Appearance.—There are some individuals who overrate the value of whatever at once captivates the senses; and who undervalue whatever requires observation and thought to be duly appreciated. The colours of the painting are beautiful; therefore, the design is admirable. That is a fine-looking man. What a fine orator! What a good man he is!

Of Sounding Words.—There are individuals who never discover the false statements and the invalid reasoning which are found in some tastelessly decorated productions. The figures set them a-gazing; the periods tickle their ear; and the sound of the words allures them to thoughts so frivolous that a child would reject them, if expressed in suitable language.

Of Inferring the Motive from the Effect.—There are not a few men who regard every change of opinion as a sign of fickleness; who distinguish neither fortunate from prudent, nor unfortunate from vicious. He has changed his opinions in regard to popular education; therefore, he is a mere weathercock. He did not pay that respect to Mr. A. which was expected; therefore, he is proud and vain. He is of the same opinion in regard to geology as Mr. C.; therefore, he is doubtless as heretical in his opinions. Nay, he is unquestionably an atheist, and something worse.

Of Authority and Manner.—Some men test the truth of an assertion by authority which they have been led accidentally to revere. There are others, again, who are disposed to test it by the manner in which it is propounded. Their reasoning, tacitly and involuntarily, is—This is the opinion of Mr. A., the leader of my party; it is therefore correct; I have no need whatever to examine it. T. is a man of no fortune—what is his opinion worth? The speaker had a fine showy manner; it was quite impossible to hear him without reasoning correctly, and feeling rightly. How completely he demolished his opponents! His very manner showed that he despised them all. It was quite sufficient that he proved a part only of what he was to prove, for he left his audience to infer the rest. It may be true that he imputed to his opponents certain sentiments which they utterly repudiate; but his authority and manner made good the imputation. That many such sophisms as the above are frequently to be met with, must occur to every sound observer who mixes with the world.

Dogmatizing.

This is but a branch of the above. When a person utters his own opinions, and endeavours to force them on his hearers, right or wrong, he is said to *dogmatize*, that is, lay down his dogmas or opinions in an improper manner. Few things are more common than this fallacious mode of disputation, which clearly originates in excessive self-esteem. What I say is right, for I have studied the subject, and I am a man of common sense. Persons of this turn of mind are always hurt at any one thinking differently from them, and look upon it as a kind of personal insult, for it amounts to calling in question their judgment.

Confusion of Ideas.

Fallacies in reasoning often lurk under a confusion of ideas, and to produce this confusion is often the object of cunning and dishonest arguers. A tricky man went into the shop of a rather simple-minded woman, and asked for a penny loaf and a penny glass of gin. The articles being given, he drank the gin, and addressed the woman as follows:—"On second thoughts, I will not take the bread; therefore, I just give it back in payment for the gin." The woman, somewhat perplexed, answered, "But you did not pay me for the bread." "Well," said the man, "I have not taken it." "But where is the payment for the gin?" "My good woman," replied the man, "haven't I told you already that I have given back the penny loaf for it." This piece of sophistry so confused the ideas of the poor woman, that she allowed the villain to depart.

Very simple questions may in this manner be made to assume an air of extraordinary difficulty. A herring and a half for three halfpence, how many for elevenpence? is a jocular question, which has perplexed many at first sight.

Suppressio Veri.

Suppressio veri, or the suppression of the truth, is a common and dishonest method of reasoning on a question. The thing is done in various ways. A person under examination by a committee of the House of Commons respecting education, is asked if he thinks it right to give "special religious instruction in schools?" He answers that "he would not give special but general religious education in schools." An opponent sees this answer in print, and in order to injure the reputation of the respondent, he says that Mr. So-and-So "declares that he would not give religious education in schools." Here the truth is suppressed; the word *special* has been left out. This is called *garbling* a sentence to suit a bad purpose.

The following is an analogous mode of procedure. A statistical writer, after making an elaborate investigation, publishes a statement of facts and figures to show that a particular corporation is in a state of insolvency. His inferences, which are quite fair, are met, not by an analysis and disproval of his statement, but by an exposure of an error in his calculations, to the extent of three shillings and sixpence! This trifling error is thereupon made to form the foundation of a train of reasoning tending to show that the writer of the statement is ignorant of arithmetic, that he is rash in judgment, and altogether wrong in his calculations. This species of dishonest reasoning is common among the warm adherents of party. A person is openly accused in an assembly of being concerned in appropriating the public money. Another rises to refute the calumny; says the accused is a most estimable individual—he is a good father and an exemplary husband; but not one word as to the actual merits of the question; and by this clap trap appeal to feelings and the force of language, all inquiry on the subject is prevented.

Professional spite, also, sometimes takes this form of equivocation. Instead of meeting the truth of any statement respecting the qualification of a rival, some point is dragged forward in reply, with which the argument has nothing to do. "That man is an excellent lawyer," says A. B does not meet this with a denial or approval, but answers—"Did you hear he was once a bankrupt?" or, "that he was brought up on charity?" or makes some other observation equally aside from the question.

Logical Analysis.

In analyzing a train of reasoning—1. Begin with the concluding assertion; 2. Trace the reasoning backwards, and observe how that assertion is proved; 3. The assertion will be a conclusion, and the proof of it a premiss; 4. Ascertain whether the reasoning thus obtained is conclusive; 5. Pursue with each premiss the same plan, until you arrive at the premises with which the whole commences.

Any train of reasoning, therefore, should contain leading or major premises, and subordinate or minor premises. In some instances, it may be found that every step backwards in the reasoning is correct, till we arrive at the final or major premises, which rest on no solid foundation. Unfair arguers are apt to set a plain person off his guard by making him grant certain premises. The Socratic method of arguing was of this nature. The opponent was asked question after question, or, in other words, to give up point after point, till he was lost in a labyrinth, and then he was at the mercy of his enemy.

In Smith's Wealth of Nations, in the chapter on the Division of Labour, we are afforded an example of fair analysis. The concluding assertion is—The division of labour increases wealth. The proofs advanced in support of the assertion are—1st, Because it increases the dexterity of the workman; 2d, It saves time; 3d, It gives rise to invention. And then those proofs are proved—Because the man who confines his attention chiefly to one department of labour works with more dexterity than one who prosecutes different sorts of labour. He who is constantly engaged at one kind of labour, does not lose time in passing from one sort of work to another. Useful inventions have generally been made by those individuals who had occasion to give their attention chiefly to their own sort of employment. The major premiss of the conclusions respectively are—Whatever increases dexterity increases wealth. Whatever saves time increases wealth. Whatever gives rise to invention increases wealth.

Ultimate Conclusion.

The Division of Labour increases Wealth.

Proved by—Major Premiss.

Whatever promotes dexterity increases wealth.
Whatever saves time increases wealth.
Whatever gives rise to invention increases wealth.
Whatever enables one man, &c.

Minor Premiss

The division of labour promotes dexterity.
The division of labour saves time.
The division of labour gives rise to invention.
The division of labour enables one man, &c.

Each of these minor premises is proved by an induction of particular facts.

The division of labour is the division of it into a number of branches or departments. Labour means, 1st, Employment; 2d, The act of labouring; 3d, The result of labour. Wealth is that which is necessary, useful, or agreeable to man, and also *exchangeable.*

Analogy.

Analogy is a consistent reference of one thing to another; and a want of this consistency leads to serious errors in reasoning; thus, it may be said—Birds swallow small stones to aid digestion, therefore men should do so too. No Christian minister ought to marry, because St. Paul recommends celibacy. Wealth demoralizes a nation, because it demoralizes some individuals. Here the proofs are inconsistent or untrue. There is not such a degree of resemblance between the stomach of a bird and that of a man, as warrants us to affirm of the one what was affirmed of the other. St. Paul dissuaded the Christian ministers of his time from marrying, because their families would have been persecuted; but the families of clergymen in our time have no such thing to fear. Wealth has not the same effect on a nation that it has on an individual. It may render some individuals proud, indolent, and prone to luxury; but a wealthy nation is industrious, and by no means comparatively proud.

DOCTRINE OF SYLLOGISMS.—SOPHISTRY.

From the preceding definition of propositions and predicables, it will appear that from *truth* nothing can really follow but what is true; whensoever, therefore, we find a false conclusion drawn from premises which seem to be true, there must be some fault in the deduction or inference, or else one of the premises is not true in the sense in which it is used in the argument. When an argument carries the face of truth with it, and yet leads us into a mistake, it is a *sophism.*

It being of importance that every thing like sophistry or a semblance of truth without the reality, should be avoided in processes of reasoning, we shall, at the risk of a little recapitulation, explain the fundamental grounds of reasoning, according to the doctrine of syllogisms.

When unable to judge of the truth or falsehood of a proposition in an immediate manner, by the mere contemplation of its subject and predicate, we are constrained to use a medium, and to compare each of them with some third idea. The three parts so formed are a *syllogism.* For example, we take the following, given by Watts:—

Our Creator must be worshipped;
God is our Creator;
Therefore, God must be worshipped.

Here it may be observed that the third term or conclusion rests on a foundation afforded by the two preceding. To ensure truth in the conclusion, the premises, major and minor, must be true, and strictly agree. We have another example, as follows:—

Every wicked man is truly miserable;
All tyrants are wicked men;
Therefore, all tyrants are truly miserable.

In forming syllogisms, great care requires to be taken to construct them in such a manner that the first and second terms are analogous, and not a mere play of words. Previous to the method of reasoning from an induction from established facts, introduced by Bacon, it was usual to reason sophistically from premises presumedly true, and consequently the most false conclusions were arrived at. The logic in vogue was that of the ancient Greek philosopher Aristotle, which it was a species of heresy to deny. "Men were everywhere taught to believe in *matter, form,* and *privation,* as the origin of all things; that the heavens were self-existent, incorruptible and unchangeable; and that all the stars were whirled round the earth in solid orbs! Aristotle's works were the great text-book of knowledge, and his logic was the only weapon of truth. Men's minds, instead of simply studying nature, were in an endless ferment about occult qualities and imaginary essences; little was talked of but *intention* and *remission*, *proportion* and *degree*, *infinity*, *formality*, *quiddity*, *individuality*, and innumerable other abstract notions. The Latin tongue, which was employed by these scholastics, was converted into a barbarous jargon, which a Roman would not have understood; and in the end, the most sectarian bitterness was produced, sometimes ending in bloody contests. In the midst of these disputes, Aristotle was still the grand authority. Christians, Jews, and Mohammedans, united in professing assent to the great lawgiver of human opinions: not Europe alone, but also Africa and Asia acknowledged his dominion; and while his Greek originals were studied at Paris, translations were read in Persia and Samarcand. The rage for disputation which now began to prevail in consequence of the spread of this philosophy, induced the council of Lateran, under Pope Innocent III., to proclaim a prohibition of the use of the physics and metaphysics of Aristotle; but, awful as were then the thunders of the Vatican, they were not mighty enough to dethrone him from that despotism over men's minds which, by long custom, had now rendered itself almost omnipotent."* It was reserved for Lord Bacon to break the mighty power of Aristotle's philosophy, and to substitute that which is now in use.† The errors of the sophists, which it may be advantageous to examine, were of two leading orders. The fault, in the first instance, may reside in the *expressed argument*, or syllogism, in which the conclusion does not follow from the premises it is apparently involved in; or secondly, it may lurk in the *concealed process of thought*, dexterously suggested by the sophist, by means of which false premises are regarded as proved, and a false though logically legitimate conclusion is of course necessitated; or in which a conclusion, likewise logically fair, and probably true as matter of fact, but irrelevant, or only partially relevant to the point at issue, is admitted as applicable and decisive. In the one class the link is wanting which should bind the inference to the previous positions; in the other, that is absent which should connect either with the real subject of dispute. A sophism, then, which is inseparable from the form of the expression, may perhaps with propriety be styled *syllogistic;* while one attaching to the subject-matter may fall to be treated as *extra-syllogistic*. It is obviously as respects the latter sort that the common mind is most open to deception; and it must at the same time be allowed that logic is here, where her aid is most essential, able to lend it but in scanty measure. The candid will, however, remember that even the meanest modicum of such service is of value, and will not quarrel with an art for failure where absolute success is plainly unattainable.

First, then, of *syllogistic fallacies;* which, indeed, by excessive generalization, might be comprised under the other class, since they are resolvable into the impression that the same or similar terms are always representative of the same or similar ideas. It is much more convenient, however, to consider them separately.

Errors of this description may proceed, in the first instance, *from confounding allied meanings of the same term*. Sometimes a word is used both in its primary and in a transitive sense. An instance in point occurs in Mr. Burke's Essay on Taste, prefixed to his celebrated disquisition on the Sublime and Beautiful. "It may perhaps appear," he observes, "that there is no material distinction between the *wit and the judgment*, as they both seem to result from different operations of the same faculty of comparing. But, in reality, whether they are or are not dependent on the same power of the mind, they differ so very materially in many respects, that a perfect union of *wit and judgment* is one of the rarest things in the world." The words *wit* and *judgment* have each, in the above passage, two distinct significations—the powers thus denominated respectively, and the products of both in peculiarly lively exercise. The inference, of course, does not hold, and the objection it is intended to meet remains unanswered.

Sometimes a metaphorical sense is slipped in, in place of the literal. We have heard that a popular orator thus managed to turn to his own account the misfortune of a rival, absent, it seems, from delicate health. "The gentlemen has said he cannot venture himself in such an atmosphere, but this is the atmosphere in which I delight to breathe." With an excited crowd, this flimsy artifice, we believe, succeeded in procuring for a stout pair of lungs the applause due to distinguished patriotism.

Occasionally, the extension of a term is changed. Thus Hume, in his Essay on Miracles, argues as if what is granted of ordinary were true of universal *experience*. Because events of this order have not come under the observation of most persons, it is concluded that they could never have come under the observation of any. A little ambiguity has sometimes arisen from the vague application of *authority*. Referring to the writer last named, in his capacity of historian, we may think fit to pronounce him an excellent authority; but unless the term be expressly guarded, we may be represented as intimating our approval of his ethical and metaphysical speculations. By *prophet* we usually understand a person supernaturally commissioned to foretell events; in the works of Mr. Carlyle, he is simply a man of commanding genius and vast practical power. *Mystery*, formerly meaning simply a thing unknown, now denotes invariably a thing that cannot be known. The notion popularly attached to *wealth* differs widely from the use of the term by writers on political economy; and much

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* Account of Lord Bacon's *Novum Organon*, in Library of Useful Knowledge.

† Francis Bacon, created Baron Verulam, who rose to the rank of Lord Chancellor of England in the reign of James I., obtained the highest reputation as a philosophical writer. In 1620, appeared his chief production in a complete form, "The *Novum Organon*, or New Method of Studying the Sciences," in which he pointed out the way in which we should begin and carry on our pursuit of knowledge in order to arrive at *truth*. The principles he laid down were to ascertain facts in the first place, and then to reason upon them towards conclusions—a mode which may now appear very obvious, and even unavoidable, but which was nevertheless unknown till explained by him. To come to particulars, Bacon tells us—

I. That the ultimate aim of philosophical investigation is to bring the course of events as much as possible under our own control, in order that we may turn it to our own advantage.

II. That as each event depends upon a certain combination of circumstances which precede it, and constitute its cause, it is evident we shall be able to command the event whenever we have it in our power to produce that combination of circumstances out of the means which nature has placed within our reach.

III. That the means of producing many events which we little dream of, are actually placed within our reach; and that nothing prevents us from using those means, but our inability to select them from the crowd of other circumstances by which they are disguised and surrounded.

IV. That therefore we should endeavour, by diligent observation, to find out what circumstances are essential, and what extraneous, to the production of each event; and its real cause being stripped free from all the perplexing concomitants which occur in nature, we shall perceive at once whether we can command the circumstances that compose it or not. This, in short, is to generalize; and having done so, we shall sometimes discover that objects, which of all others appeared the most useless, remote, and inapplicable to our purpose, possess the very properties we are in search of. Nature stands ready to minister to our designs, if we have only the sagacity to disentangle its operations from one another, to refer each event to its real source, and to trace the powers and qualities of objects into their most abstract form.

In pursuing the dictates of this noble philosophy, man is no longer impatient and ridiculous. He calmly vanquishes the barriers which oppose his wishes—he eludes the causes of pain—he widens the range of enjoyment—and, at the same time, feels the dignity of intellect, which, like a magician's talisman, has made all things bow before his feet.

practical mischief has resulted from the belief that a country is prosperous just in proportion as it amasses specie. In these cases and the like, serious mistakes have been generated, and risen to the rank of established and unimpeachable principles, through sheer inattention to the variations of terms. The more closely, indeed, the shades of meaning blend with each other, the more nearly like the similarity that subsists between them, the greater becomes the difficulty of detecting the fraud. Beyond a certain point, indeed, of difference, the most obtuse intellect will refuse to be imposed on. It is absurd, therefore, in an enumeration of fallacies, to assign a place to a glaring play upon words. Though the pun may puzzle, it can never mislead. "He who is most hungry eats most; he who eats least is most hungry; therefore, he who eats least eats most." We immediately discover that *eats* in the first member of the syllogism is equivalent to *will eat*, while in the second it stands for *has eaten*; and the apparent contradiction is solved and laughed over.

A second class of errors in reasoning, belonging to the same general order, may arise *from the oversight of certain differences between related terms*. It is often, for example, taken for granted that words springing from a common root only vary among themselves as parts of speech, whereas, in fact, the radical meaning may have become considerably modified. *Schemer* denotes an artful, truckling, unprincipled individual—qualities which it would be most unfair to ascribe to every man that chanced to be the author of a *scheme*. The two terms are related to each other, but a *devout* man is not therefore a *devotee*. In some instances, however, the derivative and primitive differ too plainly for either to become available for the purposes of sophistry. A mind that would fail to detect the transition from *art* to *artful*, from *pity* to *pitiful*, and the like, must be under the influence of principles of association no less peculiar than those which led the Laird of Ellangowan, in Guy Mannering, to give justice imbodiment in a justice of the peace.

To this head we would also refer the disingenuous use of *pseudo-synonymes*—that is, terms corresponding generally, but not alike expressive of the required shade of distinction. To *murder*, and to *put to death*, both indicate agency with a similar result; but the former phrase determines that agency to be criminal, while the latter affixes no such character to it. Many, under the impression that the terms are perfectly equivalent and interchangeable, might be induced to ascribe to *sour* substances the recognised properties of *bitter*. It is unnecessary to multiply examples.

Let us now review briefly the more frequent and more dangerous species of fallacies which we have ventured to denominate *extra-syllogistic*. The fault here was described as attaching, not to the expressed process of argument, but to the concomitant process of thought.

Sophisms, ranging under this general category, are all traceable to two sources, the first of which is the *assumption of doubtful premises*. This error appears in a great variety of forms.

Accidental coincidence is often assumed as sufficient to establish efficient connection. Two events happen nearly at the same time; therefore one is supposed the cause, and the other the effect. Of this sort of false reasoning, we remember a notable instance in Prideaux. Cambyses was mortally wounded by his sword piercing his body in the same part in which he had stabbed the sacred bull of the Egyptians. In narrating this incident, the dean expresses his concurrence in their superstitious inference, observing that the mode of the king's death was probably designed to mark the divine displeasure against his act of violence, as an insult offered to the cause of religion in general. On the same error are based the fictions of astrology. The fate of individuals and of nations has been thought to be bound up in the movements and conjunctions of the stars; and so simple an event as the appearance of a comet has ere now frightened Europe into penitence. Virgil, in his first Georgic, bids the farmer confide in those indications of the weather afforded by the aspect of the sun, since that luminary's obscuration gave faithful warning of the impending doom of Cæsar. On the same principle, the decline of the Roman power was early ascribed to the spread of Christianity. All our popular superstitions are to be similarly explained; those, for instance, which interpret as infallible preludes of death or discord, the chirping of an insect, the howling of a dog, or the spilling of a little salt.

Closely allied to the preceding fallacy is that which consists in the *assumption of a hypothetical cause*. At this stumbling-block we find the father of logic himself tripping. "All the heavenly bodies," says Aristotle, in his physics, "must move in circles, because a circle is the most perfect of all figures." The reason here assigned for a position, now known to be at variance with existing phenomena, is neither appreciable in itself nor applicable to the question. Des Cartes's hypothesis of animal spirits [illegible] Hartley's theory of vibrations, both framed to ex[illegible] transmission of sensible impressions from the [illegible] of the nerves to the brain, are both referable [illegible] source of error—the supposition, nam[illegible] en a *possible* cause has been assigned, the [illegible] been discovered.

What is [illegible] *tions, is frequently assumed to be true absolutely* [illegible] Deleterious drugs are always to be rejected; opium is a deleterious drug; therefore, opium is always to be rejected." It is plain, that a maxim which holds good, generally, of persons in health, is not applicable especially to cases of disease. This sophism appears, perhaps, more frequently in the interrogative than in the categorical form. The object of the disingenuous disputant, then, is to extort from his adversary an unconditional answer to a question so put as to require it to be qualified. When the query is advanced in a bold, triumphant tone, with its real complexity dexterously disguised, a timid and inexperienced debater will be easily silenced by this expedient. The question, for example, "Is war detestable, or is it not?" cannot be answered directly and unconditionally. If we choose the affirmative, we concede the criminality of even defensive war; if we prefer the negative, we are dealt with as the advocates of aggressive. We must explain and qualify, if we would avoid either horn of the dilemma, at the risk, indeed, of being accused by our opponent of a wish to shuffle and prevaricate, and perplex the discussion. To this head, most cases of defective parallel may conveniently be referred.

Again: *We may assume, as exhaustive of all the alternatives of a given case, what embraces only a portion of them.* Thus, in one of Lucian's Dialogues of the Dead, Menippus chooses to take for granted that the misery of Tantalus only arises from fear that he may *die* of thirst; and proceeds, accordingly, in sarcastic vein, to prove the apprehension groundless. "You say you are punished with thirst; but why is that dreadful to you? For I see no region besides this Hades, nor any second death in another quarter." Thus, too, the celebrated sophistical puzzle respecting motion. "Whatever body is in motion must move either in the place where it is, or in some place where it is not; neither of these alternatives is possible; therefore, there is no such thing as motion." Here it is assumed, that there is no such third alternative as is conveyed by the prepositions *from* and *to*, the others involving manifestly a contradiction in terms.

Next may be mentioned the error of assuming that what is true of a whole is true of a part. Critics, on this principle, have conceived themselves bound to vindicate, or puff into beauties, even the most flagrant

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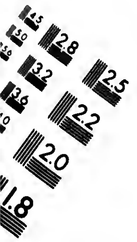
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faults of standard writers; and have seldom struck the medium between unqualified censure and extravagant praise. How often are meritorious individuals subjected to the odium, attaching, perhaps justly, to the majority of a class to which they chance to belong! How often are salutary institutions and customs neglected or decried, just because they have a common origin with others that are noxious and blameworthy! To reverse the illustration: How often are particular periods characterized as enlightened and prosperous, simply from a partial survey of the aspect of affairs! Take the era of Elizabeth. "There was, perhaps, a learned and vigorous monarch, and there were Cecils and Walsinghams, and Shakspeare's and Spensers, and Sidneys and Raleighs, with many other powerful thinkers and actors, to render it the proudest age of our national glory. And we thoughtlessly admit on our imagination this splendid exhibition as in some measure involving or implying the *collective state of the people* in that age."* And how much pernicious error has, in like manner, resulted from admitting the impression that every wise man has been always wise, every great man always great, and every good man always good.

It may be assumed that a position must be false because of certain consequences supposed to follow from it. These consequences may not follow. The truth of Galileo's astronomical theory did not infer the falsehood of the Scriptures, but merely the falsehood of the received interpretation of them. Or they may follow, and the position still be tenable. To have alleged that Galileo's theory was inconsistent with the Ptolemaic system of the universe, would have been true, but nugatory.

The above is not offered as a complete list of all the cases which we think resolvable into the fallacy of assumption, but merely as an index to its more common varieties. An adroit sophist will sometimes, without recourse to any other disguise than that of well-feigned perplexity, palm upon us, wholly unsuspicious of deception, a statement which, but for this artifice, had been the first to be tested.

The fallacy of *irrelevant conclusions* appears in two shapes.

First, A position may be proved, *altogether different from that which ought to be established*, although the sophist designs it to be mistaken for the other. Thus, Horne Tooke, in the Diversions of Purley, would have us infer the falsity of our common notions respecting the first principles of morals, by showing that the terms *right, just, true*, only point, if their etymology be consulted, to what is *ordered, commanded, trowed.* But to prove this is by no means tantamount to proving that there are no such things as immutable morality and eternal truth. Byron is reported to have said that "he had met with so many whose conduct differed from the principles they professed, and who seemed to profess those principles either because they were paid to do so, or from some other motive which an intimate acquaintance with their character would enable one to detect—that altogether he had seen few, if any, whom he could rely upon as truly and conscientiously believing the Scriptures."† Was not this conclusion intended to be taken as equivalent to another—namely, that there *were* few persons in the world sincerely entertaining these convictions?

Secondly, The proof of *part* of a position may be substituted for proof of the *whole.* Thus, if an insufficient argument, accompanied by several valid ones, be detached from the rest, and refuted singly, the sophist may plausibly insinuate that he has done enough to destroy the entire body of evidence. Or, again, to prove that certain inconveniences attach to a particular system, or that certain defects adhere to a particular institution, may with many minds pass as equivalent to the position that the system should be abandoned and the institution abolished. Instances of such artifices must occur readily to every one.

RHETORIC.

Rhetoric, in the sense used by logicians, is the faculty of perceiving and employing what is best adapted to persuasion, and is therefore the adaptation of Logic to oratory. The object of the rhetorician is to *convince* and *persuade:* the former comprehends *instruction* and *conviction;* the latter *exhortation*, or the *influencing of the will.*

We confine ourselves to the following leading points in persuasive oratory.

Persuasion.

Persuasion, or influencing the will, depends on *proof* and *exhortation;* the former *proves* the expediency of the means proposed, and the latter *excites* men to adopt these means by representing the end as desirable. *Proof* is necessary, because the *judgment must be convinced;* and *exhortation* is also necessary, because the *feelings must be influenced.* To make one *believe*, it suffices to *convince;* but to make one *act*, it is necessary to show that the action will gratify some feeling in one's mind. It is, therefore, as necessary for the orator to *awaken those feelings* which will lead to action, as to satisfy the understanding that the conduct to which he would persuade will *tend to gratify the emotions* that are raised.

The Address to the Understanding.

The address to the understanding may be *direct*, because it is under the immediate control of the will; but the address to the *feelings* must be *indirect*, because they are not under the same control. The emotion of anger or gratitude is not to be raised in the mind by *thinking about it*, but by filling the mind with such thoughts as are calculated to produce a change in the feelings. We can produce a change in the circulation of the blood by *taking a medicine that will affect it;* but we cannot produce a change in it by merely *willing.*

Some speakers fail to persuade by only showing the audience how they ought to feel, and telling them that they ought to feel. They speak only to the *reason* of their hearers. Some speakers fail to persuade by *only proving;* others by *only exhorting.*

Improper Motives.—Refutation.

Some orators excite improper motives, because they strive to excite certain emotions when circumstances do not require them. There is not unfrequently a want of skill shown in attempting to allay an improper feeling that has been excited in the audience. An improper feeling is to be allayed by exciting an opposite one. If hatred is to be allayed, then the audience must be led to dwell upon a subject which kindles benevolence.

A string of vague abuse has often the effect of a train of sound reasoning, because the *excited feelings* of the hearers blind their judgment, and cause them to lose sight of the conclusion to be proved.

In arguing, a respondent should begin by refuting the objections of his opponent, when the audience has received them favourably.

When the objections to be refuted are *ridiculous, indirect* or *ironical* refutation should be employed.

Onus Probandi, or Burden of Proof.

The *burden of proof* rests with him who would dispute any point in favour of which there is a presumption. The burden of proof rests now with him who would disprove the principle of gravitation or any other generally allowed truth.

Treating a Proposition.

Propositions may generally be treated in *four* parts

* Foster's Essay on Popular Ignorance.
† Moore's Byron, vol. vi.

the Exordium or Introduction; the Narration or Exposition; the Division; the Conclusion.

In the Introduction, such topics are to be introduced as tend to render the hearers attentive and docile, and to raise the hope of something interesting.

The Narration is an explicit declaration of the subject of discourse, and ought to terminate in the proposition to be explained

The Division ought to exhaust the subject, and not comprehend any thing besides. See Division.

In the Conclusion it is generally proper to begin with a brief recapitulation of the articles discussed, and to end with an address to the affections.

Some writers treat a proposition as follows:—1. The Introduction. 2. They explain the terms of the proposition, show what is granted and what disputed on each side, and then state the point of controversy. 3. They examine objections, and establish their own proposition. 4. They refute objections, and expose fallacies. 5. They make some observations naturally suggested by the subject.

Example.—Enthusiasm is a species of madness.

1. This is a term which is seldom understood by those who use it most frequently. It may, therefore, be useful to show what enthusiasm is.

2. Some derive it from *en thusia* (Greek), *in sacrifice*, because many of the enthusiasts of old were affected in a violent manner during the time of sacrifice. At this day different persons understand it in different senses, quite inconsistent with each other. It is here used to express a sort of madness arising from some falsely imagined divine influence.

3. There are various kinds of enthusiasm. Some enthusiasts imagine that they have gifts which they do not possess; some think to obtain the end without using the means; others think that some things are owing to divine interposition, which really are not.

4. It is a kind of madness to suppose that we have the gifts which we do not possess; for our premises are false, though our reasoning may be conclusive. Some men are misled by pride and a warm imagination to ascribe to the Deity certain impulses which are altogether unworthy of him. The man who imagines himself the peculiar favourite of Heaven, is fortifying himself against the advice of man and the grace of God.

5. Let us beware that we do not run with the common herd of enthusiasts, fancying that we are Christians when we are not; hoping to gain the end without using the means. Let us make use of every means which are conducive to our intellectual and moral improvement, and then we may expect a daily growth in that holy religion, which never can truly be termed enthusiasm.

CONCLUDING OBSERVATIONS.

The preceding definitions of the modes of reasoning, and their application to persuasive oratory, may be of use in directing the comparatively unlearned how to detect fallacies in the arguments of opponents, and what methods may be best employed to sift and arrive at the truth. We should, however, fail in our duty, if we did not add, that, without the habit of clearly arranging our ideas, and acquiring the power of grasping a subject both in its details and general features, the mere instrumental part of logic will not be of essential service in reasoning. An observation of the following rules is recommended by Watt, as serviceable in these respects:—

"I. Rule.—Accustom yourselves to clear and distinct ideas, to evident propositions, to strong and convincing arguments. Converse much with those friends, and those books, and those parts of learning, where you meet with the greatest clearness of thought and force of reasoning. The mathematical sciences, and particularly arithmetic, geometry, and mechanics, abound with these advantages: and if there were nothing valuable in them for the uses of human life, yet the very speculative parts of this sort of learning are well worth our study; for by perpetual examples they teach us to conceive with clearness, to connect our ideas and propositions in train of dependence, to reason with strength and demonstration, and to distinguish between truth and falsehood. Something of these sciences should be studied by every man who pretends to learning, and that (as Mr. Locke expresses it) not so much to make us mathematicians, as to make us reasonable creatures.

We should gain such a familiarity with evidence of perception and force of reasoning, and get such a habit of discerning clear truth, that the mind may be soon offended with obscurity and confusion: then we shall (as it were) naturally and with ease restrain our minds from rash judgment, before we attain just evidence of the proposition which is offered to us; and we shall with the same ease, and (as it were) naturally, seize and embrace every truth that is proposed with just evidence.

This habit of conceiving clearly, of judging justly, and of reasoning well, is not to be attained merely by the happiness of constitution, the brightness of genius, the best natural parts, or the best collection of logical precepts. It is custom and practice that must form and establish this habit. We must apply ourselves to it till we perform all this readily, and without reflecting on rules. A coherent thinker or a strict reasoner is not to be made at once by a set of rules, any more than a good painter or musician may be formed extempore by an excellent lecture on music or painting. It is of infinite importance, therefore, in our younger years, to be taught both the value and the practice of conceiving clearly and reasoning right; for when we are grown to the middle of life, or past it, it is no wonder that we should not learn good reasoning, any more than an ignorant clown should not be able to learn fine language, dancing, or a courtly behaviour, when his rustic airs have grown up with him till the age of forty.

For want of this care, some persons of rank and education dwell all their days among obscure ideas; they conceive and judge always in confusion, they take weak arguments for demonstration, they are led away with the disguises and shadows of truth. Now, if such persons happen to have a bright imagination, a volubility of speech, and a copiousness of language, they not only impose many errors upon their own understandings, but they stamp the image of their own mistakes upon their neighbours also, and spread their errors abroad.

It is a matter of just lamentation and pity to consider the weakness of the common multitude of mankind in this respect, how they receive any thing into their assent upon the most trifling grounds. True reasoning hath very little share in forming their opinions. They resist the most convincing arguments by an obstinate adherence to their prejudices, and believe the most improbable things with the greatest assurance. They talk of the abstrusest mysteries, and determine upon them with the utmost confidence, and without just evidence either from reason or revelation. A confused heap of dark and inconsistent ideas makes up a good part of their knowledge in matters of philosophy as well as religion, having never been taught the use and value of clear and just reasoning.

Yet it must be still confessed that there are some mysteries in religion, both natural and revealed, as well as some abstruse points in philosophy, wherein the wise as well as the unwise must be content with obscure ideas. There are several things, especially relating to the invisible world, which are unsearchable in our present state, and therefore we must believe what revelation plainly dictates, though the ideas may be obscure. Reason itself demands this of us; but we should seek for the brightest evidence both of ideas and of the connection of them, wheresoever it is attainable.

II. Rule.—Enlarge your general acquaintance with things daily, in order to attain a rich furniture of topics, or middle terms, whereby those propositions which occur may be either proved or disproved; but especially meditate and inquire with great diligence and exactness into the nature, properties, circumstances, and relations of the particular subject about which you judge or argue. Consider its causes, effects, consequences, adjuncts, opposites, signs, &c., so far as is needful to your present purpose. You should survey the question round about, and on all sides, and extend your views, as far as possible, to every thing that has a connection with it. This practice has many advantages in it, as—

1. It will be a means to suggest to your mind proper topics for argument about any proposition that relates to the same subject.

2. It will enable you, with greater readiness and justness of thought, to give an answer to any sudden question upon that subject, whether it arise in your own mind or be proposed by others.

3. This will instruct you to give a plainer and speedier solution of any difficulties that may attend the theme of your discourse, and to refute the objections of those who have espoused a contrary opinion.

4. By such a large survey of the whole subject in all its properties and relations, you will be better secured from inconsistencies, that is, from asserting or denying any thing in one place which contradicts what you have asserted or denied in another; and to attain these ends, an extensiveness of understanding and a large memory are of an unspeakable service.

One would be ready to wonder sometimes how easily great and wise and learned men are led into assertions in some parts of the same treatise, which are found to be scarce consistent with what they have asserted in other places; but the true reason is the narrowness of the mind of man, that it cannot take in all the innumerable properties and relations of one subject with a single view; and therefore, whilst they are intent on one particular part of their theme, they bend all their force of thought to prove or disprove some proposition that relates to that part, without a sufficient attention to the consequences which may flow from it, and which may unhappily affect another part of the same subject; and by this means they are sometimes led to say things which are inconsistent. In such a case, the great dealers in dispute and controversy take pleasure to cast nonsense and self-contradiction on their antagonist, with huge and hateful reproaches. For my part, I rather choose to pity human nature, whose necessary narrowness of understanding exposes us all to some degrees of this frailty. But the most extensive survey possible of our whole subject is the best remedy against it. It is our judging and arguing upon a partial view of things that exposes us to mistakes, and pushes us into absurdities, or at least to the very borders of them.

III. Rule.—In searching the knowledge of things, always keep the precise point of the present question in your eye. Take heed that you add nothing to it while you are arguing, nor omit any part of it. Watch carefully lest any new ideas slide in, to mingle themselves either with the subject or predicate. See that the question is not altered by the ambiguity of any word taken in different senses, nor let any secret prejudices of your own, or the sophistical arts of others, cheat your understanding by changing the question, or shuffling in any thing else in its room.

And for this end it is useful to keep the precise matter of inquiry as simple as may be, and disengaged from a complication of ideas which do not necessarily belong to it. By admitting a complication of ideas, and taking too many things at once into one question, the mind is sometimes dazzled and bewildered, and the truth is lost in such a variety and confusion of ideas; whereas, by limiting and narrowing the question, you take a fuller survey of the whole of it.

By keeping the single point of inquiry in our constant view, we shall be secured from sudden, rash, and impertinent responses and determinations, which some have obtruded instead of solutions and solid answers, before they perfectly know the questions.

IV. Rule.—When you have exactly considered the precise points of inquiry, or what is unknown in the question, then consider what and how much you know already of this question, or of the ideas and terms of which it is composed. It is by a comparison of the known and unknown parts of the question together, that you may find what reference the part known hath unto, or what connection it hath with, the thing that is sought; those ideas whereby the known and unknown parts of the question are connected, will furnish you with middle terms or arguments whereby the thing proposed may be proved or disproved.

In this part of your work, namely, comparing ideas together, take due time, and be not too hasty to come to a determination, especially in points of importance. Some men, when they see a little agreement or disagreement between ideas, presume a great deal, and so jump into the conclusion. This is a short way to fancy, opinion, and conceit; but a most unsafe and uncertain way to true knowledge and wisdom.

V. Rule.—In choosing your middle terms or arguments to prove any question, always take such topics as are surest and least fallible, and which carry the greatest evidence and strength with them. Be not so solicitous about the number as the weight of your arguments, especially in proving any proposition which admits of natural certainty or of complete demonstration. Many times we do injury to a cause by dwelling upon trifling arguments. We amuse our hearers with uncertainties, by multiplying the number of feeble reasonings, before we mention those which are more substantial, conclusive, and convincing. And too often we yield up our own assent to mere probable arguments, where certain proofs may be obtained.

VI. Rule.—Prove your conclusion (as far as possible) by some propositions that are in themselves more plain, evident, and certain, than the conclusion; or at least such as are more known and more intelligible to the person whom you would convince. If we neglect this rule, we shall endeavour to enlighten that which is obscure by something equally or more obscure, and to confirm that which is doubtful by something equally or more uncertain. Common sense dictates to all men, that it is impossible to establish any truth, and to convince others of it, but by something that is better known to them than that truth is.

VII. Rule.—Labour, in all your arguings, to enlighten the understanding, as well as to conquer and captivate the judgment. Argue in such a manner as may give a natural, distinct, and solid knowledge of things to your hearers, as well as to force their assent by a mere proof of the question. Now, to attain this end, the chief topic or medium of your demonstration should be fetched, as much as possible, from the nature of the thing to be proved, or from those things which are most naturally connected with it.

VIII. Rule.—Though arguments should give light to the subject, as well as constrain the assent, yet you must learn to distinguish well between an explication and an argument; and neither impose upon yourselves, nor suffer yourselves to be imposed upon by others, by mistaking a mere illustration for a convincing reason.

Axioms themselves, or self-evident propositions, may want an explication or illustration, though they are not to be proved by reasoning.

Similitudes and allusions have oftentimes a very happy influence to explain some difficult truth, and to render the idea of it familiar and easy. Where the resemblance is just and accurate, the influence of a simile may pro used so far as to show the possibility of the thing in question; but similitudes must not be taken as a solid proof of the truth or existence of those things to which they have a resemblance. A too great deference paid to similitudes, and an utter rejection of them, seem to be two extremes, and ought to be avoided. Locke, even in his inquiries after truth, makes great use of similes for illustration, and is very happy in the invention of them, though he warns us lest we mistake them for conclusive arguments.

Yet let it be noted here, that a parable or a similitude used by any author, may give a sufficient proof of the true sense and meaning of that author, provided that we draw not this similitude beyond the scope and design for which it was brought; as when our Saviour affirms, Rev. iii. 3, 'I will come to thee as a thief:' this will plainly prove that he describes the unexpectedness of his appearance, though it will by no means be drawn to signify any injustice in his design.

IX. Rule.—In your whole course of reasoning, keep your mind sincerely intent on the pursuit of truth, and follow solid argument wheresoever it leads you. Let not a party spirit, nor any passion or prejudice whatsoever, stop or avert the current of your reasoning in quest of true knowledge.

When you are inquiring, therefore, into any subject, maintain a due regard to the arguments and objections on both sides of a question: consider, compare, and balance them well before you determine for one side. It is a frequent but a very faulty practice, to hunt after arguments only to make good one side of a question, and entirely to neglect and refuse those which favour the other side. If we have not given a due weight to arguments on both sides, we do but wilfully misguide our judgment, and abuse our reason, by forbidding its search after truth. When we espouse opinions by a secret bias on the mind through the influences of fear, hope, honour, credit, interest, or any other prejudice, and then seek arguments only to support those opinions, we have neither done our duty to God nor to ourselves; and it is a matter of mere chance if we stumble upon truth in our ways to ease and preferment. The power of reasoning was given us by our Maker for this very end, to pursue truth; and we abuse one of his richest gifts, if we basely yield it up to be led astray by any of the meaner powers of nature, or the perishing interests of this life."

[WORKS ON LOGIC.]

Within a few years many works have appeared, purporting to treat of the powers and of the operations of the mind, though few of them attempt to present a system of Logic fit for those who would study it as a science, unincumbered with scholastic subtleties and useless distinctions. Most of the treatises which, until of late years, were in common use, had been formed on the mode of ancient systems, and contained of useful information little more than a description of the syllogism and a few general principles of demonstrative reasoning. Collard and Condillac simplified and improved the science of Logic, and all the subjects which properly fall within its precincts were amply discussed by Doctor Richard Kirwan, in "An Essay on the Elements, Principles, and different Modes of Reasoning." Prolixity and a fondness for detail, however, obscure the merits of this author. We may speak in high terms of the concise and admirable work of Dr. Hedge, of Harvard University, whose Elements of Logic is perhaps better than any other fitted for general use. Another valuable work, bearing the same title, has been issued by Dr. Whately, archbishop of Dublin: it is more comprehensive than that of Dr. Hedge, and may be confidently recommended to those desirous of acquiring an accurate knowledge of the principles of this important science.

The student should not confine himself to either of the above works however, but should read in connection and with reference to them, Locke's Essays on the Understanding, Reid's Essays on the Intellectual Powers, Stewart's Elements of the Philosophy of the Mind, Upham's Mental Philosophy, Campbell's Philosophy of Rhetoric, Gambier's Introduction to Moral Evidence, Beattie's Essay on Truth, Scott's Elements of Intellectual Philosophy, and the works on the subject by Watt & Kirwan.—*Am. Ed.*]

EDUCATION.

Till within the last few years, the idea commonly entertained with respect to general elementary education comprehended only certain branches of instruction familiarly known by the terms, *reading, writing, and arithmetic.* A "liberal" education added ancient and modern languages and mathematics. Such formed the entire round of accomplishments which were supposed, with the accident-directed moral training of the domestic circle, to be sufficient to fit the youth, of even the highest classes, for entering upon the varied duties of life. Nor was this scanty education thought requisite for all. A vast class was allowed to exist without the least tincture of school learning of any kind, as not being supposed to require any knowledge beyond that which immediately fitted them for the laborious duties by which they earned their bread.

The active period which has elapsed since the conclusion of the last war (1815), has been distinguished by nothing more than by the enlargement of our ordinary ideas with respect to education. It may be said to be now universally acknowledged that all—all, from the peer to the peasant—ought to be educated, however there may still be differences of opinion as to the *means* of educating, and what education should *consist of.* It is also generally admitted that *reading, writing, and arithmetic*, even when effectually taught, constitute but a branch of education, being merely instrumentary accomplishments, the acquirement and cultivation of which tend in a certain degree to improve the intellect. The study of the ancient classical languages, while still admitted by candid persons to be also a means of improving the intellect, is now no longer upheld, excepting by a few, as the grand instrument of liberal education, the character in which it was generally regarded a few years ago. It is now seen that this study gives to the youth of the middle and upper classes but a portion, and, in many instances, the least requisite portion, of what they should know on entering the world. The old elements of education may therefore be said to have sunk from their former character of all-sufficiency, and to have now taken their place as only parts of a complete education.

PRINCIPLES OF EDUCATION.

The primary meaning of the term *educate*, from the Latin *educare*, to lead or bring out, does not ill express the first great principle of the science. It may be held to assume that the human being is naturally in a comparatively rude and inert condition, and that external forces must be applied to draw forth his faculties into their full activity and power, and bring them to their highest degree of refinement and nicety of application. This is, in reality, a large part of the business of education, taking even the widest view of its purposes. A full definition would further include the regulation and discipline of those moral feelings on which our actions are mainly dependent, and also the communication of such parts of knowledge as the circumstances and prospects of individuals may render necessary.

Before correct views can be entertained with regard to education, or proper steps can be taken for working it out in practice, it is obvious that a distinct notion ought to be attained as to the character of the being to be educated. Man is this being; but the question "what is man?" is one to which science does not yet enable us to give an answer which all would acknowledge as right. For this reason it is totally impossible for any writer to present a theory of education which would be generally received as a perfect science. The subject must needs partake of the obscurity and uncertainty which as yet rest upon at least the mental character of man; and it will only advance in clearness and precision, in proportion as progress is made in a correct system of mental philosophy.

While fully acknowledging the difficulty under which every candid writer on education must lie, the present would humbly endeavour to make the nearest approach to a correct system which his views of the natural character of the human being will admit of. He considers the race as exhibiting a definite mental constitution, in all its parts harmonizing with the surrounding universe. He considers this constitution as embracing a variety of faculties, for sensation and action, which it is the business of the educator to awaken, strengthen, and regulate, so that each person may arrive at the best condition of which his character is susceptible, and most thoroughly fulfil the design of his being in all its various respects. He views, in the first place, the faculties of the physical frame as requiring to be duly exercised, so as to bring them to the utmost limit of their native power and health. Of the mental system, he views those faculties which constitute the intellectual powers as requiring to be drawn out, exercised, and instructed, so that they may operate readily and efficiently for all the various purposes which they are designed to serve; and those, again, which constitute the moral feelings as calling for the exertion upon them of all external moral influences—at the head of which stands the revealed will of God with regard to human destiny—in order that the best possible state of feeling may be attained with regard both to the affairs of the present and to a future state of existence. Upon these views of man's character a scheme of education may be founded, which rational persons, as yet unprepossessed by other notions, will, he thinks, generally acknowledge as accordant with common sense, however unprepared they may be to trace it to its foundation. He will, therefore, without further preface, proceed to describe such a scheme, adopting the appropriate divisions into *physical, moral,* and *intellectual*, and combining, as far as his space permits, practical directions with what may be called the philosophy of the subject.

PHYSICAL EDUCATION.

The object of physical education is to ensure, as far as possible, that sound and vigorous frame of body which, while all must feel it to be one of the greatest of blessings, appears to be an essential concomitant of a sound condition of the mind itself. Physical education comes into operation before any other department, for one of its first concerns is to take care that the human being shall be brought into the world in the enjoyment of a perfect organization. The mother is here the educator. She is required, during pregnancy, to order her life, with respect to food, dress, and all other habits, according to certain rules, found to be conducive to the welfare of her future offspring. Judicious medical men recommend, that, at this time, the food taken should not greatly differ from what is taken at other times. The dress should be loose and easy. Moderate exercise should be regularly, as far as possible, indulged in; and it is of the greatest consequence of all, that, while ordinary duties are attended to, a quiet, cheerful, and easy state of mind should be maintained. Departure from these rules, indulgence in late or otherwise irregular hours, and exposure to the excitements produced by violent passions, or the frivolities of fashionable life, are calculated to occasion deplorable effects on the being yet to be brought into the world.

Infancy.—The physical education of an infant involves simply the means of keeping it in health. For this purpose nature has made one signal provision, in the tenderness which she has infused into the female heart—a feeling which insures an unfailing kindness towards the young. But something besides kindness is required to rear children successfully. It is necessary that those who have the duty of nursing the young, whether mothers or substitutes for mothers, should have some knowledge of the physiology of the infant body, or at least be acquainted with the rules of management which result from such a knowledge. The sad effects of ignorance on this subject are sufficiently conspicuous, for we cannot doubt that, of the great mortality of the young (four-tenths of them dying under five years of age), much is owing to erroneous methods pursued in the nursery.

Here the leading rules only can be indicated. An infant should never be plunged into cold water, or exposed in any other way to cold, because, the circulation being comparatively languid in the infant subject, he can less endure cold than grown-up persons; and an attempt to produce hardiness may only undermine health. It is of the greatest consequence that an infant should be kept constantly clean and dry, that its hours be early and regular, and itself be as far as possible habituated to a periodic recurrence of all its wants. The mother's milk is the most appropriate food; next, that of a nurse about the same time confined; next, cow's milk warmed and diluted. Farinaceous or any other kind of solid food, is unsuitable to the stomach of an infant under six months old. A child ought, if possible, to be nursed about eight months, and somewhat longer if weakly, or when the period of eight months terminates in the dead of winter. After weaning, the food should be farinaceous—that is, of substances composed of grain, potatoes, arrow-root, &c. Animal food should be avoided till the period of infancy may be considered as nearly at an end, and even then it should be of the tenderest fibre, and administered in very simple forms and moderate quantities.

The food and general habits of the nurse are of great and direct importance. The child is immediately dependent in all respects upon the person who suckles it; thrives with that person, and also declines with her; suffers when she suffers, and is well when she is well. So remarkably is this the case, that an act so simple on her part as the taking of a hasty draught of cold water, will probably give the infant a stomach-ache within two hours. It is therefore of the greatest consequence to the welfare of the young that those from whom they draw their sustenance should observe all the rules proper to their condition. A nurse should live a quiet but not inactive life, using simple wholesome diet, avoiding stimulating drinks, and preserving, as far as possible, a cheerful mind. Fermented liquors, as porter and ale, are only to be resorted to when her strength would otherwise sink under exhaustion of her system. In fair health, a light beer is perhaps the most suitable beverage.

For the due development of the muscular system of an infant, its dress should sit light and easy upon its person and its limbs should be allowed free play on all possible occasions. The restless movements of an infant, the tossing about of its head, arms, and limbs, are to be considered as merely impulses of nature, directing it to exercise, and consequently strengthen, its muscular system. These movements should therefore be rather encouraged than repressed. Care should be taken that it is not too soon allowed to bear its own weight, as the natural consequence is bending the as yet soft bones of the legs, which may thus become deformed for life. Whenever a child of proper age is unable to bear its own weight, or walk without this effect following, we may be sure that its general health is defective: and it is a more immediate and pressing duty to take measures for remedying this defect, than to attempt to keep the limbs straight by mechanical appliances.

The general health of an infant may be described, in a word, as to be secured (supposing a good constitution at first) by food appropriate to its organs, warmth, cleanliness, regularity in sleep and other wants, a well-aired nursery, and occasional walks out of doors, protection from all injuries through the medium of the nurse and otherwise, and the muscular exercise of which its system is capable.(1)*

Childhood, Youth, and Manhood.—Physical education ought to be continued till the body is brought to the utmost degree of perfection, in all its functions, of which it is capable. The improvement of all the systems and functions of the body may be called the *education* of these systems and functions; hence recent writers on the subject speak of the education of the skin, the education of the lungs, of the digestive organs, of the muscular frame, of the brain.

In a subsequent article of this work, that on the Preservation of Health, most of the matters which fall under Physical Education are carefully treated. By reverting to that paper, the reader will find of how much importance must be the formation of habits of bodily cleanliness, seeing that the skin is a system which only can have a healthy function when it is thoroughly free from impurities, and that nothing is more indispensable for general soundness than the particular health of this part of our frame. In the same paper, the value of a due supply of pure air for the health of the respiratory organs is insisted on; as also the proper regulation of the appetite for food. The education of the muscular system implies a competent knowledge of the structure, attachment, and conditions of action, of the muscles; the operation of arterial blood and nervous influence on the muscles, and other matters, for which we refer to our article entitled Account of the Human Body.

Under this branch of physical education falls all the science of exercise—walking, riding, running, leaping, swinging, skating, dancing, fencing, cricket, ball-play, &c. The importance of these to health, in the full development of the muscles and improvement of the frame, has long been known, and by some nations steadily practised. The perfect forms of the Greeks and Persians were the result of this branch of education receiving a large share of national attention. Ample provision for such exercises should be made in all seminaries of education, infant and more advanced. What are strictly called gymnastics, are more violent and trying than any we have mentioned, consisting of climbing poles, leaping bars, swinging by the hands, and maintaining difficult positions. These require much caution in the watchful educator, and should not be allowed in slender and weakly boys. They ought not to be overdone by any youth whatever, seeing that, even in the robust, strains and ruptures have been occasioned by them.

MORAL EDUCATION.

The training of our moral nature for the due performance of our part as members of society, is that branch of education which the great majority of those who have reflected on the subject consider as by far the most important. It is a great mistake to suppose that this is a

* The numbers introduced in this manner refer to volumes of *Chambers's Educational Course*, according to a list (as far as published) given at the close of the section "Intellectual Education." It will be understood that the volume referred to either treats that department of the theory and practice of education fully, or is a school book in which the subject is embodied.

branch which the advocates of improvements in education have generally overlooked. As far as we have observed, all but a small sect of this class of philanthropists acknowledge its paramountcy. This is the part of education which, in a national system, would call for the most attention, because, while degrees of intellectual attainment are proper for different classes of men, there is no class of whom it can be said, that a *right and perfect moral development* is not of the utmost consequence both to themselves and the society of which they form a part. Besides such a benefit, that of an acquaintance with the mere elements of literature sinks into insignificance. There is no need, however, to exalt any department of education at the expense of another. It may be true, that intellectual development is not expressly moral development; but it must be clear to every candid person, that the refinement and expansion of mind obtained from intellectual culture, are favourable to the moral nature. A thinking man is not on that account likely to be the less a virtuous man; else, much of our common observations of life must be a delusion. We would therefore say, let no department of education be considered as calling for exclusive or disproportionate cultivation; but let all go on in harmony together.

Moral education can have no definition from us but the development and regimen of the moral nature of those who are to be educated. Of the perplexity which attends this part of our being, it is unnecessary to speak. Let us only see if we can settle upon any principles by which it may be beneficially affected. It appears to include a variety of native feelings, of various strength and tendency to activity in every different person, yet all of them liable to be acted upon by appropriate external means, to good as well as to evil. In a mind totally untrained, the good dispositions are not without some energy; but, generally, where there is a want of regulation of the feelings, and of certain principles to which the character of emotions and actions may be referred as to a standard, the moral being is a scene of deplorable confusion—the more so, of course, in instances where there is a considerable natural endowment of the inferior feelings. We have then the coarse, sensual, and selfish conduct which has been the mark of the rude throughout all ages. On the other hand, we cannot doubt that many natures, not originally of a high cast, thrown under influences which tended to check the less worthy tendencies, to strengthen the good, and to induce regularity over all, must have been thereby enabled to pass through life in a creditable manner, if not with some higher result less open to observation.

One principle thus strikes us at the outset as of very great consequence, namely, the circumstances, or, so to speak, the moral atmosphere, in which the being to be educated is placed. It is but matter of every-day observation, that a child reared amidst gross scenes, where no restraint is imposed upon any of the feelings by those around him, will prove, in all likelihood, a very different being from one brought up amidst virtuous and gentle people. Such a difference, we cannot doubt, would exist even where no attempt had been made by the latter parties to fashion the moral character of the young creature committed to their charge. It is exactly a difference of this nature which exists between the youths native to the vale of the Missouri (or those of the not less savage classes which social circumstances produce in most great cities) and those of civilized countries in general: circumstances decide the one set to be barbarians, and the other to be tolerably well-behaved persons. This *education of circumstances*, though so powerful, is unfortunately not always within the command of well-meaning parents. Individuals are here generally able to do little of themselves, if the persons by whom they are necessarily surrounded be not of the character that is desirable. Thus, it often happens that a poor though well-disposed man is obliged to live in a part of a city where his children can only breathe moral contamination; and we can scarcely imagine a greater hardship. Yet these are just reasons why every effort should be made to promote a universal improvement of society; and it must rarely happen that some arrangements cannot be made, of a character likely to operate favourably on the young persons who are the objects of care.

We would here impress the importance of removing *temptation* as much as possible out of the way of young persons. There is a notion amongst some, that a little temptation is not amiss, as a means of training the young to withstand greater assaults. But this is, we are convinced, an ill-founded doctrine, and most fatal policy. It is of the nature of every one of our feelings to be awakened into activity by the presentation of its appropriate object; and it is the equally natural result, that the frequent activity promotes the power and the tendency to activity of those feelings. By presenting, then, what are called temptations, we are taking a direct means of educating and strengthening the inclinations towards error. On the contrary, a feeling, allowed to lie dormant, loses in power, and becomes always less and less liable to act. There is perhaps a confusion of ideas at the bottom of the objectionable theory. The true plan seems to be to remove all actual temptation, but to give the intellect and the moral feelings proper warning against all such dangers, and thus prepare them for resistance when the time of unavoidable trial arrives. We would say, then, do not allow the young to see or touch evil things, or even to be in company where such things are to be spoken lightly of, from an idea that they are thus to be hardened against temptation. Be content to inspire a salutary horror of such things by your own report, if you only are so fortunate as to be able to keep your young charge exempt from positive contact with what is discommendable. An error may of course be committed in speaking too strongly against what you disapprove of, in which case, the young person no sooner discovers the exaggeration, than, from a principle of contradiction, he is inclined to embrace the vice. But discretion will save from this mistake. Upon the whole, it may be set down as a most important rule in education, to reduce temptation to the smallest possible bounds.

Nearly connected with the education of circumstances is the *education of example*. Here personal conduct in the educating party is all in all. Children are remarkably disposed to imitation. They imitate instinctively, without having necessarily any discrimination of the character of the act which they are imitating. The general nature of their conduct is therefore ruled very much by the nature of the conduct presented to their observation. So much is this the case, that, if a child be carefully watched, he will be observed to contract a tendency to scolding and beating, from that very discipline by which, most erroneously, an endeavour is made to correct his errors. It must obviously, then, be of the greatest importance that the demeanour and general actions of the educator, and of the family in which a child is reared, should be models of all that is proper. Just the more amiable and correct in all respects that this conduct is, so will the young be the more likely to form those habits which their best friends could wish. We will not pause to consider the effect which a positively vicious course of life is calculated to have on such of the young as witness it. The kind of bad example which we have here a chance of helping to abolish, is that which shows itself in acts far within the circle of positive vice. Such are the use of offensive and uncivil language, wranglings, domineering, low and sordid habits of all kinds. If parents and the other grown-up members of a family do not restrain themselves from all such acts in the presence of children, there cannot be a doubt that the children will likewise be addicted to them. It may be a somewhat startling doctrine, but we nevertheless declare our full conviction that there is not the least need for ever using, in the presence of or towards children, any language which might not be addressed by a well-bred person to a perfect equal. All ordering, dragooning, scolding, and, much more, all violence, exerted for the purpose of managing or punishing a child, are unmitigated errors and evils. A child has feelings to be wounded and roused up into contradiction by harsh usage, as well as any grown-up person; and it is well known that such means are not serviceable for gaining any end with our fellow-creatures. A civil request, if reasonable, will succeed with a child as with a man. Gentle and respectful language gain as much upon an uncorrupted child's nature as upon a man's. Such treatment can have no chance of *spoiling* a young person: it will only promote his being made a rational, well-bred being, instead of a wrangler or tyrant.

The *preceptive part* of moral education, though the lowest in power, is not to be overlooked. A good maxim or a sound advice, well-timed, and made thoroughly intelligible and thoroughly acceptable, will rarely fail to have a good effect. Even supposing it to be little regarded at the time, it may remain in the memory, and come into play on some future occasion, when perhaps more necessary than now. In such moral seeds, there is a vitality like that of the seeds of plants, which may have been buried too deep for germination for thousands of years, and yet, when placed in the proper circumstances, visited by sap and heat, will send up as goodly specimens of their kind as if they had been shed from a parent stem of last year's growth. It will therefore be proper, from time to time, to inculcate moral lessons, appropriate to the capacity of the child. This may be done directly, by giving good maxims to be learned by heart; but it will be done better by means of narratives showing the virtues in action. This is because a child much more readily apprehends a series of incidents than an abstract truth. It will also be well to allow the simple narration, in the first place, to be received into his mind, and then to allow himself, if possible, to make out the moral. Call his own moral feelings, as far as may be, into judgment upon the case, and only tell him whether he is right or wrong, till he fully comprehends it in all its bearings. Thus his own good feelings, as well as his judgment, are brought into exercise, and thus a far deeper impression is made than if the whole case, including the moral, were merely related to him.(8)* It is a duty of preceptive education to warn against and check evil, as well as to inculcate good. When any thing wrong is done, we but imperfectly correct it by saying, "Don't do that," or inflicting censure or punishment. It is necessary that we should convince the understanding and move the feelings of the child to a sense of the impropriety of his conduct. This may be done by mild argument and illustration, calling upon himself ultimately to say whether such conduct is commendable or not, and whether it ought to be repeated or avoided. He thus becomes judge upon his own case, and is forced to condemn himself, where, if condemned by others, his opposive feelings might have only presented resistance and defiance. At some schools, including those for infants, it has been found possible to impress such lessons by means of a kind of trial, the school-fellows being the jury. The case is stated to the assembled children: they are asked to say if such conduct is right or wrong. They invariably give a sound decision, and the effect is most powerful. Obdurate natures, to which a reprimand from master or parent would at the moment be as nothing or worse, are found unable to resist the force of the *public opinion of their own society*—as is every day found to be the case with grown-up people, such being, in fact, a law of human nature.

Circumstances, example, precept, are all inferior in effect to *Training*, which is more particularly the novel feature of modern education. This principle may be said to have its natural basis in the law of habit. It is indicated in the text, "Train up a child in the way he should go, and when he is old he will not depart from it;" and in the maxim, "Just as the twig is bent, the tree is inclined." We are so constituted, that, when accustomed to do any thing, we do it almost without the governance of our will or judgment. We do it easily, and generally well. If accustomed, for instance, to a particular class of intellectual operations, we acquire a facility in going through them, which generally strikes others with wonder. If accustomed to the exercise of a particular class of feelings, be they good or bad, they in time awake in us unprompted, and we become their almost passive instruments. To habituate the feelings to the exercise and regulation which is productive of the best results, is moral training.

The feelings are of very various character. Proceeding upon Dr. Gall's description of them, which seems to us to be the best, we find the first class described as selfish, yet necessary for the preservation of the individual and the species; others directed to objects apart from self, yet as liable also to misdirection and abuse. It is altogether a strangely mingled web, yet not without a certain definiteness of constitutional arrangement and of purpose. Here it may be at once admitted, as a fact not less clear from philosophical inquiry than from revelation, that perfection in the complicated operations of our moral nature is not to be looked for. But it is equally certain that there are influences which may act advantageously in regulating, directing, and harmonizing these operations.

The selfish or lower feelings are the first in the individual to call for attention, and they may therefore be first treated in this place. That early developed instinct which regards food, is so liable to be over-indulged by a mistaken kindness, that we feel particularly called upon to give a warning with regard to it. The unavoidable effect of such over-indulgence is to produce pampering and fastidious habits, equally degrading to the moral as they are dangerous to the physical system. The food of the young should never be otherwise than simple, if we were merely to regard their health; still more should it be so, if we would preserve in them manly and hardy habits. On the rare occasions when a little treat is afforded, care should of course be taken that it is of a nature in all respects harmless. Comfits should be few and far between, if ever given at all; and rewards and punishments should never have reference to edible things. As to liquor of any kind, such as men are themselves but too much accustomed to indulge in, certainly one drop should never enter the lips of a young person on any pretext whatever. There are few sights more distressing to a reflecting mind, than that of parents handing the so fatal wine-cup to their children. The quantity of food given to the young should never be stinted from penurious or ascetic motives; but it is very certain that great errors are committed in giving too much and too frequently. Eating is altogether much a matter of habit, and that with regard to quantity as well as quality. The amount actually required for the efficient support of the system is, under natural circumstances, not great: it is generally much exceeded. There is therefore room for a judicious restriction, within the range of common practice. It is but a result of the general law, that a systematic moderation

* The Moral Class-Book, here referred to, supplies a variety of narratives showing the virtues in action, together with a selection of moral maxims from Scripture and other sources.

at this period of life will lead to an easily maintained temperance in future days, and thus be productive of the greatest blessings.

The combative and destructive dispositions of children are also early manifested. The great activity of these faculties in boys is particularly remarkable, being shown as much in a wild spirit of adventure, for innocent objects, but often leading into danger, as in any direct form of violence. The superabundant vitality of this period of life seems to be a cause, or at least a necessary accompaniment, of the energy of these faculties. No peril intimidates; little compunction is felt in dealing with either man or beast. In all this there is no doubt a good end in view; but it still remains for the educator to regulate these dispositions. The *contendative* spirit may be directed to the overcoming of difficult tasks, the taking of energetic exercise, and the visiting of places and objects the examination of which may be useful. The other feeling, instead of being allowed to show itself in rage, passion, and resentment, to inflict pain on harmless animals, to torture or oppress companions, or take delight in defacing or destroying inanimate and perhaps ornamental or useful objects, may be trained to reserve actual manifestations of its energy for objects clearly noxious. It is to be lamented that education, as heretofore and still in many places conducted, rather tends to foster than to regulate or moderate this propensity. The old notion that to be able to fight is essential to a youth, still, we fear, in some measure guides directors of education, at least so far as to induce their taking little pains to prevent scenes of outrage where only youthful good humour and kindness should prevail. The oppressive system of fagging is also still, to the disgrace of our age, allowed in some of our public seminaries. It is well, no doubt, that he who is to find life a thorny and difficult path, should not enter it with too gentle or timid dispositions; but surely it is not impossible to draw a distinction between quarrels, blows, and tyranny, and the encouragement of a spirit sufficiently manly and energetic for all the common needs of our life.

The first object of the educator with regard to these feelings, ought to be to impress the lesson that their exercise is good or bad just as they have good or bad objects in view—that they must, in all cases, be under the guidance of the moral sentiments and judgment. The pupils should be trained to check every impulse of these feelings which they are conscious has not a legitimate object in view, and only to allow them any freedom when careful reflection has satisfied them that such a course is entitled to the entire sanction of the moral law. Particular regard should be paid to the suppression of the spirit of wanton cruelty, of malice, of revenge, of uncharitableness. And one important means of working out these ends will be to allow no example of harshness, cruelty, or quarrelsomeness, ever to appear before the eyes of the young. It is very desirable that those who conduct schools in which the children of the humbler classes are educated, should address themselves particularly to the formation of habits favourable to humanity. Large sections of the humbler classes, particularly those who have any thing to do with animals, are habitually cruel. Much might be done to mitigate this distressing characteristic, by carefully impressing at school the wickedness involved in every description of cruelty to animals.

The secretive disposition calls for a large share of attention from those who would bring up a child well. This tendency of our nature appears to have a legitimate operation in dictating such a reserve as may be necessary for the restraint of our ordinary feelings, where their expression would be disagreeable or mischievous; but it is liable to great abuse, and particularly amongst the young. The first impulse of all unregulated minds, young and old, is to conceal the truth, if such expedient seem calculated to save them any harm or inconvenience. It is only when the greater evil of lying is thoroughly understood, that this tendency ceases. It becomes, therefore, of great consequence to check the first instances that are observed in the young of a disposition to conceal the truth for selfish or base purposes, and to seek to establish principles and habits of a contrary character. For this end nothing is so necessary as a mild and just treatment of children under all circumstances, seeing that when severity or injustice is to be apprehended, a direct and far too great temptation is given for secretive conduct.

It is difficult to legislate between the evils of blabbing, and the equally notorious evils of a habitual system of conspiring for the concealment of truths which conscientiousness would direct being told. There can be little doubt that the "*don't tell*" practices of the nursery and school are calculated to implant and foster the seeds of disingenuousness in the youthful mind. Yet it is not less true, that to encourage a tale-bearing habit would be destructive to all manly and honourable feeling. Here caution, judgment, and a careful discrimination of cases, must be the chief guides of the educator. We would, for our part, deem it a duty to lean as much as possible to the principle of having the truth told at all hazards. The educator may do much by a rigid system of inspection, and omitting no opportunity of breaking up all confederacies against the truth. As he never will allow *shirking*, if he can help it, so also he will never, on his own part, be guilty of the meanness of *winking*. The more open and candid his own conduct in all his relations towards his pupils, the better will it be for them. There exists a school on improved principles, where the most lively mutual confidence exists between the masters and their pupils, and on the part of the pupils towards each other, with the best effects on all hands. Honour is thus so habitually observed, that the desks containing the little property, letters, &c., of the pupils, need no locks. There is much evil in families from children being brought up in non-confidential habits with their parents and with each other. The family parlour and table should be a scene where all can unfold their ordinary thoughts, without fear of censure or ridicule. It is the best means of insuring that the young people will act with the concurrence of their parents, when they come to take any of the more serious steps of life.

The acquisitive feeling requires much more educational care than it has usually received. We need not detain the reader with an exposition of the legitimate use of this faculty, which prompts man to accumulate and store up the goods of life, for regular instead of precarious use. To this impulse capital owes its existence, without which there could be no civilization. The Author of our being has stamped importance on this faculty, by the strength of the propensity. None more requires modification, regulation, and right direction. It is often too strong for conscientiousness, and is the source of by far the largest amount of crime. But, besides this, it is even with the honest too much manifested in abuse. Its objects are made the paramount pursuit of life, and in its intense selfishness it withers to dust every generous and kindly feeling of the heart. In a commercial country, like our own, it deeply degrades a large proportion of the community, and leads to much individual and social suffering.

These evils are the consequences of the natural strength of this feeling, the absence of regulating education, and the presence of positive mis-education. Selfish and exclusive appropriation of desirable things, either to eat or hoard, is a lesson taught the youngest, both by precept and example; and there is none more easily learned. Here bribery operates, till infant morality becomes mere matter of barter, and good conduct and attentive study are estimated by the infant merchant by what they will thing. Perhaps we err in so soon introducing children to the use of money; it is at least desirable that they should not be accustomed too soon, or at any time, to an engrossing sense of its value and importance. It is well to accustom them to take care of any thing that is their own, but not to set too great store by their little possessions, or to be too exclusive in the use of them. A habit of scrupulous regard to the distinction between *mine* and *thine*, is one which cannot be too early formed, at the same time that they are accustomed to make a generous use of whatever is their own.

Self-esteem and love of praise or approbation are early awakened feelings, and the more call for regulation that they are so liable to be called into exercise by the procedure of education itself. Here it is particularly important to keep in mind what are the legitimate uses of these feelings. A well regulated self-esteem obviously gives that confidence in ourselves and our powers which is necessary for all our efforts in life; while a moderate regard to the opinions of others is useful in prompting to such efforts, and in restraining us from many displays of caprice and absurdity to which we should otherwise be liable. It will of course be well to encourage these feelings, as far as they tend to give necessary confidence, and to maintain a decent regard for character in the world, but no further. Their vices, pride and vanity, too much reliance upon self, and too abject a regard to the world's opinion, are to be sedulously guarded against. In the procedure of education, they are so readily available as means of stimulating to exertion and encouraging good (that is, not troublesome) behaviour, that it is not surprising that they are so extensively made use of for those purposes. The whole system of place-taking, prizes, medals, &c., is founded on them. It cannot be doubted that educators are thus guilty, in many instances, of fostering invidious and even destructive feelings in those under their charge; the whole system is unquestionably a selfish one. Feeling strongly these objections, some modern educationists advocate the entire abolition of all marks of *emulatively comparative* proficiency or good behaviour at school, retaining only an accurate register of individual advancement, to enable the pupil to mark his own progress. Theoretically this is right; and we may hope that, when education is fully organized on a right footing and supported by an improved adult society, the whole system of competition, including every kind of rewards and punishments, will be dispensed with. Meanwhile we must leave educators to act on these points according to their best discretion, only strongly recommending them to dispense as far as possible with all these inferior, and, to a certain extent, degrading and corrupting influences.

Cautiousness—a feeling intended, in its right direction, to prompt to foresight and the avoidance of unnecessary dangers, but, in its excess, pusillanimity and cowardice—calls for a careful treatment. Among unthinking persons, it is mere sport to frighten children with narratives, objects, and exclamations, calculated to inspire terror. Thus their imaginations are filled with bugbears, which harass them constantly, and make it the severest punishment to be left at any time alone, or to be in the dark. In cases where a predisposition exists, the most serious consequences sometimes flow from this irrational treatment. An enlightened educator never allows an ideal terror of any kind to enter the mind of his child or pupil. As the feeling may be strong or weak in the particular case, he seeks to moderate or to foster it, giving encouragement and stimulus if it be defective, and prompting to caution if it be otherwise. He carefully impresses the lesson that danger and hazard may be laudably encountered for a good object, but that it is folly to undertake the least risk when no end is to be gained by it. For example, he would approve of his pupil perilling his own life to save a friend from drowning, but not of his going across a lake thinly frozen, merely to show his courage.

The selfish feelings appear in a natural subordination to those which are usually called "higher," and sometimes, by excellence, "the moral sentiments." These are what mainly give the characteristic, "goodness," to an individual, and so rule the social machine, that general movements are usually of a virtuous character, and vice is obliged to remain in nooks and corners, or put on the garb of virtue when she appears. It is to the proper training and regulation of this class of feelings that the educator chiefly looks for the result he aims at—namely, the right formation of character.

Conscientiousness, the conscience, the moral sense, or by whatever other name it is called, is that innate feeling which gives the disposition to follow right and avoid wrong in all circumstances. To bring this feeling into its full force, it is necessary to train it with the aid of intellect to lend it discrimination. The pupil must be accustomed to observe its rules, as to the property of others, their reputation, their comfort, and happiness, the right decision of every question in which their interests are concerned, and also with regard to the truth in all things. He thus becomes fixed in equitable, disinterested, and ingenuous habits, beyond all the powers of ordinary temptation. It will be no exercise to this sentiment, to tell the young to avoid certain acts, because they are mean and only practised by the vile, or because they will procure universal odium. That is an appeal to love of approbation, not to conscientiousness, to the development of which it will be rather unfavourable than otherwise. To fortify conscientiousness against what is wrong, we must directly address itself, by an endeavour to show the actual unjustness or baseness of any particular course of conduct, or the integrity and purity of the opposite; taking care to induce an act positively conscientious on all possible occasions, as in the acting upon a sentiment do the means of improving it chiefly lie.

So, also, with benevolence. We must not content ourselves with presenting ideal pictures of the distresses of our fellow-creatures to the minds of the young, thinking that to excite their commiseration is enough. We must endeavour to induce them to perform *acts* of kindness and charity—we must endeavour to make them give, from their own means, or at some expense of self-denial, succour to the unfortunate; and for this reason it will be proper that they are occasionally brought to witness cases of actual suffering, and made to administer relief with their own hands. It was a beautiful old custom of Christian princes and princesses, to have a number of poor persons occasionally brought before them, that they might administer to their relief and comfort by washing their feet with their own hands. It was its least good effect to humble rank to the level of mortality: the better one was to give activity to the sentiment of benevolence, too apt in such persons to become dormant, from their very elevation above all spheres in which human suffering exists. Benevolence is also to be shown in what is called an obliging disposition, a readiness to sacrifice ourselves and take some trouble whenever our doing so can at all promote the happiness of our fellow-creatures. It is likewise shown in mercy towards the weak, including animals, and in a forgiving placable temper. "Teach your children never to wound a person's feelings because he is poor, because he is deformed, because he is unfortunate, because he holds an humble station in life, because he is poorly clad, because he is weak in body and mind, because he is awkward, or because the God of nature has bestowed upon him a darker skin than theirs."*

Justice and kindness to others have a worthy associate

* Goodrich's Fireside Education.

in respect or veneration for others who are of superior worth, and for superior objects in general, including the objects of religious faith. This is also a native sentiment of the mind, and one which sends a beautiful light throughout the world. The scoffing and undervaluing propensity is its opposite, a disposition rarely found associated with estimable qualities. The sentiment of veneration is that on which all social grades depend; it is the spirit of subordination itself. It is a folly when exercised with regard to mere artificial rank unattended by worthy qualities; but with regard to persons elevated either by their native good qualities, or the function which has been intrusted to them to execute, it is as much due as is our pity and succour for the unfortunate. It is *perhaps* this feeling which chiefly gives a regard for the feelings of others; for we must think our fellow-creatures of some consequence, before we will be disposed to go out of our way on their account. The feeling, therefore, eminently deserves the care of the educator; but great pains must be taken to give it a right direction. We must teach the young to discriminate judiciously as to objects really entitled to their reverence. It may here be remarked, that the feeling of veneration is one which may prove of great importance in certain contingencies to which the educator is liable. When a child has been indulged or mis-trained to such an extent that he defies all the reins to which he has been accustomed, it will generally be found that removing him to a new scene, and into the charge of individuals who, whether from their character or from the force of novelty, excite the veneration of the young delinquent, is attended with a good effect, which it only requires firmness, discretion, and kindness in the new teacher to follow up, for a complete reformation.

The above may be said to be the natural means of cultivating and forming the moral character of those intrusted to our hands. And these natural means are of great consequence, and entitled to all the respect we can give them; for they are in reality means of divine appointment, designed to serve in the great work of mutual improvement. But the most powerful means of modifying human character is that other revelation which has come to us in a more direct manner, and which is fully disclosed in the pages of Scripture. As soon as this can be made intelligible to the young, it should be imparted, not under those rudely familiar circumstances which too often attend religious education in the school-room and at home, where the child is conscious of little besides a struggle to commit certain texts and dogmas to memory, but in the quiet of confidential converse, when the thoughts are called home, and the soul is open to awe, love, hope, and all the gentler emotions of our nature. Then may we hope to convey some just impressions of the grand yet tender relation in which man stands to his Creator, his destiny on earth, and the appointments for the future. Then only may we hope to impart just feelings with regard to the inscrutable scheme on which the weal or wo of an eternity depends. It is obvious that, if we succeed in these things, we must awaken in the moral nature a self-sustaining influence infinitely more powerful than precept, example, training, and all the other natural machinery of a moral education. Yet it should never be lost sight of, that neither means will singly be operative. Upon a mind which has been left rude and unregulated, the efforts which ultimately take the name of religious education can make little impression. The words which have been learned will probably remain only as words, without producing any real religious feeling, much less any improvement of conduct. Indeed, both the morals and the intellect must be cultivated to a considerable extent, before religion can be any thing but a passing sound. There must be a prepared intellect to understand it, and prepared moral feelings to give it a reverential reception, and entertain its behests in the spirit due to them, not to speak of acting upon its precepts.

To recapitulate—the moral nurture of the young is to be accomplished by a variety of means: first, by placing them in a pure moral atmosphere, presenting what is good and nothing evil of human conduct before their sight, familiarizing them with every sound precept, and giving their various feelings due regulation, exercise, and training; next, by imbuing them, under the circumstances most calculated to be effective, with those religious truths which so infinitely transcend all others in importance. In order to impress our lessons still more pointedly, we beg to add some express directions, which we think may be advantageously followed in the management of the young, more particularly those at the infant stage.

Anticipate and prevent fretfulness and ill-temper, by keeping the child in good health, ease, and comfort. Never quiet with giving to eat, or by bribing in any way, still less by opiates. For the first few months avoid loud and harsh sounds in the hearing of children, or violent lights in their sight: address them in soft tones; do nothing to frighten them; and never jerk or roughly handle them. Avoid angry words and violence both to a child and in its presence, by which means a naturally violent child will be trained to gentleness. Moderate any propensity of a child, such as anger, violence, greediness for food, cunning, &c., which appears too active. Show him no example of these. Let the mother be, and let her select servants, such as she wishes the child to be. The youngest child is affected by the conduct of those in whose arms he lives. Cultivate and express benevolence and cheerfulness; in such an atmosphere a child must become benevolent and cheerful. Let a mother *feel as she ought*, and she will *look as she feels*. Much of a child's earliest moral training is by looks and gestures. When necessary, exhibit firmness and authority, always with perfect temper, composure, and self-possession. Never give the child that which it cries for; and avoid being too ready in answering children's demands, else they become impatient of refusal, and selfish. When the child is most violent, the mother should be most calm and silent. Out-screaming a screaming child is as useless as it is mischievous. Steady denial of the object screamed for is the best cure for screaming. In such contests, witnesses should withdraw, and leave mother and child alone. A child is very ready to look round and attract the aid of *foreign* sympathy in its little rebellions. Never promise to give when the child leaves off crying: let the crying be the reason for *not* giving. Constant warnings, reproofs, threats, and entreaties—as, *let that alone—be quiet—how naughty you are*, &c., all uttered in haste and irritation, are most pernicious. No fixed or definite moral improvement, but the reverse, results from this too common practice. Watch destructiveness, shown in fly and insect killing, and smashing and breaking, quarrelling, striking, &c. Never encourage revenge. Never allow a child to witness the killing of animals. Counterwork secretiveness by exposing its manœuvres. Regulate notions of property—one's own and another's. Never strike a child, and never teach it to strike again. Never tell a child to beat or threaten any animal or object. Corporal correction may be avoided by judicious substitutes. Set an example of cleanliness, order, punctuality, delicacy, politeness, and proper ease of manner. This is better than *teaching manners*, as it is called. Inculcate early, and manifest in yourself, a delicate regard for the rights of others and their feelings, in contrast with selfish vanity, arrogance, and exclusive attention to one's own ease, comfort, and gratification. Prevent all indelicacies and slovenly habits at table—touching the utensils, stretching for what is wanted, sitting awkwardly, &c. Study early to gain a child's confidence by judicious sympathy in its joys and sorrows. Have no concealment with it.

govern by love, and not by fear: the contrast between children governed by the one and the others is truly instructive. Never forget that kindness is power with man and beast. *The Arab never strikes his horse.* Cultivate truth, justice, and candour in the child, and manifest them in yourself. With a child whose firmness is apt to run into obstinacy, never contend; in doing so, you aggravate the feeling by manifesting the same feeling in yourself, and by further showing your combativeness, exciting the child's opposition. Divert the child from the object, and put in activity its benevolence, justice, and reason. Never frighten to obtain a child's obedience: threats of hobgoblins, and all false terrors, are most injurious in their direct effects, and, being generally discovered to be falsehoods, operate most immorally.

We beg to conclude the section with the following remarks from Dr. Combe's excellent manual for the management of infancy:—"It is a common and pernicious error in modern education, that the passions and moral emotions implanted in the human mind are the results of intellectual cultivation; that intellectual discipline will suffice to regulate them. Under this mistaken notion, parents are often disappointed and displeased with a child, when, after a full explanation of the impropriety of the feeling or passion, it still, on the recurrence of the temptation, gives way to it as much as before. I have known a father, under this false impression, lecture, and threaten, and punish his child, and take every way to correct it but the right one. Fortunately for mankind, however, morality and religion have a much more solid foundation than a mere deduction from an erring intellect. They are based on feelings implanted in the very nature of man, and which mere intellectual cultivation or neglect can neither generate nor destroy; and their real strength and authority will not be fully recognised, till they are cherished and developed in strict accordance with their natural constitution. Like the external senses, they must be habitually exercised upon their appropriate objects—in worshipping the true God, and in doing justice, and loving mercy—before they can attain their proper influence over the character, and their true authority in regulating human conduct. From almost the first hour of existence, this principle should be systematically acted upon, and the utmost care be taken to secure at all times a healthy moral atmosphere for the young. To do perfect justice to the infant, there is required, on the part of the mother, a combination of cheerful activity, good sense, knowledge, readiness of resource, and unfailing kindness and impartiality, which is not often to be met with. But by aiming at a high standard, we shall make a nearer approximation to what is required, than if we rest satisfied in indifference with whatever occurs. It is lamentable to reflect how numerous are those mothers, who, from indolence or other causes, leave the entire control of their offspring to an unqualified attendant, and even themselves give way to expressions of anger or caprice, which cannot fail to act injuriously upon the infant mind. Let us, then, not deceive ourselves, but ever bear in mind, that what we desire our children to become, we must endeavour to be before them. If we wish them to grow up kind, gentle, affectionate, upright, and true, we must habitually exhibit the same qualities as regulating principles in our conduct, because these qualities act as so many stimuli to the respective faculties in the child. If we cannot restrain our own passions, but at one time overwhelm the young with kindness and at another surprise and confound them by our caprice or deceit, we may with as much reason expect to gather grapes from thistles, or figs from thorns, as to develop moral purity and simplicity of character in them. It is vain to argue that, because the infant intellect is feeble, it cannot detect the inconsistency which we practise. The feelings and reasoning faculties being perfectly distinct from each other, may, and sometimes do, act independently; and the feelings at once condemn, although the judgment may be unable to assign a reason for doing so. Here is another of the many admirable proofs which we meet with in the animal economy of the harmony and beauty which pervade all the works of God, and which render it impossible to pursue a right course, without also doing collateral good, or to pursue a wrong course without producing collateral evil. If the mother, for example, controls her own temper for the sake of her child, and endeavours systematically to seek the guidance of her higher and pure feelings in her general conduct, the good which results is not limited to the consequent improvement of the child. She herself becomes healthier and happier, and every day adds to the pleasure of success. If the mother, on the other hand, gives way to fits of passion, selfishness, caprice, and injustice, the evil is by no means limited to the suffering which she brings upon herself. Her child also suffers, both in disposition and in happiness; and while the mother secures, in the one case, the love and regard of all who come into communication with her, she rouses, in the other, only their fear or dislike."

INTELLECTUAL EDUCATION.

By intellectual education we hold it to be implied that the human intellect, originally a mere instrument ready to be exerted, requires, for the full development of its powers, and subsequently, for the ready use of those powers, the application of certain external stimuli, and the force and regulation of a certain discipline; also, that the intellect, besides being thus improved in its own character and energies, requires to be possessed of certain knowledge and certain accomplishments, in order to a proper performance of the various duties of life. We shall not stop to make a nice investigation as to the various powers of the intellect and their modes of acting, but at once assume that, with senses serving as media for the access of impressions from the external world, it includes powers which can take cognisance of things, or perceive, and powers which can compare things, and trace their connection in cause and effect (reflecting); these having various modes of action recognised, as memory, association, &c.; and that these various media, powers, and modes of operation, may all be improved by use and exercise.

Intellectual education properly begins with the first symptoms of consciousness in the infant—the first indications that the senses and internal observing powers, the germs of which exist in the youngest infant, are beginning to act.

The senses require the earliest attention of the nurse. Sight, hearing, and touch, are, in a very short time after birth, in obvious activity; but they require at first to be very delicately treated. Exposure to bright lights and sudden loud sounds, has produced blindness and deafness for life. Both senses should be brought on gradually. These, as well as touch, should then be judiciously exercised upon their own objects, placed at different and increasing audible and visible distances, till at great distances objects can be seen and slight sounds heard. Objects should also be touched blindfold, and discriminated. Smell and taste are improvable by similar means. It would form an extremely interesting occupation to an intelligent nurse, for many a moment of ennui which she now endures, in her care of an infant, to exercise its senses on their appropriate objects. When nothing is done, or when the child is shut up in a small room with no range of vision, not only is no progress made, but there is great danger of short-sightedness being either induced or aggravated.

Leaving the external senses, and advancing to the internal faculties of the mind—the powers of feeling, observing, and thinking—we may remark that the brain, which is as much the instrument of these powers as the eyes and ears are of their respective external senses, is at birth, and for some time after it, too imperfect and delicate in its substance for active manifestation. The desire of food, and sensibility to bodily pain, alone appear, and are, indeed, all that are then necessary. But the more delicate the brain, the more delicately ought it to be treated; for an injury to it may produce idiocy or imbecility for life. In the exercise and cultivation of the intellectual organs, it has been found, from experience, that great caution is required. It is here that the brain is most apt to be overworked; and it is here that that premature activity, called *precocity*, appears. Under the head Precocity, Mrs. Barwell gives the following emphatic counsel:—"When a child appears to be over-*intelligent*, or too *clever* or *wise* for its age, this is a symptom of unnatural development of the brain; it is a kind of disease, which often ends fatally. Avoid, therefore, exercising the child's *ability*; treat it as an animal, with nutritive food, muscular out-door exercise, and plenty of sleep; and do this, and *this only*, for some years." We allude to the subject of precocity thus early, in treating of intellectual training, because its indications often appear in very early infancy, and erroneous treatment cannot be too soon avoided.

Before two years of age, much important intellectual education is going on. It is not the education of books; it is gradual introduction to surrounding objects. How early the eyes are used to gaze at, and the hands stretched out to grasp and become familiar with, every thing presented or observed, need not be here insisted on. A judicious nurse will direct this impulse of nature and much assist this self-education, so that the earliest impressions may be made by such objects as form the materials of existence, and their qualities, never to be effaced in after life; while the observing faculties will have a healthier growth, by means of an easy and pleasingly directed exercise. Modern educationists have often complained of a prevalent want, in people of all ages, of what may be called *observativeness*—the power or rather habit of noticing what is before and around us. Multitudes pass through life, of whom it may be said that they have missed four objects in five which came in their way. This could be met in early infancy by taking the proper means of establishing habits of observation. "Look here;" "see this;" "feel that;" "weigh the other thing;" "what beautiful colours;" "smell that flower," should be the simple and constant lessons of the nurse; and she would find both the intellect and dispositions of the child improved by such exercise. The contrast, in after life, between children so trained, and those who never observe any thing, would be both striking and instructive.(1)

From Two to Six Years of Age.—Intellectually prepared by the nurse up to the point at which we have arrived—when the child has reached the age of two years, and when, if it can by any means be so arranged, he or she should join an infant-school—the intellectual education will, so to speak, take a more scholastic form. The lessons will be somewhat more systematic, and suited for the simultaneous attention of numbers. But still the caution will never be lost sight of, that, from two to six, the intellectual exercises should be light and attractive, and never long continued at one time; air, exercise, and play, regularly alternating with instruction. The paramount object at that period of life, let it never be forgotten, is *moral* training; to which object companions of the same age, in considerable number, are as essential as light is to the exercise of the eyes, or air to that of the lungs. Benevolence, truth, justice, honesty, attachment, all imply companions. Although, at that age, the intellectual training is secondary, when compared with the moral, yet without tasking the infant faculties, without giving to the pursuits any character less attractive than regulated play, a great degree of intellectual acquisition and improvement may be realized.

The introduction which the child has received in the nursery to the material world, will form a stage in his progress for the more systematic teaching from two to six years of age. *Objects* will still be the *material* of his studies; but they will be so arranged and classed as to conduct him through a complete knowledge of the external features, qualities, and uses—short of their chemical composition—of nearly all the objects with which ordinary life is conversant;—simple objects, parts of objects, objects natural and artificial, mineral, vegetable, animal, with their parts, conditions, differences, agreements, manufacture, and abstract qualities, and classification of objects by resemblances and differences. In these exercises several hundred useful ideas may be imparted; all of them made real by the connection of each with some material type.

Simultaneously and incidentally, the words expressing the objects and their qualities, &c., will be given, and, in connection with the object, will never be forgotten. Incidentally, too, the word will be exhibited printed, and so *read* as well as pronounced, and likewise spelled. The letters of the alphabet will be separately taught as objects. This learning of things and words together will be found beneficial as to both. When the senses are explained, which we assume has been done, the exercise will be easy and improving which connects the objects with each sense, or with several at a time; in other words, whether the pupil has seen, heard, touched, smelled, tasted, or weighed, the object or its quality. Thus, without a task, almost insensibly, and as it were at play, the child, in four years, will have attained a sum of knowledge of great extent and value, which will form the basis of an enlarged mind in after life, and prepare for the future acquisitions of science and philosophy. The rule should be rigidly observed, that no object in nature or art should ever be spoken of to a child without an endeavour being made to present it to him either in reality, model, or drawing, and this practice should be continued till the object has become familiar to him.

Between two and six, besides the acquisition of knowledge of objects, much elementary knowledge may be gradually, easily, and almost insensibly, imparted;—the simpler geography—arithmetic by means of Wilderspin's ball-frame, or *arithmeticon*—the pence-table—weights and measures—letters, syllables, words, lessons on pictures of animals, &c.—lessons on maxims moral and prudential—anecdotes and stories with a moral and improving tendency, told elliptically, that is, by words being left out for the children to supply, &c. At this age the vocal powers and musical ear should be exercised, which is both amusing and instructive to the children; many of the lessons may be sung. Much knowledge of common and useful things, connected with life and manners, may be communicated at this age, with an impression that will never be effaced. Lessons, too, connected with exercise in the practice, may be given on the benefits of cleanliness, ventilation, temperance, with all the evil effects of their contraries; while prejudices, fallacies, tyrannies, cruelties, unfairnesses, selfishnesses, bad habits, &c., all of which operate so mischievously on society, may be met by anticipation in lessons and counter-practice, so as to be avoided in after life. It is plain that the moral and intellectual training must proceed hand in hand.(2)

From Six to Fourteen Years of Age.—In a rightly arranged and complete course of elementary intellectual education, it is presumed that the period from two to six years of age has been spent in an infant-school. The effect which such a preparation has in facilitating the subsequent operations of the teacher is so great, that every effort should be made to give children the advantage of it.

From six to fourteen is the period of the elementary schools. This is the time during which children, besides having their moral education carried on efficiently, are to be introduced to those branches of instruction which are necessary for the business of life—a process which includes within itself the exercise and development of the intellectual faculties, and the formation of habits of intellectual application and taste.

The two great questions are, what is to be taught; and how are we to teach it? Mother tongue—the power of reading it, acquaintance with its grammatical structure, and with the exact meanings of its words, and the power of composing it with fluency and elegance—is certainly entitled to the first attention. There are three modes of teaching it. First, the old practice of instructing children in it by rote, without regarding whether they ever thoroughly comprehend a single syllable of it, or are ultimately able to make the least use of it. Second, what is called the Explanatory Method, practised in the Edinburgh Sessional School and many other seminaries, whereby it is at least secured that the pupils have some synonym for every term that comes under their notice, so as to give some reason to believe that they understand it. Third, the Exhibitory Method, which adds to other expedients that of showing, in all possible cases, the objects referred to in lessons, or at least presenting drawings of them on a black board or otherwise. Considering how little the young are prepared for the abstract, and how eagerly, under a natural impulse, they grasp at the tangible, we need scarcely say that the last method appears to us as one of which advantage should be taken as far as possible.

The first step may be a regular series of lessons on the consonants, single and compound, as they occur both at the beginnings and ends of words. In the selection of monosyllabic words for this purpose, care should be taken, for obvious reasons, to avoid such as refer to coarse and mean ideas. The powers of single vowels being thus also taught, it will be proper next to advance to words in which double vowels or digraphs are exemplified; and so on, as in the work here referred to.(3) The lessons for practice should consist of sentences of such a nature as to admit of amusing explanation and illustration by sketches on the black board, and by sensible objects.

1. *Names of things* will perhaps be best explained by showing the object itself, or its picture, and by asking the children to tell what they know *about* the object. Their own simple definitions are very often the best.

2. *Names of qualities*, by requesting children to name objects that *have* the quality. For example, to explain *deep*—"Tell me any thing that is *deep*." The following have been named—"The sea, a well, a coal-pit, a canal."

3. *Names of actions*, by performing the action named, or describing it by some interesting anecdote, so as to show practically the meaning of the word.

These suggestions may by some be considered trifling and childish, but a proper trial is requested, and the result will show whether children make more real improvement by the above simple and obvious expedients, or by etymological erudities and dictionary definitions.(4)

Grammar will incidentally accompany the reading, in the form of parsing. By what is called the *incidental method* much advantage is gained; knowledge of an object and its qualities is obtained: its name is pronounced, written down, and read; while its description is read and parsed; all which exercises, instead of impeding, actually aid and facilitate each other. A judicious extension of the incidental method may be made one of the most important means of advancing popular education. Learning to spell orally columns of a book, is a waste of time and an irksome labour. We spell only when we write; and the power is really not attained by the old school exercise of spelling, but by reading; the words become familiar to the eye as *specific forms*. No one who reads much can remain a bad orthographer; and no one writes much who has not previously read much more.

Simple Lessons in Reading.—The child may now make a step forward in the art of reading and spelling, and be prepared for more methodical intellectual culture. At the same time, in order to *amuse*, and induce reading for *the pleasure it communicates*, the subjects of the lessons should be of that species of narrative which delights the infant mind, bearing, in each case, a reference to the perceptions of the pupil, or tending to encourage in him a love of the beautiful in nature. Instead of the old unprofitable reading and spelling in schools, the improved plan of instruction in English consists of—First, Correct reading, dividing and spelling of words; meaning by spelling, not the laborious and useless committal to memory of whole columns of spelled words, but, 1, naming letters singly by their powers, grouping them into syllables, and these again into words, so as to *read* a language; 2, putting down letters on paper, in proper number, order, &c., so as to produce a combination expressive of sound, and thus *write* a language. Spelling is acquired by constant practice in reading, writing from dictation, copying pieces from good authors, composing and correcting original essays, and performing systematic grammatical exercises. Second, Understanding what is read—proved by searching examination, and illustratively aided by real objects. What is called the elliptical method is here much used, the child supplying the omitted words, and receiving, according to the skill and information of the teacher, much collateral information. Very simple ideas only ought to be called up, and such matters alluded to as may be supposed to interest and encourage the dawning faculties. We cannot too earnestly recommend the practice of illustration by pictures and sensible objects. The *black board* and chalk should be in constant use, and every teacher should qualify himself to draw ready off-hand sketches. The rudest outline done on the spot excites more interest than the finest engraving. The lessons themselves, in detail, are given in the work here referred to.(5) The curiosity of young persons is necessarily first excited by the things which lie most immediately around them, and the circumstances and procedure of familiar life. These are the subjects of their earliest inquiries, and it is extremely desirable that clear, distinct, and correct explanations of them should be invariably given. Most parents of intelligent and well-regulated minds take care that such should be the nature of the answers given to the first inquiries of children; but it is needless to point out, that many persons who have children under their care, either possess not the ability, or have not the necessary leisure, or will not be at the pains, to give correct and satisfactory answers. Lessons should be given which aim strictly at an explanation of *external appearances* in the natural and social world. *Principles* are for subsequent study. The subjects may be such as the following:—Of God and the works of creation; of animated creatures; of mankind; of the country; processes of husbandry; inanimate objects of all common kinds.(6)

In elementary education, after some progress has been made in the power of reading, the different conditions of a child at about seven, and at from ten to fourteen years of age, suggest the necessity of two series or courses of instruction—one of a simple, primer-like character, the other more advanced, but both going over nearly the same ground. This is the more necessary, as so many children are taken from school about ten years of age. In the construction of a series of schoolbooks, already more than once quoted, we have proceeded so far upon this arrangement, most of the volumes of the advanced course being foreshadowed in that which may be called the *preliminary*. We observe the same arrangement on the present occasion.

Preliminary.

Introduction to Geography.—The pupil having, in the infant school, had some instruction in the simplest elements of geography, may, in his seventh or eighth year, pursue the study more regularly. Lessons may now be given which will suit those whose education allows but a small portion of time for geography—lessons calculated to impress a fair measure of that most useful knowledge even on the future manual labourer. These need not give copious lists of localities, capes, bays, districts, and towns, it being presumed that the learner has maps before him on which he will be exercised. He cannot, moreover, be introduced too early to the GLOBE, for the spherical as well as relative position of its great divisions, with their latitude and longitude. Proportion should also be impressed upon him; this is apt to be confused by maps of different sizes. The relative situation of countries need not be much adverted to, that being best learned on the maps. The chief attention should be devoted to the *characters, physical and political, of the countries*. The plan should be followed of treating, generally, in the first place, of the plants, animals, and races of men, in the different regions; and, in the second, of the most important particulars peculiar to each country, which cannot be brought under general heads. With the maps and globe always before the pupil, much useful information may by this method be conveyed.(9)

Writing.—This is entirely an art, to be acquired by practice, with the assistance, first of a skilled teacher, to train to the mode of sitting, of holding the pen, &c.; and, second, of suitable exemplars of the various kinds of writing. A free and bold practice with chalk upon a black board would probably form a good introduction to the art of writing. It was by such means, under the guidance of his father, that the celebrated Porson acquired that accomplishment of singularly elegant writing, for which he was scarcely less remarkable than for his extraordinary attainments in classical literature.

Introduction to Arithmetic.—The simplest elements of arithmetic are presumed also to have been taught in the infant school, by means of the instrument called *Arithmeticon*. In this early school period, it may be pursued by means of regular exercises wrought upon slates, according to the rules presented in an appropriate book. An active teacher may also do much for this part of school education by conducting mental exercises, or exercises in which no sensible figures are used. It is found an excellent discipline for giving habits of attention and concentration.

Introduction to English Composition.—The pupil may be, at this early period, introduced to English composition. We recommend the modern plan of teaching the rules last. Let the pupil successively compose and write down nouns; then their qualities, or adjectives; then the action or change, or verbs. He has been a *composer* from the moment he began as a child to prattle. Let him go on, and he will insensibly infer the essential laws of language, by his own experience and his teacher's hints, more rationally and more thoroughly than from a system of grammatical rules, necessarily dry, irksome, and repulsive. In giving these lessons on composition, the following suggestions will be attended to:—1. It is suggested that, previously to a pupil's entering on composition, he should spend a few weeks in copying, with great accuracy, short pieces in prose from some good author. This will give the habit of neatness and exactness in the use of points, capitals, &c., and, if carefully managed, will form an excellent preliminary exercise. 2. Each pupil should be provided with a quantity of common paper for the scroll copy, an exercise-book for transcribing, and this text-book. 3. Let the teacher place fifteen or twenty familiar objects on a table or desk before the class, and request the pupils to comply with the direction in the first lesson, by writing on the spot the names of the articles; and so on with the other lessons, in order. 4. When the lists are finished, they should be exchanged, and each pupil should correct the spelling, &c., of his neighbour's work. 5. This done, the papers may be returned to their owners, for the purpose of their reviewing the criticisms; and all should be encouraged to protest against false corrections. 6. The teacher should then pass round the class, deciding disputed points, explaining the ground of each decision, questioning the pupils, and allowing them freely to question him. 7. The scroll-copy, thus corrected, should be taken home by its owner, neatly transcribed into the exercise-book, which, duly dated, should be handed to the teacher next day. 8. The teacher may then mark the errors in the transcript, asking the pupils to show the cause of each correction. 9. The exercise-book should then be returned to the owner, with a *number* (in the teacher's handwriting) indicating the rank of the exercise. 10. At the end of each lesson, the pupils should be questioned on the parts of speech employed, meaning of words, knowledge gained, &c. 11. The pupils should use *black* ink in writing the exercise, and *red* in correcting. The teacher's criticisms, remarks, and numbers, should be in *blue* ink. These distinctions, though apparently trifling, will be found important. 12. Three or four lessons may be given weekly, according to circumstances. Less than half an hour will suffice for writing each exercise, and little more than that time will be required for correction. The lessons will proceed from objects to qualities and actions, each embracing a very wide field of exercise. The derivation of words from other languages, or ETYMOLOGY, both simple and compound, may, at the same time, be an incidental exercise. (10)

Introduction to the Sciences. The pupil has hitherto been conversant with the *external* features of objects, and the ordinary uses to which they are put. At the age of nine or ten he may be gradually introduced to philosophical *principles*—to a connected and systematic view of nature, the most obvious parts of which it is composed, and the laws by which it is governed. The subjects will be—the extent of the material world; the stars, the solar system, the earth as a planet, the moon, eclipses, masses of matter—their attractions and motions; the earth—its general superficial features, its structure; the soil, the atmosphere, heat, light, electricity, and magnetism; evaporation, clouds, rain, frost, ice, snow, the winds; elements of matter—their combinations; the vegetable creation; animal creation; man—his general character and history, his bodily nature, his mental nature.(7)

Rudiments of Music.—About this stage of education, the pupil may be introduced to the principles and rules of vocal music. This is invariably a branch of education in several continental countries, and is attracting marked attention in Britain. In the infant school we have already recommended simple singing by the ear; the pupil may now not only study musical rules, but learn to sing from notes.*

* We are far from being satisfied with the means yet practised for teaching vocal music in schools. Very encouraging progress is making in London by Mr. Hullah, under the eye of Dr. Kay, the able and excellent Secretary of the Committee of Privy-Council, sanctioned by the Committee. The method employed by Mr. Hullah is the synthetic method of M. Wilhem's work, published in Paris under the sanction of the Minister of Public Instruction. The method is successfully practised in the school for teachers at Battersea, established and almost exclusively supported by Dr. Kay; and a singing school for teachers, on that method, approved by the committee, has been established in Exeter Hall. The committee have published the first part of a Manual; and one of their minutes devotes eleven octavo pages to a minute description of the organization of singing schools on the Wilhem method. We much approve of the system, and trust it may lead to the universal introduction of good vocal music into education

Advanced

Geography. A year or two after the pupil has mastered the Geographical Primer, he may proceed to study geography in a more enlarged and generally informing manner. Taking England as the first of a series of countries, he will study its situation, extent, division, and general detail of localities; after which will come its physical geography, including superficial features, climate, soil, and vegetable productions, minerals, animals, natural curiosities; next, its historical geography, including remarkable events, antiquities; its political geography, including its civil state, revenue, army and navy, and ecclesiastical state; its social geography, including its national character, language, literature, arts and sciences, manufactures and commerce. In thus studying the geography of particular countries, a constant reference to maps is necessary. By having these sufficiently large, and the natural features strongly marked, as in the series here referred to (26), a whole class can learn at once.

Arithmetic and Grammar.—These branches are now pursued on more comprehensive plans, and with a deeper investigation of principles. In connection with the former stands book-keeping; with the latter, etymology and composition—all of which will now be thoroughly mastered, as technicalities of the greatest importance for the business of life.

Drawing.—This is an art, of the same character as writing, less imperatively necessary, but yet entitled to more attention than is generally paid to it. Its elements may be acquired by all, and are calculated to be useful in many circumstances throughout life. These may be taught by the use of chalk upon a black board. The objects should be the simplest delineations of common things, beginning with practice in straight and curved lines, and proceeding to a paling, a wall, a gate, a guide-post, a house, a rustic bridge, utensils, tools, and implements, flowers, patterns, and animals. On the black board, the chalk, compasses, and rule, may be employed; on the slate, only the hand and eye should be used at this stage of the young pupil's progress. Deeper lines will show foregrounds—lighter, backgrounds; and thus the first notions may be given of aërial perspective. By rendering universal some instruction in drawing of common objects, real talent, where it exists, will never be concealed; while much pleasure will be derived from efforts far short of those of the higher order of genius.(11)

The pupil will in due time advance to the elements of drawing and perspective, and the art of sketching from nature.(12) Terms in the art of perspective should be explained to him, and figures delineated, which are nothing more than the simple geometrical diagrams. The sector, visual rays, points of sight, all the rules of perspective, should be plainly and intelligibly laid down. Black-lead pencil drawing, characters of foliage, light and shade, and tinting; styles and modes of treatment in sketching from nature, both landscapes and figures, with the rules for arrangement and effect, should all be made plain to and practised by the pupil, the teacher guiding his efforts. We may remark here, and the observation is of general application, that the teacher must keep in mind that the intellectual powers are bestowed on different individuals in different degrees; and such differences must be allowed for. It will soon be seen whether the pupil possesses powerfully the drawing or pictorial faculties. If he does not, he should never be pushed beyond the simplest elements of the art. The same is true of other branches of study.

Natural or Mechanical Philosophy.—The pupil, now advancing to his eleventh and twelfth year, may proceed to the elements of mechanical philosophy, by custom, though too extensively, called *natural philosophy* or *physics*: seeing that, under that denomination, chemistry and even natural history have as good a claim to be ranked. It is a question whether this branch of physical science, or chemistry, should be studied first. We think they may, in their elements, proceed together; but if singly, it seems rather more natural to attend to the more visible and tangible properties and powers of matter, unchanged in its substance, than to those that require a change in the constitution of matter, often its destructive analysis, to ascertain its composition. All should be familiar with the laws of matter and motion—with matter's impenetrability, extension, figure, divisibility, inertia, attraction, cohesion, capillary attraction, chemical attraction, magnetic attraction, gravitation, repulsion, heat, evaporation, contraction, ignition, density, specific gravity, compressibility, elasticity, dilatability; with motion and forces, weight in falling bodies, centre of gravity, pendulum, centrifugal force, projectiles, action and reaction, motion in elastic bodies, reflected motion, composition of motion and of forces.(15)

Mechanics and Machinery.—The pupil, after having attained a competent knowledge of the above particulars, may proceed to study the mechanical powers, and their philosophy—the lever pulley, and inclined plane, which are the primary mechanical powers; while from the lever and inclined plane come the other three, or secondary mechanical powers—the wheel and axle from the lever, and the wedge and the screw from the inclined plane. The combinations of mechanical powers, friction, human labour, horse-power, draught, water-power, and steam power, and all the science of machinery, will naturally follow.(16)

Hydrostatics, Hydraulics, and Pneumatics, will next in order engage the pupil's attention; and he should not be suffered to proceed without having mastered, by the test of strict and searching examination, the previous subjects, which form a series.

When he has become familiar with the mechanics of solids, he will proceed to the study of the laws of fluids, including the aëriform fluids. The hydrostatical part embraces pressure of water, levels, specific gravity, fluid support, &c. Under hydraulics—the hydraulic press, aqueducts, fountains, friction betwen fluids and solids, action of water in rivers, waves, change of temperature, &c.

Under pneumatics are comprised—the atmosphere, laws of air, pressure of air, the air-pump, pressure of air on solids and liquids, on mercury; the barometer, pumps, siphons, steam, latent heat, winds, sea and land breezes, ventilation, diving-bell, buoyant property of aëriform fluids, balloons.(17)

Optics, Acoustics, and Astronomy, will complete a course of natural philosophy.

Chemistry.—It will now be time to lay a foundation for the pupil's future progress in chemical science, and at the same time impart to him a practical knowledge of the chemical laws and operations which are at work around him in daily life.(14) Such are respiration, combustion, heat, light, water, poisonous gases; these are all matters upon which comfort, health, and life itself, may depend. The teacher should begin with showing experiments, and should be possessed of a museum of substances and chemical agents, with an apparatus.

Animal Physiology.—The important purpose served by including this subject in juvenile education, is the preservation of health, not its restoration when lost; the *prevention* of disease, not its *cure*, with which last the ignorant cannot be trusted. It ought to be impressed as a maxim, that although we ought not to be our own doctors, we need not be our own destroyers. We ourselves can bear testimony to the successful and gratifying introduction of this study in a Scottish parish school in Falkirk, under the care of Mr. Downie; and to the interest taken by the pupils of both sexes, from nine to twelve years of age, in the lessons, which are illustrated, as they ought always to be, by diagrams.(13)

Mental Philosophy.—This is a department of science which it is the fashion of our age to overlook. Yet what can be more important than a knowledge of that wonderful power by which we think and act, and which more especially connects us with the things above and beyond this humble and transitory scene? No serviceable manual as yet exists for imparting a knowledge of mind in schools; but an intelligent master has it in his power to do much by oral instruction.

Mathematics.—This important branch of study cannot be omitted in elementary education. In its widest sense, it is that science which treats of measurable quantity, in magnitude and in number. *Geometry* is the branch of mathematics which treats of that species of quantity called magnitude, both theoretically and practically. Theoretical geometry investigates the relations and properties of magnitudes in three dimensions—as lines, surfaces, and solids. Although magnitudes have no *material* existence, they may be represented by diagrams. That branch of geometry which relates to magnitudes described on a plane, is called Plane Geometry. This requires six elementary books—a book on the quadrature and rectification of the circle, a book on geometrical maxima and minima, an exposition of the method of geometrical analysis, and an additional second and fifth book. The basis of the first six books should be the *Elements of Euclid*, as given in the very correct edition by Simpson, with the improved fifth book by Playfair, and the other improvements of the latter geometrician contained in his original edition of Euclid's *Elements*. The pupil will proceed with the definitions, postulates, and axioms.(18) Solid and spherical geometry and conic sections (19) will next engage the pupil; and, finally, the elements of algebra.(20)

Elocution may be the next pursuit of the pupil. In this branch of study, the subjects of articulation, inflection, modulation, and the measure of speech, will be familiarly explained.(25)

History, &c.—History and biography are important branches of information, of which it is well to acquire the elements at school. The history of the mother country, its literature, and great men, has the most immediate claim upon attention, after which come the histories of the countries to which geographical and political circumstances, or any other cause, have given importance in our estimation.(21 22 23 24)

Natural History.—As a study for the last two years of the fourteen, ought to be reserved natural history, which is better understood, and more beneficially acquired, after than before the study of the elements of chemistry and mechanical philosophy. The pupil, in this branch, will learn to distinguish the animal, vegetable, and mineral kingdoms; the atmosphere and its phenomena; the winds, the ocean with its tides and currents; the discoveries of geology; the nature of animals and plants, &c.

Political Economy.—A pupil who has entered his fourteenth year, with his mind stored with the knowledge and strengthened by the exercise of the education we have described, should be introduced to the elementary principles of political economy. Society suffers in its vital interests from the prevalence of ignorance and prejudice in this great field of speculation and action.

Logic.—The elements of logic appear to us to form the appropriate conclusion to our practical elementary course from six to fourteen. All that precedes it is knowledge, and as such chiefly addressed to the *knowing* faculties of the mind. But man has also *reflecting* faculties; and it constitutes the chief end and object of our knowledge to furnish these with materials for their exercise, which is called reasoning. This, the highest operation of mind, is regulated by laws in the nature of things, which right reason both discovers and obeys. These laws systematized constitute the science, practically the art, of logic. The pupil, while he masters its principles, should be well exercised in their application.

Religion.—The first principles of religion are understood to have been imparted under the circumstances indicated in our section on moral education. In a school-course, due provision must be made to carry out this all-important department. Looking only to what the principles of education ask from us on this point, we would direct, first, the continuation of the method formerly described; next, daily scripture reading; next, a subjection of the individual pupils to the agency of the ordinary means of diffusing religious knowledge and maintaining religious impressions.*

Languages.—Though it is a great error to regard the acquirement of one or two ancient languages, and a school study of a few of the books written in them, as constituting a liberal education, unquestionably a liberal education ought to include that acquirement and that study. The commencement of a classical course, as it is called, may be made during the latter part of the elementary period; but it should mainly be postponed till after fourteen, when the comparative ripeness of the mind enables a pupil to acquire more of this kind of knowledge, and that more effectually, in one year, than in three or four at an earlier stage. The study of the classical languages is a special education, required by those whose occupations are to be of a philosophical or literary character. In an expressly literary education, they would always form a conspicuous element. And the refining effect which the admirable productions of the Grecian and Roman writers is calculated to have upon the minds of all must be at once admitted. The abuse of these languages in education has been solely in their being made the sum and substance of all education, and, though in a less degree, in their being taught at a period of life when it is impossible to experience their softening and improving influence.

MECHANISM FOR EDUCATION.

The mechanism for education may be said to be of two kinds—that which is furnished in the family circle, and that which is furnished by public establishments.

The mother is an educator of nature's appointment, and the first. To her falls the duty of securing the sound organization of the infant as far as it can be done by obedience to nature's rules before and after his birth. She has the duty of drawing his senses and intellectual faculties into that gentle exercise which gives them vivacity without being attended by danger, and that of establishing the basis of regular and correct moral habits. For all these purposes she is in a position of great influence; for her infant, accustomed to look chiefly and

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* CHAMBERS'S EDUCATIONAL COURSE.

1. Infant Treatment under Two years of Age.
2. Infant Education from Two to Six Years of Age.
3. First Book of Reading.
4. Second Book of Reading.
5. Simple Lessons in Reading.
6. Rudiments of Knowledge.
7. Introduction to the Sciences.
8. The Moral Class-Book.
9. A Geographical Primer.
10. Introduction to English Composition
11. First Book of Drawing.
12. Second Book of Drawing.
13. Animal Physiology.
14. Rudiments of Chemistry.
15. Natural Philosophy, First Book.
16. Natural Philosophy, Second Book.
17. Natural Philosophy, Third Book
18. Elements of Plane Geometry.
19. Solid and Spherical Geometry.
20. Elements of Algebra.
21. History and Present State of the British Empire.
22. Exemplary and Instructive Biography.
23. History of the English Language and Literature.
24. History of Greece.
25. Principles of Elocution.
26. School-room Maps of England, Ireland, Scotland, Europe, Asia, Palestine, North America, South America, Africa, and the Hemispheres.

most immediately to her for protection, kindness, and every comfort, is unavoidably disposed to pay to her that veneration on which genuine influence depends. She is, as has been well said, the DEITY of the child, and nothing but a sad misuse of her own feelings can prevent her from being all-powerful over him for the regulation of the whole economy of his being, at least during the first two or three years of his life.

So far as moral education depends, as we have shown, on moral atmosphere, and the influence of immediate example, the importance of home as a part of the mechanism of education must be acknowledged. Before the period of school attendance, home is all in all: thereafter, it still continues to bear a great share in the duty. The formation of moral habits, and the development of religious feelings, will depend much on what is done in these respects in the family circle. Parents may even serve as aids to the business of school, to a degree of which they have in general little conception. First, they may do much in the way of enforcing and providing for that important requisite, regular attendance. Second, they may strengthen the hands of the teacher by paying him proper respect. Compared with these objects, the mere superintendence of lessons given out to be learned at home, is, though itself important, a trifle. There is a tendency in parents to be over-easy in the admission of excuses for attending school; and they often take away their children for a considerable time, for reasons affecting their own conveniency and pleasure. It is also not uncommon for them to look down upon teachers, and speak of them, and even to them, in no very respectful terms. All these are errors of a fatal character, seeing that they weaken the school mechanism in some of its most important requisites.

A child becomes a fit subject for the education of public establishments at two years of age. From this age till six, he should, if possible, attend an infant-school.

The *infant-school*, although a modern invention, is a part of educational mechanism which is now generally approved of throughout Europe, being in vogue not only in Britain, France, Holland, and Germany, but even in Italy. It is, when rightly constituted, only a nursery upon a large scale—a place where infants may be reared in company instead of being kept in solitude—where they may be reared in pure and well regulated circumstances, instead of being exposed to the contaminations of a public street. It is peculiarly essential for the children of the poorer classes, who are otherwise so liable to become a mere infantine *canaille;* but it might be well for children of every grade to be brought up in infant-schools, as society is essential to the working out of many of the problems of education.

An infant-school should generally be calculated for about 100, or not more than 140 pupils, of both sexes. Two teachers, male and female (if possible, a man and his wife), are required, the one to superintend the boys, and the other the girls. The school should be well ventilated, and fitted up with a long gallery containing six or seven tiers of seats, and divided into two departments for the various sexes, the younger children being disposed on the lowest forms. The walls should be furnished with drawings of natural and other objects; and a black board and arithmetic-ball frame should likewise be provided. A piece of play-ground is so essential, that no establishment without one is entitled to be considered as an infant-school. It should have flower-borders, which the children are trained to respect, and places of convenience where cleanly and delicate habits are inculcated. A circular swing is required for the amusement and to promote the physical health of the children; and it will be well to have a quantity of wooden prisms, of the form of bricks, with which they may engage in the building of houses, towers, and other structures, according to fancy.

The intellectual education of an infant school is limited to the learning of little hymns and knowledge rhymes, the study of simple geometrical forms, and of the merest elements of arithmetic, exercises upon narrative passages of Scripture, the properties of objects, the characters of animals, the names of countries and cities, &c. In some, reading and grammar have been introduced to satisfy prejudiced parents; but these are departures from the right character of the institution. Most of the lessons are metrical, and sung to simple airs. The moral department, confessedly the chief, consists in the learning of good precepts, scriptural and otherwise, the fostering of kindly, and gentle, and the restraint of angry and malevolent feelings, the formation of conscientious, polite, and delicate habits. It is remarkable how far a good infant-school teacher can accomplish these objects, and how quickly any new pupil is brought into harmony with the spirit of the place.

An infant-school teacher requires a union of qualifications which is not often attainable. He should possess a gentle and affectionate character, with an unlimited patience, yet have that intellectual activity and vivacity which are necessary for sustaining attention in young children. He must both be a well-informed man and capable of making what he knows intelligible to those who know nothing: he must both be firm and discreet in management, and possessed of manners of almost infantine playfulness. A knowledge of music and a good voice are among the qualifications which he requires.

The elementary schools following upon the infant seminaries (where these exist, or, otherwise, being the first schools), are different in different countries, not only in the materials and modes of instruction, but in the extent to which they carry on pupils. In Britain, they are generally in a state considerably inferior to what is found in Holland and Prussia. In a rightly constituted system, there would be two seminaries between the infant-school and the university, the first or primary school being devoted to those branches of instruction in which all should participate, and the second or secondary school affording continued and more advanced instruction to those destined for professions and for the more important places in society, and as such being preparatory to the university. The parish-school and the grammar school of a small Scottish burgh may be considered as an arrangement approaching to what is required in this respect.

The primary school is applicable to the ages between six and ten or eleven. In a country under a national system of education, one would be required for every group of population above a thousand in number, as the attendance would then probably be from a hundred to a hundred and fifty. Reading, grammar, arithmetic, the elements of geography, history, and science, and moral training, would form the chief features of the business of a primary school. And to this extent all should be educated. It follows that infant and primary schools ought to be special subjects of state provision and care. Society is expressly interested in seeing all children trained and instructed thus far, that they may become a moral and intelligent population. So strongly is this regarded in Prussia, that education, up to the point in question, is enforced by law. Certainly, it is at least well to encourage parents, by all means consistent with the spirit of a free country, to have their children educated to this extent. While the state, then, regulates the education of infant and primary schools, the state should also furnish it gratuitously, or all but gratuitously, thus removing all difficulty which may be felt by indigent individuals, the very class whose children are apt to become most dangerous if left uneducated. It has often been objected to the idea of gratuitous education, that what is obtained for nothing is not valued; but the education furnished by the state (or, as an alternative, by local assessment) would not be really gratuitous. Every parent would know that he contributed to the fund by which the school was supported, and that this was much the same thing as paying fees.

In order to ensure a supply of well-qualified teachers, as well as for the sake of uniformity of methods, the infant and primary schools would each require district normal schools. Teaching is an art. It is one of considerable nicety, requiring both natural and acquired gifts of no ordinary kind. Without a due apprenticeship to it, no man can be expected to satisfy the demands of the modern educationist. There is a large amount of detail, both in the methods of procedure and in the material of instruction, which a candidate for this employment must have thoroughly mastered before he can duly teach. There is also an aptness and facility for the duty which nothing but practice can give. For all of these reasons, schools for the training of teachers, or normal schools [so called from *norma* (Latin), a rule,] are indispensable. We have not room here to enter fully into the details of a well-constituted normal school of any kind, but may pause for a moment to indicate the important principle, that it is not sufficient for a young man to sit by, observing the procedure of a well-conducted school; he must enter personally into the business, and be accustomed to act as teacher himself, in order to attain the right qualifications.

We have considered the infant and primary schools as comprehending the education required by all the children of a state, and as therefore calling for state support and regulation. For this reason, we have indicated a conclusion to the primary school period somewhat later than what is practically the case in schools answering more or less to this description. Generally, the primary school period may be said to end at nine years of age, at which time a boy, for example, is considered as fitted to commence a classical course in a higher school. While the material of intellectual education remains generally as it is, this arrangement will be appropriate; but if we consider some branches of general knowledge as necessary for all, we must postpone the conclusion of the primary period to ten or eleven. At that age, the children of the humbler classes would be fitted to commence the active life to which they are usually destined, while others would be equally ready to go forward into advanced schools.

The secondary school—answering to the grammar schools and academies of Britain, the colleges and *pensions* of France, the gymnasia of Switzerland and the German states—is the first school appropriate chiefly to the middle and upper classes. As its benefits are not universal, it should be supported solely by those who take advantage of its instructions, although the state may extend to it protection and regulation. The higher intelligence required of the middle and upper classes, and the special education required for the professions which many of these classes are called to follow, constitute the necessity for secondary schools. They are introductory to a university course for those who are to follow law, medicine, divinity, or any of those other occupations which are now rising into the same rank with the "professions;" those otherwise destined here obtain that comparatively liberal education which is required in the middle walks of life. The course of instruction proper to a secondary school corresponds with what has been pointed out in the preceding section as the advanced department of intellectual education. It may here be proper to remark, that, when we speak of certain classes of the community attending this advanced order of schools, we do not mean that these are to be conducted on exclusive principles. Let their fees be as moderate as possible, and let all who can afford attend. In such circumstances, it would often happen that children of the humbler classes, who showed an aptitude for a superior education, would obtain it, and be thereby enabled to make an advance in life suitable to their faculties.

Religious instruction is presumed, as formerly indicated, to be imparted, throughout the whole period of elementary education, in schools. Here a difficulty as to arrangement unfortunately arises from the various views which are taken on doctrinal points. The teaching of doctrine according to the views of any one denomination, necessarily precludes from the school where it is done, the children of those who dissent from the views in question. On the other hand, if doctrine be excluded, those who are most eager for the inculcation of particular doctrines or for the maintenance of particular religious institutions, are offended. To obviate the difficulty as far as possible, a particular arrangement has been made in Holland, in the Irish national schools, and some others; Scripture reading is there confined to such parts as include no controverted doctrines, and to a general reference to the Bible on preceptive points, and all else is taught to the pupils, at extra hours, by their particular pastors. It is thus thought possible to teach religion as efficiently as by any other plan, while the school is allowed to be a common good to all classes of the community, and a means of bringing up the children of religious parties in harmony together.

INDUSTRIAL EDUCATION.

The mingling of industrial arts with education, is an idea of modern times. One of the first examples of it, by which general attention was attracted, originated at Hofwyl in Switzerland, in 1806, under the care of a man of fortune still living, M. de Fellenberg. Here the object was to teach farming on improved principles, while general education was conducted on an almost incidental plan, at intervals, by the superior of the establishment. Schools of this kind have since been planted in other parts of the continent, and in the United Kingdom. Latterly, industrial education has been extended from agriculture to handicrafts.

As a specimen of a purely "agricultural school," we select that of Templemoyle, near Londonderry, which appears to be conducted in an efficient manner. Established in 1827 by the North-West of Ireland Agricultural Society, for the purpose of giving young men "a plain English education and a knowledge of the principles and practice of agriculture," it lately contained sixty-six pupils, for each of whom a small payment was made. The superiors are a teaching farmer and a schoolmaster, beneath whom is a matron to superintend the domestic establishment.

"At half-past five the pupils rise, arrange their rooms, say their prayers, and, in two divisions, which alternate on different days, are engaged until eight in study or in work; half the pupils are with the farmer, and half under the schoolmaster, except on extraordinary occasions, when the services of all are required for the farm, or the season releases them from their agricultural duties. At eight they breakfast, and are free until nine; work and attend school in alternate divisions, from nine until one. Dine at one, and have recreation until two. From two to six, are at work and in school alternately. From six to seven, sup and have recreation. From seven to nine, prepare the lessons for the next day, have prayers, and retire at nine. On Sundays they attend their respective places of worship, and occupy a part of the remainder of the day in religious reading.

"The intellectual instruction consists in spelling, reading, grammar, geography, arithmetic, writing, and book-keeping, with some elementary and practical geometry and trigonometry. The farmer gives lectures also in the evening upon the theory of agriculture. It is intended to introduce lectures on botany and agricultural chemistry.

"The practice includes all the operations of farming, under the different approved systems; the rearing of cattle, the management of a dairy, and, in general, the incidental as well as the direct occupations of the farmer or agricultural labourer. The head farmer, or agricultural master, is expected to explain the principles of the work in which the pupils are engaged, and to take opportunities for incidental instruction. The operations which he is specially called upon, in the regulations of the committee, to teach, are, ploughing and the setting of the plough, the use of farming instruments in general, the qualities of stock and modes of recognising them, the treatment and management of dairy and farming stock, the making and repairing of fences, the rotation of crops and those best adapted to different varieties of soils, the modes of draining, reclaiming, and improving lands, and the most recent inventions and improvements in agricultural implements. The farmer takes those who are sufficiently advanced in knowledge and age to be benefited thereby, to the fairs, to assist in the sale of the products of the farm and stock.

"The pupils are divided, for work, into sections, each of which has its monitor, or chief, and consists of eight or ten boys. The head monitor, or superintendent, has the control of them, in the absence of the master, and arranges with him the distribution of their time, takes an account of the stock, and of the products of the labour, and advises with the master in regard to the farm, in such a way as to prepare himself for actual superintendence. This place is occupied by the elder pupils in rotation.

"The farm consists of one hundred and thirty-three acres,* of which one hundred and twenty-five are arable land. It is worked so as to present examples of the most approved rotation of crops, the fields embraced in the same series of shifts lying adjacent to one another. The whole is drained by underground drains, according to the Scottish system, and is well enclosed with different fences as specimens, and trials of the various kinds."†

Industrial village schools are well exemplified in that of Ealing, about five miles from London, established by a benevolent lady. The principles held in view in establishing this seminary were, that the children should early acquire habits of patient industry; that they should be acquainted with the value of labour, and know the connection between it and property; that they should have intelligence, skill, and an acquaintance with the objects by which they are surrounded; that the higher sentiments, the social and moral part of their being, should receive a full development. The industrial occupation is gardening, pursued in a piece of ground connected with the school. "It is divided, one portion being reserved for the use of the school, another being subdivided into small gardens for the boys. The pupils work in the first under monitors, and receive a compensation in proportion to the useful results of their labour. The second they hire at fixed rates, and dispose of the produce as they please, always receiving, however, the market price for it from the school, if they choose to dispose of it there. The younger children are not allowed to undertake gardens on their own account, but work for others or for the establishment. Partnerships are sometimes formed among them for the more advantageous cultivation of larger pieces of ground. An account current with each pupil is kept, in which he is charged with the rent of his ground, and the seeds and plants which he has purchased from the stock, and credited with the produce which he has sold to the school."*

In-door occupations are less desirable in alternation with school instruction than these healthy out-of-door labours, but must have the effect of training to steady and persevering habits, not to speak of the actual skill conferred by them. As an example of a school in which such occupations are pursued, we select that of the Royal Military Asylum at Chelsea, where 600 children of non-commissioned officers are reared. Those above eleven are here taught handicrafts, about four hours a-day of three days of the week being thus devoted. "Rather less than a hundred boys work as tailors; fifty each day alternately: about the same number are employed in a similar manner, as shoemakers, capmakers, and in covering and repairing their old school-books; besides which, there are two sets or companies of knitters and of shirt-makers, and others who are engaged as porters, gardeners, kitchen-work, &c. Every thing is done by those who work at the trades except the cutting-out. This branch, requiring more experience, is managed by the old regimental shoemakers, tailors, &c., who, with aged sergeants and corporals, and their wives, manage the concerns of the institution. The system of monitors and teachers to overlook the other boys at work is generally adopted; while, in addition to the various branches of industry mentioned, the school furnishes a company of drummers and fifers, and an excellent band of music; the players necessarily devoting a considerable part of their time to the practice of their instruments."† Though there are some defects, the asylum is allowed to be "an evidence that a greater degree of progress may be made in reading, writing, and arithmetic, and in other branches of learning, than is attained in the great majority of schools, and yet that the boys may be taught music, gymnastic exercises, and various useful trades; thus improving their health, increasing their means of enjoyment, and promoting their future interests, much more effectually than by the prevailing methods."‡

Industrial education is practised with marked success in various institutions for the reform of young criminals, as in Parkhurst Penitentiary, Isle of Wight, and the Warwick County Asylum; in several for the refuge of destitute persons, as in that at Hoxton, and the Guernsey Hospital; and in various schools for orphan and pauper children under the New Poor-Law Act, of which that at Norwood is a most interesting example. It is not as an *improvement*, which may or may not be adopted, that industrial education is here to be advocated: it is called for as something *absolutely necessary*, to counteract an inherent tendency of all asylums for the maintenance and education of children to become monastic institutions. The children are kept apart from external nature. From human society, and from many or most of the common operations of life. They come out as helpless nearly as they went in. Industrial education presents itself as almost the only conceivable means of fitting such children for entering the world in any thing like the same condition as other children. It is not essential that any one child be made a proficient in any one art; the great end is to make them generally acquainted with the arts of life, and to prepare them by habits of industry for earning their own bread when they grow up. From the attention which the Poor-Law Commissioners are giving to the subject, we have no doubt that in a short time we shall see the whole or the forty-five thousand orphan and pauper

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* A plot of the ground, as surveyed by the pupils, and drawn by one of the number, was presented to me, showing the details of the arrangement, and the classification of its parts. The construction of this drawing was one of the practical exercises of the class.

† Bache's Report on Education in Europe. Philadelphia, 1839.

* Bache's Report on Education in Europe.

† Report of National School Society.

‡ Some Account of the Royal Military Asylum, Chelsea. Second Publication of the Central Society of Education. P 190

children of England educated in this wholesome manner. In the late reports of the commissioners there are some excellent hints thrown out. Different arrangements are recommended for different districts. It is suggested, that in an agricultural district there ought to be a large garden which the children should be taught to cultivate, in order to become acquainted with those duties which they will probably be called to perform when they are sent out into the world. They should also be taught to erect sheds or outhouses, to make wheelbarrows and other simple utensils, and to fashion desks and forms for the school. Thus, as farm-servants, they will be able to execute a number of little jobs in carpentry, which would otherwise require the interference of the proper tradesman. To enable them to contribute to their own personal comfort and that of their household, without an expenditure of their earnings, they should be taught to make and mend their own clothes and shoes, to plait straw hats, to make straw mattresses, and whitewash walls. In a manufacturing district, the employments should bear a similar relation to the trades of the neighbourhood, and in or near a seaport, the arts connected with maritime life should be taught. Such, in brief, are the views of the Commissioners respecting the boys: they recommend that the girls should be trained to the household duties of cooking, cleaning, and washing clothes, sewing and knitting, by having to perform those duties as far as required in the workhouse. It is worthy of remark, that in the Marylebone charity for girls, this plan has been for many years acted upon with excellent results. There the girls are accustomed to make their own beds, to clean their own knives, forks, and shoes, and to be scrupulously clean in their dress. "Their chief employment is needle-work; but they are employed in rotation to scour the school-rooms, the play-rooms, and the washing-rooms, the tables, forms, and stairs, as well as to prepare and remove the meals of the rest of the scholars, and to wait upon the domestic superintendent and officers."*

The reporter of these circumstances adds, and we fully concur in his sentiments—"The value of charities of this description is too obvious to require particular comment. By establishing *good habits*, they doubtless accomplish more than can ever be effected by mere precept; and they not only tend to make useful servants, but provident, neat, and intelligent wives and mothers. If it were possible to engraft some part of such a system on the national and other schools, these advantages would become generally diffused, and the consequence would be a great increase in the comfort of the houses of the poor, and an accompanying contentment, productive of the best results on the character, among young married men of the working-classes, whom the extravagance or mismanagement of untidy and ignorant partners often drives to alehouses, and other resorts of idleness and dissipation."

* Quarterly Journal of Education, i. 287

DRAWING AND PERSPECTIVE.

Drawing is an imitative art, by which the forms, positions and relations of objects are represented on a flat surface. The faculties employed in this as in other imitative arts, are possessed in a certain degree by all persons. Some possess these faculties in so high a degree, as to become fitted to exercise them as a profession, for the gratification of mankind at large. In others, they are manifested so moderately, that a protracted effort to make such persons become tolerable draughtsmen would only be labour thrown away. The majority, however, are so far endowed, as to be able, when instructed, to delineate any simple object, and to enjoy much pleasure from higher delineations produced by others.

The practice of elementary drawing at school, hitherto greatly overlooked, is calculated to produce the most beneficial results. As regards those who possess the faculties for design in a high degree of excellence, early practice will awaken those faculties, and, furnishing them with stimulants to progress, secure the benefit of their ultimate exercise for the community. Lesser degrees of excellence will also be developed—such as would in vain perhaps essay excellence in the higher walks of art, but might become of incalculable value in connection with certain branches of manufacture.

As a means of elevating tastes and desires, and thereby embellishing what might be otherwise a routine of commonplace existence, drawing appears in its most interesting light. The person who has acquired a knowledge of botany feels a new pleasure in examining the parts of a hitherto unseen plant; he who has acquired a knowledge of geology is interested in passing along a road, the side of which displays a deep section of rock, or from which he may view various granitic elevations; he who has acquainted himself with the principles of machinery experiences an enjoyment in contemplating the intricacies of some great engine, which another knows nothing of; and in the same manner he who has studied the art of drawing discovers a source of new and innocent gratification in the innumerable forms and tints of external nature. Things formerly passed with a careless eye and a vacant mind, then assume a character which arrests attention and awakens thought. Those faculties of the mind which perceive and appreciate the figure, colour, and arrangements of objects, and trace in all a natural and appropriate beauty, spring up from a dormancy which might have otherwise known no interruption; a new association of our mysterious being with the physical world around us is practically established; and the value of existence becomes by just so much enhanced. Not surely that it is desirable that an absorbing interest should be created in all minds respecting the outward aspect of nature, to the neglect of the more serious affairs of life. All that can be contended for is, that as many as possible should be rendered capable of looking with pleasure, instead of indifference, upon the beauties of nature, so that they may realize the benefit of this part of the intellectual and sentimental powers which have been conferred upon them; a portion of their nature which, like others, may be abused, but, in its moderate use, is not only a source of innocent pleasure, but may become the means of anticipating and supplanting many pursuits of a less worthy character. Nor, while the art is perhaps chiefly acquired with these views, may it be without some results of a more directly useful kind. In many situations—when wandering in our own, or roaming in foreign countries—we may see objects of which we would be glad to carry away some memorandum, and of which the slightest pencil sketch would be sufficient to awaken a recollection at any other time. And yet, for want of a few elementary lessons in drawing, many of even those who travel for the purpose of informing the public, are unable to commemorate such objects, or, at the best, can give only a few scratches, which a professional artist has afterwards to fashion into shape—a shape, of course, in which correct representation is not to be looked for. In this point of view, drawing takes its place, as a useful art, by the side of writing, being, like it, a means of description, and one which may occasionally be even more serviceable than that art, though certainly not capable of so general an application.

Referring to the volumes on Drawing in our EDUCATIONAL COURSE for a methodic series of instructions, our design on the present occasion is to present a popular view of what may be done by comparatively unlearned persons to acquire a knowledge of the art, including perspective, which is the foundation of all pictorial delineation. It will be understood, then, that in all our observations we address ourselves directly to the pupil.

DRAWING.

Drawing is effected by various materials, as chalk, black-lead, or coloured pencils, Indian ink, &c. Drawings of a simple kind are made principally on white paper or Bristol board, but also sometimes on tinted papers, in which case the lighter parts are brought out by white crayons. Commence a study of the art by acquiring ease of hand, and in fact learn what the hand can do by its different evolutions. For this purpose, drawing lines with chalk on a black board is perhaps the best exercise. Either, therefore, on a board with chalk, or on paper with a pencil, learn to make drawings of lines, straight, curved, or a modification of either. Observe how much more beautiful is the appearance and effect of a curve in comparison with a straight line, and how nature delights in this waving of forms, of which we have examples in the bending of boughs in trees, the serpentine winding of rivers, and the curvilinear forms of animals.

You may begin the drawing of objects by copying other drawings; but this species of exercise can only make you familiar with the manner in which lines answer the purpose of representation. To be master of the art, you must throw aside all drawings or copies, and learn to draw by your own ingenuity from tangible objects in nature and art. In this study, the hand is taught to obey the conceptions of the mind. When, for example, we see a chair standing on the floor, we observe its shape or figure, its line of back, seat, legs, and all other parts about it. We then take a pencil, and bending the mind intensely on the form of the chair, try to define all the lines of the object on the paper or board. The more perfectly that the hand can obey the direction of the mind, while bent in thought on the object, so will the drawing be more true in all its details.

The pupil, therefore, must be taught to call up the whole power of his mind respecting the appearance of an object, when he wishes to represent it by a drawing. On this, indeed, may be said to rest the fundamental principle of delineation in all its branches. No one can possibly attain even a mediocrity in the art, who does not, less or more, possess this power of recalling images to the mind, and of training his hand to act in strict conjunction with its dictates. The hand is only the instrument employed by the imitative faculty, and can do nothing useful without the strong concurrence of the will. Accomplishment in penmanship, and every other art in which design or figure is an element, is founded on this fundamental basis.

In these elementary lessons an idea of perspective will be unconsciously gained. It will be noticed that strong outlines mark the objects or parts of objects nearest the eye or in the foreground; while, to make parts retire, or have an appearance of being at a greater distance, the lines must be made light, and the representations smaller. It is a matter of first consequence to bring out effects on a broad scale, not by repeated small markings, but by a comparatively few bold lines of greater and lesser thickness. You will observe that an object may be represented in two ways—first, by mere outlines describing its figure; and, second, by introducing strong shades among the outlines. Take, for illustration, figure 1. Here the blades of a plant are re-

Fig. 1.

presented by a few thin and thick lines properly disposed, and by a little shading being thrown in to bring out the effect.

Fig. 2.

A just idea of the value of lights and shades may be said to be the beginning of all excellence in pictorial delineation; and you are recommended to lose no opportunity of acquiring it. The most simple objects afford examples. In fig. 2 we have a group of this nature, being a stone, a piece of broken wood, and the leaves of a tall grassy plant, such as may be observed in a field or by the roadside.

Mr. D. R. Hay, in his excellent work, "The Laws of Harmonious colouring," has the following practical observations on the method to be followed by young men in gaining a knowledge of drawing, with reference to patterns, decorations, and ornamental designs:—"The course of study I am about to point out is within the reach of all—even those in the most humble situations of life. They will find it of easy acquirement, and a source of continual enjoyment, in the improved medium through which it will lead them to view the most ordinary productions of nature. She shall be their instructor; for all that I can pretend to do is to point out to them a practical mode of receiving her lessons. To the uninitiated I therefore address myself; and let them not be dissuaded from beginning, by having no predilection for the study—the more they persevere the more they will love it.

"In the first place, your attempts ought to be of the most simple nature, and on as large a scale as you can conveniently adopt: therefore, begin by procuring a black painted board or slate of from two to three feet square, and with white chalk practise the drawing of squares, circles, and ovals, without any guide to your hand. You may make yourself copies of these figures by the ordinary rules. When you are tolerably perfect at these, upon the proper combination of which depends all linear harmony, you may practise in the same way triangles, hexagons, octagons, and such other figures as arise from the various combinations of the straight line. Next, by your circular and oval lines, you may form crescents, circular and flattened volutes, regular undulations, and other figures, which arise out of their various combinations, first making an accurate copy to yourself of each figure by measurement, and continuing to practise until you can form it by the eye with perfect ease. Avoid forming your figures by little bits at a time; do each line as much as possible by one sweep of the hand. When you find yourself pretty perfect in this kind of practice, I would recommend you at once to draw from nature. You may take for your first subject a cabbage leaf, the larger the better, and persevere in copying it, full size, until you can represent it accurately in outline, with its principal fibres. You may then vary your practice by other simple subjects of a similar kind, until you find you can do them all with ease.

"Before endeavouring to draw more than one leaf at a time, you must know a little of perspective. The most simple mode by which you will attain such knowledge of this art as will be most useful for your present purpose, is to hang a circular object, such as a hoop, between you and the window; set it a-moving gently round, recede a little from it, and you will find that, as one side of it retires and the other comes forward, the circle which it describes becomes narrower and narrower, until it disappears altogether, and leaves nothing but a dark line, as if a stick instead of a hoop were hanging before you. I recommend you to do this between you and the window, because the hoop will appear like a dark line, and you will thereby be better able to mark the change that takes place in the shape of the circle. Fix it in various positions, and draw from it, and observe that it is a different figure from an oval. You may now hang up your cabbage leaf, or that of any other large and well-developed vegetable, and you will observe the same change in its figure as it turns round. Make an outline of its shape while its front is half turned from you, then bring it from between you and the light, and place it where the light will fall upon it, with its face half turned from you, as when it hung before the window. Take your outline, and within it draw the principal fibres as you see them. To do this properly, will require a great deal of practice, but it will pave the way to your being able to draw the most complete groups of flowers and foliage that can be placed before you. You may now hang before you a small branch of any tree or plant, with two or more leaves upon it—the larger the leaves are the better—and endeavour to make outlines of them, varying their shape according to their perspective, as already described; be particular on this point, for a great deal depends upon it.

"You may now lay aside your chalk and slate, and provide yourself with a few sheets of common cartridge-paper, and some pieces of common charcoal—that made from lime-tree is the best. Stretch a whole sheet of your cartridge-paper upon your board by a wafer or a little paste at each corner. Place before you a cabbage, cauliflower, stalk of dock-blades, or any such large vegetable, and they will be more picturesque if the outer leaves are hanging loose. Copy these carefully in outline, using your charcoal gently, that any inaccuracy may be easily dusted off. A large thistle with its foliage is likewise an excellent example, but more difficult. Indeed you cannot go wrong in your choice—hemlock, fern, nettle, are all worthy of your study. From these the richest and most effective of Gothic ornaments were taken by our forefathers. The more you study such subjects, the more beauty and grace you will find in their forms."

When a considerable advance has been made in the elementary department of drawing, it will be proper to go on to the higher stage of perspective drawing, in exact accordance with the rules on the subject. For this you will require the following

Requisites for Drawing.—Among the various articles required in systematic drawing, the first place may be given to a wooden board of convenient size, or about two feet in length by eighteen inches in breadth; it should be perfectly smooth and perfectly squared. On this board the paper on which the drawing is to be executed should be properly fastened. This is done by damping the surface of the paper with a wet sponge, and after it has fully expanded, fastening it down with a little thin glue round the edges; it should be laid on the board evenly, and left to dry in the air.

The next requisite is a flat rule called a T-square; this is a thin straight-edge, or rule, attached at right angles to a short piece of wood much thicker, so that when the cross-piece is moved along any side of the board, the rule will project across the paper, and by its edge pencil lines may be drawn straight from left to right and from top to bottom. To test the accuracy of the square, let other lines be made from the opposite sides of the board; and if they agree with the former lines, by being parallel to each other, all is right. On this the correctness of the drawings will materially depend.

To these must be added a pair of compasses—an instrument so well known, that it is only necessary to remark, that the points should be just so sharp as to hold on the paper without piercing it. The compasses should be held lightly by two fingers and the thumb, and moved with the least pressure which the operation may require.

These simple implements will be sufficient, until a knowledge of the art suggests the necessity for a case of mathematical instruments.

Paper may be purchased of all qualities; for early practice, it is sufficient for it to be what is called *hard*, that is, able to endure being written upon with pen and ink.

Black-lead pencils are of various qualities: a soft pencil gives off the lead too freely, and will not retain its point; a hard pencil wounds the surface of the paper, and cannot be easily obliterated; therefore the medium pencil is best for drawing perspective. The wood should be carefully cut from its point, and the lead sharpened by being gently rubbed on a file, which produces a better point than can be formed with a knife.

Indian-rubber, or a clean crumb of bread, to take out lines incorrectly drawn, is also necessary.

Every student of drawing is supposed to be acquainted with the form of acute, obtuse, and right angles, circles, ellipses, and other simple mathematical figures, and therefore we need occupy no time here in describing them: those who wish to refresh their memory on these matters are referred to our article GEOMETRY.

PERSPECTIVE DRAWING.

The study of perspective is commenced by acquiring a knowledge of certain principles, and the technical appellations by which they are described. The first thing which you will attend to is the existence in all correct perspective drawings of a *horizontal line*. The horizontal line is always the height of the spectator's eye, and, of course, fields or hills may be above this imaginary line in a picture. In the following diagrams, the horizontal line is always marked H. There is a certain point on the horizontal line to which the eye is directed; this is called the *point of sight*, and in the following diagrams is marked P.

As noticed in our article OPTICS, the apparent magnitude of any object is influenced by its distance from the eye; if near, the object seems large, if remote, it is small. It is, then, a most important principle in perspective drawing, to regulate the size of the objects marked according to the distance at which we wish them to appear. We have a good example of this gradual diminution of objects as they recede from the eye, in the manner in which a long avenue of trees seems to close in a point at its further extremity. It would be possible for a person, unskilled in the rules of perspective, and merely by the general directions already given, to give a representation on paper of the manner in which objects thus seem to diminish, as, for example, a row of posts; but as mathematical science gives exact rules on the subject, no one need trust to chance, but appeal to principles of unerring accuracy. We crave attention to these principles, which we illustrate by certain lines in the diagrams which follow.

Figure 3 represents a quadrangular drawing, of which AB is the base. Across the picture, at rather more than

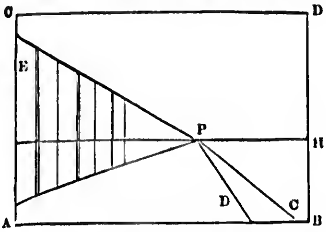


Fig. 3.

a third of the height, is a line H, representing the horizontal line. On the horizontal line, a point at P is the point of sight, and to this point all objects are diminished in proportion as they approach it. Thus, a road represented by the two lines CD tapers to a point at P, and a row of posts E diminish towards the same centre of observation.

The horizontal line, which, it will be perceived, regulates some important points in pictorial delineation, may be placed high or low at pleasure; but it is generally regulated in its elevation by the nature of the subject to be drawn. If placed high up, it leaves too small a proportion of sky, and produces what is called a bird's-eye view; if placed near the base, unless the scene be mountainous, the proportion of sky will be too great. In general, the horizontal line should be drawn at about one-third of the height of the picture. The point of sight may also be fixed at pleasure; but its best situation is removed from the centre towards one of the sides; if directly in the centre, the perspective would have too formal an effect.

When an object having angles, as a box, stands on a base parallel to the horizon, and two of its sides or surfaces can be seen, that which is farthest from the eye will recede according to the situation of the point of sight. Place a box as in fig. 4, immediately in front of the eye; AB is its bottom or base, and EF is the farther edge of its top. AB, the base, being parallel to the horizontal line H, the point of sight will be at P, and the visual rays from the upper corners of the box will centre in P, because the eye is in front, and above the object. Any alteration of the position of the box, or the eye, will consequently require a corresponding arrangement of the laws of perspective.

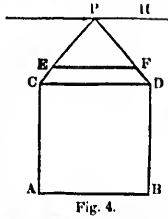


Fig. 4.

Place the box toward the farther side of the table, immediately in front, and lower the eye till the horizontal line is one-third down the box, when the top will be lost sight of; there let the eye be fixed, by resting the chin on any convenient object, and the front, or only one side of the box, will be seen. Then let the box be moved to the left, in a straight line, the position of the eye being retained, and a second side of the box will come into sight; its receding lines or visual rays will then be centered in the altered point of sight, and the side in front will retain its form, because its base is parallel with the horizon. When this experiment has been made, and the situations of the box and the eye have been considered—presuming the box to have been a cube—proceed to ascertain the mode of representing this object according to the rules of perspective, referring to the natural appearance of the box occasionally, the more effectually to fix the mutual resemblances in the mind. Fig. 5 will show the process by which all the particulars may be demonstrated. Presuming the paper is fastened down on the drawing-board, the T-square and pencil ready, commence thus: Apply the T-square and draw the base line AB, and also the boundary of the picture CD. Then draw the horizontal line H across the paper; this may be fixed at pleasure, but parallel to AB. Then find the half of the base AB, and draw a perpendicular beneath the picture to O, and on it place the profiled angle of 60 degrees, just at that distance which, by continuing the sides of the angle, they will intersect the extremities of the base, and together form an equilateral triangle, as AOB: this must be strictly attended to. Now, as before observed, the point of sight is better when removed from the centre of the picture; and taking a station to the right, by a horizontal line from O to S, this becomes the station whence the picture is seen, and the point of sight is therefore found by the perpendicular line from S to P on the horizontal line. Now, as a vanishing point is required to determine the width of the receding side of the box, the profiled angle of 90 degrees is to be placed at S on the perpendicular PS, and the side line continued until it intersects the horizontal line at V, which fixes the vanishing point: this also must be strictly attended to. It will be observed that the angle at S is one of 45 degrees, being the half of the profiled angle of 90.

We now call attention to the situation of the eye, which is always on a level with the horizontal line; therefore, the true position of S is immediately in front of P, or, as if the perspective lines beneath the picture could be raised up to the level of S, and fixed at that distance from the picture, to show the true situation of the eye when viewing the object. The front square shape of the box may then be drawn in, occupying less than half the base of the picture, in order to show the perspective, as at fig. 3; then, from the nearest perpendicular of the box draw the visual rays from the top and the bottom of the square to P, which give the diminutions. Now, a line drawn from the corner of the box near A to the vanishing point V, will intersect the diminishing line, which gave the receding base of the box at L; and a perpendicular line from L to K on this intersection, will give the true representation of the square box as seen in perspective. If this were a cube of glass, the farther sides would be seen, as shown by the finer lines in the diagram.

Repeat this study in different sizes, referring to the natural appearance of the box, in order to feel, as well as see, the coincidence between that and the object produced by the rules of linear perspective. It is of importance that this diagram should be thoroughly understood, because many of the rules employed in it are frequently required.

The boundary of a picture, or the plane, may be of any proportions. The base is marked in fig. 3, AB. The perpendicular, from the middle of this base line, assists in finding the situation for the angle of 60 degrees O, the width of the base, measured from the extremities to the perpendicular O, forming an equilateral triangle

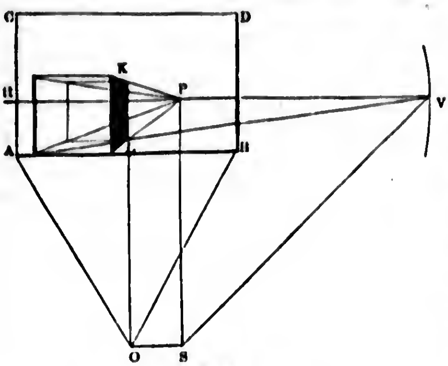


Fig. 5.

as AOB. This is a rule, whatever may be the size of the picture; it also shows the proper distance at which a picture should be viewed. This expanse of vision, at an angle of 60 degrees, is marked in the diagram O, and places the point of sight in the middle of the picture, which is very often objectionable; therefore, a line parallel with the base is drawn from O, and on this line the better station is taken, which is marked in the diagram S. Now, the horizontal line H having been taken at pleasure, a perpendicular drawn into it from S will give the point of sight at P, into which the visual rays are drawn that regulate the receding side of the object. The vanishing point V is entirely distinct from the point of sight, of which there can be but one; but vanishing points may be numerous. This, marked in the diagram V, is of great consequence, for by it is determined the proper width of the object, by the line which intersects the visual ray from the base of the box A to V, as at L; and here the perpendicular to K, which intersects the upper visual ray, completes the perspective form of the object.

No objects better exemplify rules in perspective than articles of household furniture, such as boxes, chairs, tables, and chests of drawers. We direct your attention to the following illustrations: Fig. 6 exhibits a parlour chair and a footstool. Observe that the chair stands with the corner of its seat nearest to the spectator, the point of sight being in the middle of the picture. The receding sides of the chair have their respective parts regulated by diagonals to their vanishing points. The footstool stands on a line parallel to the base, and therefore its visual rays tend to the point of sight in the centre of the picture. These may prepare the mind of the student to consider, that objects, when differently situated, have each their vanishing points regulated by the angle at which they are viewed.

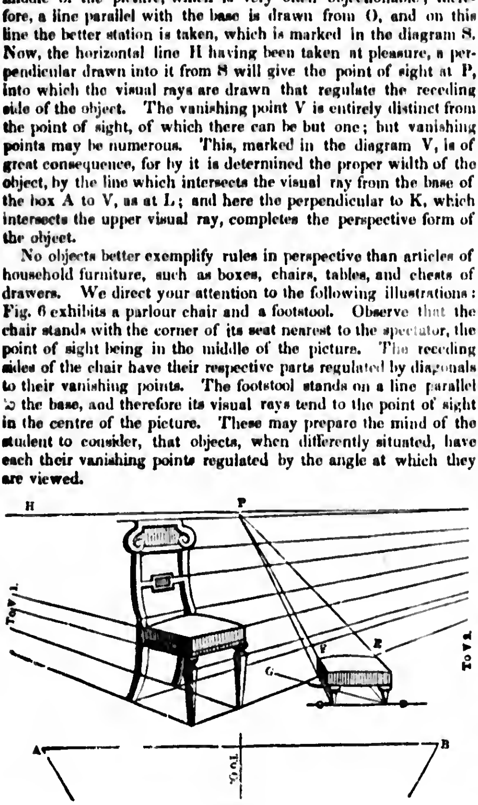


Fig. 6.

We recommend you, on all occasions, to draw the horizontal line so far on either side, that it will be intersected by the diagonals, which are to be drawn at an angle of 90 degrees from the station, into the horizontal line, where they determine the vanishing points. These are only indicated in the diagrams by the direction of those lines, and the words "to V 1" or "to V 2."

In fig. 6, the base line AB is drawn, its centre determined, and the perpendicular drawn to O; the angle of 60 degrees is taken in agreement with the base line, making an equilateral triangle, and the point of sight P is fixed on the horizontal line H. The vanishing points are found by the angle of 90 degrees at O, projected on either side to V 1 on the left, and V 2 on the right, as before described. All the diminutions of corresponding ornaments on the back and front legs of the chair are drawn to V 2, while the side of the chair is regulated by V 1. The footstool is placed parallel to the base on the line CD, and its diminution regulated by the rays EP and FP. The diagonal G from the leg of the footstool D, to the vanishing point V 1, would determine the square of the stool, or the position of the farther leg, at the point where it intersected the ray CP.

Fig. 7 shows the perspective lines required to represent a writing-desk placed diagonally on a table which stands on the base line. The base of the picture is drawn as AB, the centre is taken, and a perpendicular drawn to O, for the angle of 60 degrees. The horizontal line is drawn at H. The parallel is drawn from O to S, and there the perpendicular to the horizontal line fixes the point of sight at P. Then the angle of 90 degrees is taken at S, and the sides being projected to the horizontal line, gives the vanishing points V 1 on the left, and V 2 on the right. Now, the table being seen in front, or on the base line, the visual rays from the legs and the top are drawn to the point of sight P. The table being supposed to be a parallelogram, its side, seen in perspective, will be about half its width seen in front; therefore let half the space seen in front be set off from the leg on the right; and the diagonal from that half to V 1 will give the diminution of the side of the table, where it intersects the ray from the front leg to the point of sight P, at R. A parallel line from this to the ray from the other front leg will give the situation T for the most distant leg. The writing-desk being presented with its corner towards the spectator, both sides will require their receding points, which are determined by the vanishing points V 1 and V 2. Such familiar objects should be drawn, by which the more readily to fix in the mind of the student the leading principles of linear perspective.

It will be seen that, when an object has its base line parallel to the horizon, the point of sight is in the picture, and that it is arranged in agreement with the [illegible] under which the object is viewed. [illegible] object which has four sides, [illegible] those sides be immediately in front of the eye, the visual rays will be hidden, because the point of sight is in or behind the object. It will also be seen, that if the object be moved on either side, or the point of sight be altered by a change of station, the visual rays determine the receding side of the object immediately on a second side being seen.

If the base line of an object be removed from its parallel to the base line of a picture, the angle under which the object is viewed becomes altered in strict conformity with its changed po-sides, the particulars of which the student may ascertain by placing an object in the various positions.

Suppose a chest of drawers, or a cube, to be placed and seen as in fig. 3, and while the nearest corner is to act as a pivot, the end near A. to be moved so as to cause a space between the base line of the

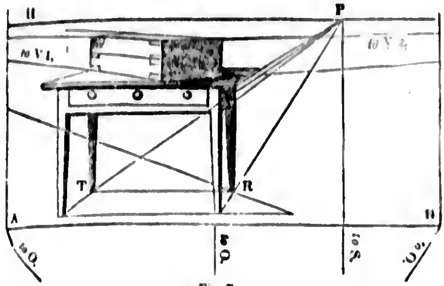


Fig. 7.

object at that end and the fixed base line of the picture, the angle of vision would require that the base and top lines of the object should have their vanishing points. The object could be moved thus in different directions till that which in the diagram is the receding side would become the front, and each position would require a diagram; but the student is presumed to have become acquainted with the fact, that, at each pause in the movement of his object on its pivot, there will be exhibited a diminution on one side, proportionate to the increase of the other side; until, by continuing these rotatory movements of the object, that side which was at first presented obliquely, becomes the front, and its base parallel to the base of the picture. The original front of the object, by the revolving movements, will have been lost or hidden, exactly in proportion as the receding side advanced to the front. Thus the vanishing point extended as the advancing side became more evident, just in proportion as the receding side diminished. Make these experiments, and observe, on the first change of position deviating from a parallel with the base of the picture, that the vanishing point V 1 was required, and so far removed on the horizontal line on the left, as perhaps to require an angle of 80 degrees at the station, while V 2 on the right would then require an angle of 10 degrees. Any subsequent change of position in the object will alter the angles for the respective vanishing points, and these together always making an angle of 90 degrees.

Fig. 8 shows the method by which the situations of windows may be properly drawn in the representation of a house, seen obliquely. Draw the base line AB: find the angle of 60 degrees on the perpendicular from the centre, and mark the station S: determine the horizontal line H, and the point of sight on it, perpendicular to S: find the angle of ninety degrees, and draw the lines to the vanishing points V 1 and V 2: draw the nearest perpendicular of the house C, and fix where the nearest windows are placed, also their height and width, DE: draw these diagonals to the vanishing point V 2; they regulate the diminution of the heights of all the

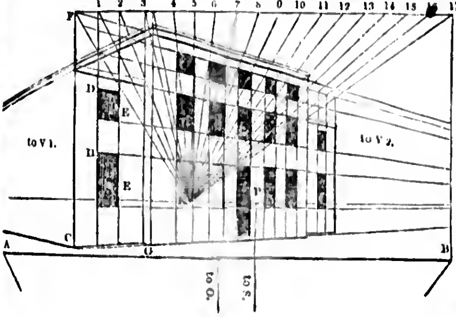


Fig. 8.

windows: draw also the cornice and the base lines; then draw a fine line F parallel to the horizon, and touching the perpendicular C; then, with the compasses, take the measure of the space between the perpendicular C, which is the corner of the house, and the edge of the window D, and mark it on the line F as at 1; then take the width of the window E, and mark it as at 2. It is better to have a second pair of compasses to prevent mistake in the alternate alteration that is required, or the space for the windows may be marked with the point of a needle on a piece of writing-paper, and then marked off carefully on the line F; then the compasses will mark the space between the windows only. The small projection which separates the centre from the wings must be noticed, as at G; then the space with compasses 4, then the window 5, then the space 6, then the window 7, then the space 8, then the window 9, then the space 10, then the window 11, then the space 12, then the window 13, then the space 14. This being the further extremity of the centre of the house, the corresponding projection to G must be noticed, as being so much of the next space hidden behind the projecting centre; it will therefore be marked 15, then the window 16, then the space 17. These compose the spaces and widths of the windows as seen in the front of the house: and it must be mentioned, that the points which have been made on the line F, must be perfectly true on the line, or the truth of the diminution will be impaired. Now, assume a point about the middle of the house, on the horizontal line, as at K, and draw diagonals from all the points made on the line F into the point K, observing that the point of the pencil runs into both at every line. A needle may be placed at K, against which the straight-edge may be pressed, to assist in drawing the diagram correctly. Now, the diagonals which regulated the diminution in the height of these widows, as drawn to V 2, will be intersected by the radii drawn from the point K into the marks on the line F, and those intersections will show the diminution of width according to the laws of linear perspective.

As this diagram may be crowded with lines, you are recommended to examine the intersections carefully, and mark the forms of the windows with a hard pencil, and then draw in all the perpendiculars as regulated by the radii on the diagonal lines. If in this state of the diagram there should appear any confusion, it will be far better to commence another; and the larger the drawing is, the less risk is there of disappointment. The side of the building, that is, the wing and the portion of the centre seen above, with the little projection at G, are drawn by diagonals to the vanishing point V 1.

You are advised not to pass this diagram without having obtained a perfect knowledge of the principles by which the diminutions are regulated. Difficult as this may appear, it ought by all means to be attempted, for it cannot be too strongly impressed on the mind, that no perfection in drawing, no delicacy in finishing, nor boldness of effect, can atone for deficiency in perspective. When a little progress has been made in this, so that the judgment is prepared to understand the arrangements which objects must undergo to be correctly represented on a flat surface, a scene in nature can be sketched without any material difficulty.

Fig. 9 represents a method by which archways are put into perspective.

The base AB, the horizontal line H, and the point of sight P, are determined as in the preceding diagrams. In this it will be seen, that, if the point P had been retained in the centre of the subject, the sides of each respective arch would have been alike; to obviate this, P is placed a little to the left of of the centre.

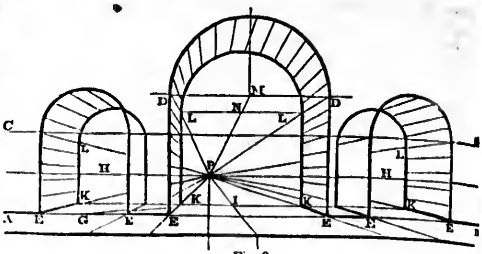


Fig. 9.

This is a subject which may often be met with, and you are advised to study such objects in nature, be they of one or more arches; ever remembering that the station must be preserved with the head towards the point of sight; the eyes only are to be turned from one part to another. You will thus practically learn the distance at which to take a station for such studies. If it be taken too near, too little of the subject will be seen. If it be taken too far off, then there will be more expansion than is required, and the subject will not show the minutiæ.

Suppose such an object as fig. 9 to be in front of the draughtsman: the piers between the arches should be sketched as perpendicularly as possible, and the arches turned by hand: then the depth of the receding sides, as nearly as the judgment may direct, and as much of the masonry as may point out the perspective of the subject: then, while all is fresh in the memory, attach the sketch to the drawing-board, and by the T-square draw the base AB, the horizontal line H, the point of sight P, and the vanishing point V 2; then, by the T-square, correct all the perpendiculars and horizontals; draw the line CC, which is the chord of the smaller arcs, and DD, which is the chord of the large arc, and observe that the perpendiculars intersect the line C and those at the centre arc at D: then find the centre for the arc M, and describe it correctly from one perpendicular into the other: do the same from their centres to the smaller arcs; and thus the superficies of the subject will be defined: then draw the visual rays from the base of all the perpendiculars E, and from the intersections on CC and DD, to the point of sight P, which give the receding lines for the visible sides of the archways. If the piers be square, a line drawn from the base of the perpendicular of the centre archway E, to the vanishing point V 2, will give the perspective width of the receding parts. If the piers be one square in front, and two squares deep, mark off a square to the left of the perpendicular, as at G; and a diagonal drawn thence to V 2 will give the receding depth where it intersects the visual ray EP at K. At this intersection draw the horizontal line I; and where this intersects the visual rays at EP, as at K, raise the perpendiculars till they intersect the visual rays CP and DP, as at LL. Thus will the receding sides of the archway be determined. To find the arc at the farther end of the subject, draw the horizontals LL; and the visual ray MP, where these intersect at N, is the centre on which the arch may be described. The smaller arches are to be found by a similar process.

Now, the correcting of such a sketch by the application of the rules of perspective, will show where the eye and hand have failed in giving a faithful representation of the object. Therefore, again visit the spot, taking a station strictly in agreement with that in the drawing, and compare the corrected lines with those which nature will present. Let all be rigidly examined, and the result will not fail to be satisfactory.

We recommend that every opportunity should be taken to sketch such subjects from nature; they furnish excellent studies for linear perspective, and one such study would convey more information than the copying of a dozen drawings or diagrams.

SKETCHING FROM NATURE.

Having acquired a certain facility of hand, and mastered the principles of perspective, you may proceed to the more agreeable study of sketching from natural scenery. At first, do not attempt any difficult or complex subject. Select some assemblage of ordinary objects, such as may be thought agreeable in themselves, and likely to be represented with ease and satisfaction. The scene selected should not contain more than three or four objects of different kinds—such as a cottage, one or two trees, and a small rustic paling, with perhaps the addition of a little glimpse of background. You will observe that an artist rarely ever takes an object in its broadest and most regular form: he never represents a house, for instance, as if he had taken up his position right in front of it, as an architect would do; nor would he paint a row of trees at a right angle to his own position, seeing that the effect of such representations would be tame and formal. He endeavours to catch the careless grace of nature, as she appears to casual observation. A house, particularly, should always be viewed from a point a little aside from the front, so as to bring in as many of its angularities as possible. A group of natural objects should be represented as if the draughtsman had just by chance got his eye upon it; and yet the selection of a point from which this effect may be obtained must be a matter of study. For an early lesson in sketching from nature, it is enough that the objects be outlined; to fill in details, and give the full effect of light and shade, must be left to a future period in the career of a young artist.

As an example of the scenes which may be selected for early sketches from nature, fig. 10 is given, being simply a cottage backed by a few trees, and having some broken ground in front, while a glimpse of the sea is obtained at the side of the picture. The station of the draughtsman is here at S, in order that the cottage may not appear to have been viewed formally, and that the trees behind may give to the scene its neat pyramidal form, while the broken grounds in front communicate boldness of character, and the straight line of the sea at P (which is the horizontal line) affords a pleasing contrast to the other lines of the drawing.

It will be remarked that the cottage stands on a line parallel to the base AB, the point of sight P is perpendicular to the station S; consequently, the rays that regulate the side of the chimney, the upper and under lines of the roof, and the window on that side of the cottage, all centre in P.

Provided with a sketch-book, (measuring perhaps 10 inches long by 7 inches broad,) the first thing to be done is to select a station from which the drawing is to be executed. A difficulty may present itself respecting the size of the proposed drawing; but the dimensions may be determined in a very simple man-

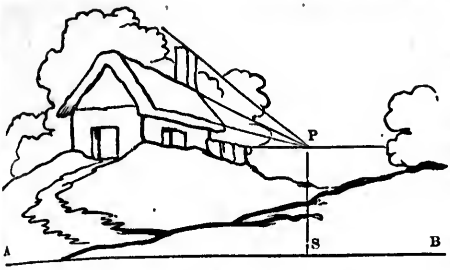


Fig. 10.

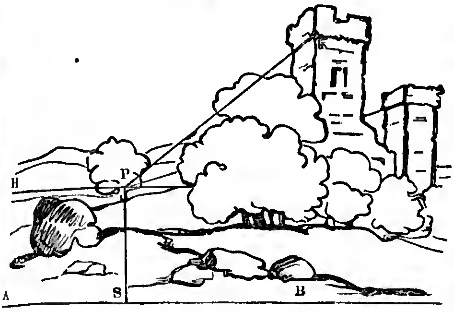


Fig. 11.

ner. Hold up the sketch-book in front, with one eye closed, and the space in the scene covered by the book is that which may be drawn; of course, the farther off the book is held, the less of the subject will be covered. When the extent of the scene is arranged, the book may be gently lowered, and a few dots made on the top margin, merely to point out the relative situations of particular features, as the width of the cottage, and the trees. Then, remembering to preserve the station, mark the point of sight on the distant horizon. Do not be in haste, but judge of the relative distances of the most prominent parts, such, for instance as the gable end of the cottage and its length, and tenderly mark them on the places to be so occupied. When these or more dots for guides have been placed, examine their relative distances, and compare them with the objects, by holding the sketch-book out in front so as to see the agreement between them over the margin. To arrange these particulars well at first, will save much trouble in obliterating falsely drawn lines. Be careful in sketching to preserve the perpendiculars of walls and chimney; that is, by placing them at right angles with the base line, which is now the lower edge of the sketch-book.

To prevent the hand from injuring the sketch as it proceeds, commence on the left and proceed to the right. Endeavour to sketch the lines with a lightness of hand, or with what is called freedom, the effect of which is very distinct from lines drawn by a straight-edge: let them be rather broken, or a little wavy, yet having the general appearance of straightness. Let the masses of foliage be sketched with the same ease and confidence that the capital letter E, or the flourish of the D, are made in writing. Sketch the grounds, in their different undulations, rather more angularly, or as if ruggedly dashed in, and strengthen the lines where separation of parts seem to be required.

In examining the objects of which a scene like the foregoing is composed, you will observe that the lines for the cottage have one character, the lines for the trees another, and the lines for the ground a third character, which detach the objects from each other. A simple outline of these three forms is sufficient to be aimed at, for the introduction of more markings or separations would only tend to confuse early studies.

If the lines, on a first attempt, be not all which could be expected, they furnish a proof that the mind is in advance of the hand, and should operate as a stimulus to exertion. In a few studies you may discover, that, by beginning with a cut point to the pencil, it gradually wears away, and gives an increasing thickness of line; this is often very advantageous, for, as the sketching advances to the foreground, the bolder lines of the pencil contribute to the separation of parts, to regulate distances, and give a more spirited effect to the subject. You will also discover, after a little practice, that, by a gentle twist of the pencil, a fresh point or surface will come in contact with the paper, and with it a finer line may be drawn. Occasionally, by pressing harder on the pencil, an increase of power will be communicated to such parts as may require separation or additional spirit, as on the rude line which forms the foreground in fig. 10, and gradually on the pathway to the cottage door.

Suppose a scene to consist of two or more plans, as the remains of a castle on an irregular surface, with a mass of trees in front, and near it, as the principal or leading feature of the scene, an arm of the sea, and remote hills forming the background or distance, and a rude foreground. We shall suppose that a scene of this nature, as represented in fig. 11, can be conveniently visited. Commence by selecting a station that will present a variety of forms or opposition of character, such as lofty objects contrasted by small objects, which will prevent the appearance of equal heights or parallels, and also prevent the scene from being crowded or closed up. The castle toward one side of the picture, and the distance on the other, so as to form an irregular diagonal mass, are in better relief than if the building with the trees were more in the middle of the subject. The opposition of angular to circular forms produces a pleasing effect in a sketch, and should be observed. If the perpendiculars of a ruin be broken, the general appearance must be that of standing upright; for however mutilated towers or walls may be, there will still be evidences of their having been properly constructed. When these particulars shall have been considered, proceed to arrange the situation of the principal mass, by dotting on the edge of the sketch-book; and by faintly indicating the forms determine the horizontal line, observing that hills may appear far above; in fig. 11, it is at H on the extremity of the water, the station is at S, and consequently the point of sight at P, into which are drawn the visual rays, or lines which regulate the receding sides of the towers. These and the perpendiculars being arranged, they may be boldly sketched in, and the trees freely marked, in a character partaking of the semicircular; the fewer markings the better, for it is the useless separation of parts composing a mass that destroys the breadth and boldness of a sketch. The distant hills may be tenderly indicated with a fine point, and the foreground may be coarsely defined with a broad-pointed pencil, in order to detach it from the parts more distant. Here and there an additional spot or touch of the bold pencil may be given, to assist in preserving the gradations of distance.

The same object in nature will often present many excellent subjects for the sketch-book; even moving to a distance of fifty yards may present a scene of increased interest. Do not therefore fail to take advantage of such stations, and sketch an outline from each, in order to exercise the judgment by comparing the subject afterwards. It is also useful to ascertain how nearly the eye has determined the truth, by applying the rules of linear perspective to every sketch at the earliest convenience. Many advantages arise from two or three students sketching the same scenes in company, for various valuable remarks are thereby elicited, tending to the mutual benefit of the party. The sketch-book should be preserved complete, as containing records of advance in judgment and correctness of delineation.

In drawing from nature, as in penmanship, every person may be said to possess a *manner* of his own. Some draw stiffly, and others with remarkable freedom. You are recommended to catch the tone of those who form their sketches in a bold and free style, but by no means imitate any one. Your object ought to be to draw scenes with *natural truth and beauty*, regardless of all *mannerisms*. At first you can scarcely avoid drawing with a certain degree of formal stiffness, but animated by a desire to excel, and exercising taste and judgment, your practice will improve, and your sketches will not fail to meet with approbation. Whatever be the difficulties you encounter, others whose works you admire were at the outset equally embarrassed; for rest assured that in most cases in which great proficiency has been attained in the art of delineation, no small degree of trouble has been endured, and many failures have taken place, before the artist was finally successful.

Drawing Foliage.—To draw correctly the various kinds of trees, with their respective characters of foliage, requires the most careful study and frequent exercise from nature. In an elaborate work on Landscape Drawing, published by Leigh, London, the following remarks occur on the characters of foliage:—"When a tree is near the eye, the leaves are distinctly separated from each other; their particular form, the insertion of their stems into the branch, the perfection of their local colour, are all apparent. Remove this object to the second plan, the foliage assumes masses, retaining the character, but the tone is altered; the separation of parts is no longer evident, yet it is recognised as the object previously inspected. Remove it still farther from the eye, the masses assume a uniform tone, relieved by indications of light and shade, softened by the intervention of atmosphere. Remove this object still more distant, it is rendered indistinct, and forms a portion of the mass of light or shade in which it may be situated. Nature presents these appearances to every inquiring eye, and the mode of representing them must depend on the perseverance of those who delight in transcribing them into their sketch-books." This is so just, that the student might imagine the tree first inspected retiring gradually into indistinctness, and displaying, as it receded, the due portions of aërial effect. It also teaches how tenderly the outline must be expressed in extreme distance, how much more evident the marking may appear in the mid-distance, how much more defined the form becomes by light, shade, and markings, on the second plan, and how distinct the expression of character and power of touch ought to be, as they approach the eye or the foreground.

Fig. 12. The willow has been represented by perpendicular markings, terminating in a point, to give the idea of its pendant foliage. A broad mass of light is usually preserved, and an increase of markings is given to one side of each subdivision of foliage, with considerable power of characteristic markings on the shade-side of the tree, besides an occasional repetition of touch for effect.

The fir has been represented by short angular markings connected with each other, much like the zig-zag scratch with a pen to obliterate an incorrect word. These markings are continued in agreement with the projections of the branches, are repeated with increased power on the shade-side of the tree, and a few slight markings are given on the extremities, and beneath the masses, to indicate folinge on the farther side of the tree.

The elm has been represented by escalops in a semicircular direction, so distributed as to give the idea of thick foliage; the masses are separated by detached markings, indicating the same character, and their rotundity given by repetitions, with occasional increase of power. A few dots on the extremities will relieve the harshness of the outline, where the escalops are too evident or regular.

The oak has been represented, as in fig. 13, by a character which partakes of angular and broken circular markings, intermingled with dots and sharp touches. The lighter parts are pencilled tenderly, and the shade portions are repeated upon, with additional power given by sharp angular markings.

We mention these varieties for the purpose of showing that foliage is not to be represented by distinctly pourtraying every leaf, but by a bold grouping and superficial outlining; the purpose being served by merely a general representation. Suppose a tree is to be selected for placing in the foreground of a drawing, where its peculiarities are required to be displayed. Let the growth of the branches be observed; a straight line is rarely to be seen, nor do they spring from each other with uniformity; there is usually an undulating line, often graceful, or a wild luxuriance, ever pleasing, in these supports to the foliage. Let the effect of the leaves which may compose a principal mass be indicated, not the outline of a leaf or

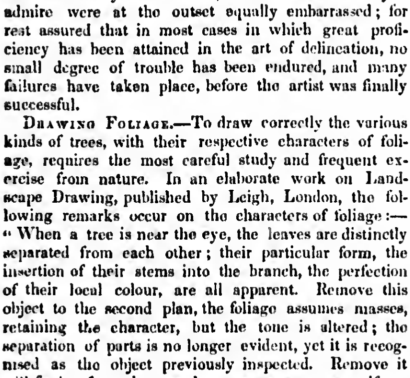


Fig. 12.

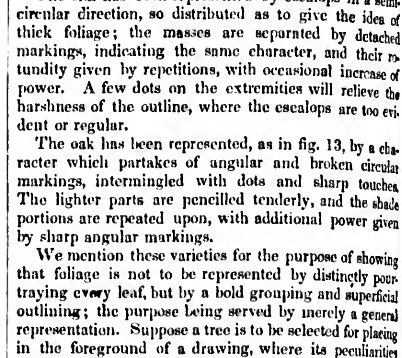


Fig. 13.

leaves, which would prove labour in vain, but what is seen as much by the imagination as the eye—that is, not the detail, but the effect. If too much regularity appear, destroy it by projecting a touch or two on the extremities, and attack any formality by additional markings, in conformity with the character adopted. Oftentimes the mere waving of the pencil, or a powerful repetition with the broad point, will not only remove a monotonous appearance, but communicate characteristic spirit and effect.

Experience has shown, that, while students could sketch the extremities of various branches of trees with good effect, they have felt embarrassed in giving a corresponding correctness to the mass, or masses of foliage, belonging to the same tree. This has arisen from not having duly considered that each mass required to be treated as a centre, from which the character should be spread towards its respective boundary, with such discrimination as to obviate all appearances of formality, and then, by the introduction of repetitions of markings and touches, to arrange the separate parts, so as to preserve but one central mass, however it might be situated. A few trials, with the observance of these particulars, will remove the difficulty. Sometimes the hues of nature in their variety may at a future time be added. The light and shade in Indian-ink cannot be thus used as a basis, because under colour it is injurious to transparency. The light and shade in bistre is rich in mass, powerful in touch, and susceptible of giving transparency, with a high degree of finish. Either may be adopted, as the succeeding hints will apply to one as well as the other. Cakes of Indian-ink, of bistre, or of neutral tint, may be had of the venders of colours for artists. They should be free from grit; and when they were well ground, and duly incorporated with gum and white sugar-candy, they will deposit no sediment.

Flower-Drawing.—In connection with the drawing of foliage and trees, we should particularly recommend the practice of flower-drawing. At first you may copy drawings or prints of flowers, with a view to catching the mode of delineation in groups; nature, however, in this, as in every thing else, must be your true school, and to that we direct your attention. We press this advice in a particular manner on young mechanics who are studying ornamental design with regard to their profession. No doubt, examples of ancient and modern ornament are of great value in this branch of drawing; but, as Mr. Hay justly remarks in his work on Colouring, "flowers are your best practice, as you will now have obtained freedom of execution. To those who have gained a facility in copying the beautiful forms which prevail in the vegetable kingdom, and who have had such instructions in the use of water-colours as may enable them to copy individual flowers with ease, I would recommend the acquirement of a thorough knowledge of the laws of harmonious colouring. They will then be able to group and arrange flowers in the most agreeable and effective manner in regard to colour, as their previous experience must have taught them to accomplish in combination of form.

"Dr. Ure says, that 'the modes in which taste is cultivated at Lyons deserve particular study and imitation in this country. Among the weavers of the place, the children, and all persons busied in devising patterns, much attention is devoted to every thing in any way connected with the beautiful, either in figure or colour. Weavers may be seen in their holiday leisure gathering flowers, and grouping them in the most engaging combinations. They are continually suggesting new designs to their employers, and are thus the fruitful source of elegant patterns.' Hence the French flower-patterns are remarkably free from incongruities, being copied from nature with scientific precision.

"All these facilities for the improvement of our fancy manufactures are within the reach of the most humble. The pursuit of such a course of study as I have endeavoured to point out, would not only augment their sources of innocent pleasure, but lead them to other instructive pursuits. The youth, in searching for the most graceful and picturesque plants in nature's most profuse and wildest productions, would be naturally led to commence the study of botany, for he would then have some interest in the inquiry. And it may be easily imagined with what avidity the more advanced would add to his knowledge of that pleasing science, or the gratification he would derive from the study and practice of horticulture.

"I need scarcely (continues this writer) point out the advantages to be derived from the cultivation of flowers by those engaged in designing ornamental patterns. The productions of a well-managed flower-garden to such would be, in my opinion, of more real utility, as objects of study, than the contents of the Louvre. In those productions of nature they will find the most exquisite beauty and elegance of form, and, even in single flowers, the most perfect combinations of colouring.

"In saying that the study of such subjects is of more utility to the ornamental designer than that of those great works of art which have been the admiration of ages, I do not mean to undervalue the benefit that any one, and especially the artist, may derive from studying works of this description. I am aware that 'the eye has its principle of correspondence with what is just, beautiful, and elegant, and that it acquires, like the ear, an habitual delicacy, and answers, with the same provisions, to the finest impressions. Being therefore versed in the works of the best masters, it soon learns to distinguish true impressions from false, and grace from affectation.' I have therefore not the least doubt that those who have risen to some degree of eminence as ornamental designers, would reap great benefit in attaining a knowledge of the various styles and subtleties of colouring, by carefully studying and copying, in masses of colour alone, the best works of art to which they can get access, and applying these arrangements to the particular figures of their patterns."

LIGHT AND SHADE—TINTING.

In every scene, during the presence of light, some parts fall immediately under the effect of the light, while others are thrown into shade. In art, advantage is taken of this mixture of light and dark parts, not only for the facility with which it enables the draughtsman to separate the parts of a scene, but for the agreeable effects which may be produced by the judicious association and distribution of the light and shade. In the representation of a round object, it is only by a careful disposition of the light upon the convex part, and the truth of the attendant reflected light and shadow, that the appearance of roundness is communicated. The means by which the effect of light and shade are to be produced by tints, are now to be described. First, with regard to the preparatory steps in the process.

Provide the best *hard* drawing-paper, which may be had of various size and substance. For subjects in which minute and fine delineation is required, the paper should be smooth on the surface; but when the subject is of a rural character, in which all the shagginess of nature is to be introduced, the paper should be of a rough description, for roughness of surface in such a case will assist in giving truth to the representation. Drawing-papers have frequently a greasiness of surface, which prevents a tint from being spread with evenness; the slightest infusion of gall into the water with which the tint is made, will remedy the defect; or the surface of the paper may be sponged with the gall and water before fastening it on the drawing-board.

A few camel-hair pencils must be provided; say two *flat inch tins*, to distribute a tint over a large space; two *swan-quills*, to wash in smaller spaces; and two *hen* *quills*, to pick in minute parts. The qualities of these denominations of hair-pencils are various. A bad one is far worse than a bad pen; with this it may be possible to write, but with a bad pencil every effort will be foiled. A proof of the quality may be made in the following manner, prior to purchase: When dipped in water, if it spring into a line with the quill, and retain its point, select it; if it spread into two or more points, reject it; and observe, that it is not requisite for a pencil to be touched two or three times on the edge of a vessel containing water, nor to be passed between the lips, since these might give a point to a bad one. Provide also a few small delf saucers, in which to mix the tints, and two cups or glasses, to contain water; one to be preserved pure, and the other in which the pencils are to be washed.

The tints may be made according to taste: from Indian-ink, a black; bistre, a brown; or neutral tint, a gray: they are alike capable of communicating smoothness and spirit. With reference to further advancement in the art, it is proper to state, that the light and shade of a landscape in the neutral tint, is a basis on which the hues of nature in their variety may at a future time be added. The light and shade in bistre is rich in mass, powerful in touch, and susceptible of giving transparency with a high degree of finish.

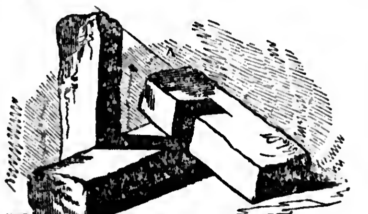


Fig. 14.

It may be observed, that the relief of an object depends on the just arrangement of the light, the due management of the half-tint and shade, with the proper introduction of the shadow.

Fig. 14 represents three rude stones full in the light, the line A showing the direction in which it falls. The shade-side of two, and the end of the third, show a play of light toward the lower parts, which is to be observed in nature. The shadow is marked stronger beneath, while that which is cast on the inclined stone is strongest at the base of the upright stone, and becomes lighter as it falls on the varying surfaces of the others.

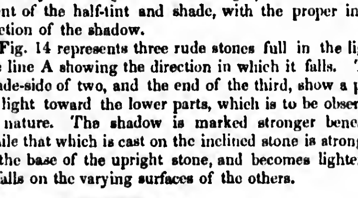


Fig. 15.

Fig. 15 represents an acorn dislodged from its cup. The illumination is from the left, and falls on the rotundity of the acorn, the greatest light being on the most prominent part. In this case, a slight portion of half-tint is placed along the upper edge, while the under side gradually approaches through half-tint to shade, and then softens into reflected light on the lower edge, which contributes to the character of smooth roundness, the power of the shadow beneath assisting in giving effect to the object. The light operates in the same manner on the cup, being cast on the advancing part of the hollow; its shade is cast on the receding part opposed to the light, on the same principle that the exterior of the cup is treated, while the shadow relieves the half-tint, as in the previous instance. These plain and circular objects are introduced to call the student's attention to such natural objects, in which it may be there observed how admirably the lights and shades are intermingled with half-tints, so as to obviate all harshness or violent opposition, while the shadows give a due effect, harmonizing the whole, and rendering the minutiæ worthy of the closest investigation.

Suppose you have made a sketch of such an object, at least six times the size of fig. 14, and that it is fastened down on the drawing-board; a few small saucers, and two vessels containing pure water, on the right hand near the pencils, with the window on the left, so that the sunshine does not fall on the drawing-board: Let a tint be made, according to the previous directions, from either of the cakes before mentioned, and of any strength the student may think proper. Mix it well with the pencil to be used, and always let that be rather larger than might seem to be required—say, a swan-quill. The pencil is properly charged for use when it has been stirred into the tint and gently touched, or passed two or three times on the edge of the saucer. This must be done carefully, because, if the pencil contain too much tint, there is a difficulty in spreading it neatly, and the edges will be hard. If the pencil contain too small a quantity, it will be impossible to spread the tint. If the space be large, it will require a little experience to keep the pencil equally charged with the tint.

Whatever may be the tint chosen, it must be washed over all the parts which do not receive the light. Thus, with the pencil charged with tint, as before described, commence at the top of the perpendicular stone, fill in the form, and proceed by slow motions downwards, so as to keep the floating or lower edge of the tint constantly being acted upon by the pencil, while it is distributing the tint neatly to the shapes required. The pencil must not be returned to repair omissions, as that would destroy the evenness of tint; the parts should be washed in with correctness at the first. The pencil may then be carried across the shadow to the shade of the flat stone and its shadow on the ground, with attention to the edges; then the upper surface of the diagonally-placed stone, with its shade and shadow. If these spaces be well washed in, they will appear of one uniform power of tint. When it is perfectly dry, strengthen the tint in the saucer by an addition of colour from the cake: this increase of power to the tint must be judged of by experience in its application over the tint first washed in. If the subject be examined, it will appear to consist of three gradations of tint; that which has been spread is the first, as on the upper surface of the diagonally-placed stone; the second gradation of tint appears on all the other shaded parts; and the third gradation is confined to the shadows. It may be noticed, that, if too much colour is added to the first tint, it would produce a harsh effect; and if too little is added, the effect would be deficient: in either case, the due gradation would not be observed. Experiments may be made on a piece of paper, till the proper strength of the tint has been ascertained; it may then be applied to the shades and shadows as before, but omitting the upper surface of the diagonal stone. When this is perfectly dry, the tint must be again strengthened to the third gradation of power, with the same precautions as before; and with it wash in the shadows, keeping the edges of this tint rather within the boundaries of the preceding.

Mass, Half-Tint, and Shade.—Suppose such a scene as fig. 11 to have been sketched, and you are disposed to give effect to the outline by a few tints. Consider under what circumstances of light it has been seen in nature, or under what circumstances it might be seen. Imagine it an evening effect, the sun having descended behind the broad mass formed by the castle and trees; these, on different broken surfaces, constituting the second plan; beyond which is a mid-distance, terminating in water and remote hills; the foreground composed of a rude mass, with rock and bushes interspersed. With this outline you are presumed to be familiar, and will perceive that, by placing the light behind the principal objects, an opposition will be established that must give a character to the whole. Thus, the principal will be in half-tint; the light brightest behind the castle, and gradually subdued along the distance; the foreground powerful, so as to relieve the half-tint of the principal, and oppose the distance; thus the gradations or keeping will be preserved, and effect given to the subject.

Attempt the subject first on a small scale to become acquainted with the process, and afterwards on one much larger, for improvement. With the first gradation of tint, as in the preceding cases, commence at the top of the tower, and proceed downwards by slow movements, so as to preserve the outline, sweeping the pencil round the masses of foliage, and covering all the second plan; continue the wash over the foreground, except the edge where the pieces of rock are situated; these may be omitted, to relieve the mass from the second plan. When the tint is dry, make the second gradation of strength, and wash over again the trees and the ground on which they are situated. Then begin on the left on the foreground, and wash over the mass till within a little of the lights which were left untouched with the first wash. In these lights, and in repetitions of wash towards them, be careful not to let any perpendicular shapes appear; any promiscuous irregularity of form will better express ruggedness of surface. When this is dry, reduce a little of the first tint with water, and wash it in the distant hills; then reduce the tint yet more, and with it wash in the space for the sky. As this may represent clouds, an even tint is not of material consequence; the pencil, therefore, should have less tint in it than usual. Begin at the angle on the left hand, and wash over the space, leaving such parts untouched as fancy may select, occasionally touching the extreme point of the pencil in the pure water, so that the tint may become still weaker as it approaches the part just above the castle. If this be well done, whatever may be the forms left untouched in the sky, the appearance will be that of a light or tender tint, getting gradually weaker in a diagonal direction towards the chief light behind the castle.

In this state the drawing would exhibit some effect, and might receive any additional washes or touches that may be suggested by the taste or the judgment of the student. After obtaining a knowledge of the distribution of the tints in their gradations, let the subject be drawn again considerably larger, and now investigate the general principle which regulates the proposed effect, and reflect on each particular part of the process, so as to comprehend the motive for every application of tint. When the tints are washed in, let the drawing be placed at some distance, where it can all be seen at once, without the surrounding objects interfering with the view. At this due removal which is regulated by the size of the drawing, the gradations of distance, and the keeping, will more clearly show their correctness or inaccuracy. If the drawing be large, the flat tints on the second plan will tamely express masses of foliage, or the union of many trees; and the castle will require some characteristic markings. The black-lead pencil may be used upon the tint to indicate a variety of form on the building, or to separate the mass into trees of various heights, and these will serve as guides for the introduction of repetition of wash or touch. This proceeding implies finish, and may be carried to the extent dictated by the judgment of the student; but it must ever be borne in mind, that breadth of effect is injured by every addition that disturbs a mass. Variety may be introduced, so as to attack a monotonous space or mass, without destroying it. Whenever it appears that more is required to complete the drawing, and the improvement is not suggested by a glance, desist immediately; put the drawing aside, and engage in something else. In a few days, on recurring to the subject, it will be seen with a fresh eye; new ideas will arise; a little will be added, or a little power will be reduced, so as to effect an improvement which no straining of the faculties in the former instance could have produced. A drawing may thus be subjected to frequent revision, and retouched as an advance in taste shall direct.

Suppose such a subject as fig. 10 be sketched, for the purpose of study, in breadth of light, the opposite of the last effect: let a tint be made less powerful than the first gradation—such a tint as might represent clouds that were not gloomy—and with it wash over the space for the sky, preserving the forms of the trees, and softening off the tint in a diagonal direction, so as to leave the light along the horizon, with the greatest breadth on the right. When dry, repeat a few washes on the angle towards the left and along the top, so as to produce a gradation of power from the top to the horizon, and it will give the effect of retiring or keeping. If the tint has not been washed in with evenness, endeavour to convert any conspicuous form into a cloud, by picking or filling in on its edges a corresponding tint, so as to make it form part of another more appropriate shape. Then, with that power of tint, considered as the first gradation, commence at a part not so high as the gable of the cottage, upon the trees, with an irregular form, distinct from a straight line, and continue the tint over the trees beneath, to the line of ground on which the cottage stands. Begin again at the lower part of the base beneath the cottage, and wash in the tint up to where the ground line before mentioned joins the boundary of the subject, and continue to wash in the tint, in agreement with the form of an indicated path to the cottage door, and so across to the mass of foreground and bush on the right. When all is perfectly dry, make the second gradation of power in tint, and wash over the lower portion of the trees close to the cottage, with the space before washed in, observing not to let it approach the edges of the previously washed tint, lest the shapes should appear harsh, particularly on the bush opposed to the light horizon. It must be observed, that the power which was required to separate masses in outline, ceases to be proper on the application of tint, as there is no decided outline in nature. With the tint of the second gradation, wash in the door, the window, the shade of the roof with its shadow, and the shade side of the chimney. Then, with the third gradation of power, wash in the foreground and the lower part of the bush, with the precautions before mentioned. When dry, place the drawing at a due distance, according to its size; and observe, if the effect be that of a cottage in a mass of light, that the gable end cannot properly receive the same degree of illumination as the roof and the side where the window is; it will therefore be proper to wash over it a tint that will keep it in its place. You must reflect, that, as the light is concentrated, by the illumination from the right being poured upon the cottage, its relieving mass of half-tint will be lighter than on other occasions; therefore, a tint lighter than the clouds will be sufficient to detach it from the brighter side, without destroying the mass of light in which the cottage is placed. As in the case of the preceding subject, any repetition of wash or touch that may seem to be required should be added, being careful to preserve the intended effect. A little practice will teach that the trees should be diversified with tender tints, so as not to destroy the mass of light; that the distant sea should be washed with a tint to relieve it from the horizon; that the ground on which the cottage stands may be broken or enriched with characteristic forms; and that the foreground may be touched with a power that shall judiciously detach it from the second plan.

In the examination of drawings, during the progress of retouching, if a part appear too light, or another part too dark, so as to produce the effect of *spottiness*, cover such part with the fingers, and imagine the appearance with any proposed alteration; if an improvement be suggested, at once adopt it, and examine again; always paying attention to preservation of the masses, on which both simplicity and effect depend. A drawing should be ascertained to have *one principal light*, while the subordinate lights diminish in brilliancy, in proportion as they are removed from the principal. Masses of shade should decrease in power of tint, conformable to their degrees of remoteness. These are essential to keeping and effect. Making-out or marking more than the respective distances require, touches which are inappropriate, or harshness of any description, are all departures from the principles of the art, and deviations from natural appearances. Although effects may be observed in nature at variance with these rules—such, for instance, as light scattered equally on the foreground and the mid-distance, or the whole scene being beneath a glare of sunshine, or in shade by the clouded state of the atmosphere—yet these are effects unsuited for pictorial delineation, because they are deficient in what constitutes beauty and attraction in the art.

You may have observed how essential a sky is in giving effect to a drawing. The great variety of forms, lights, half-tints, and shades, the storm, the distant falling shower, and other incidental effects, which the atmosphere presents to the view, should always be regarded with attention, not only because advantage may be taken of such diversity for powerful contrast, but because a well arranged sky is a beautiful portion of a landscape. The repetition of tender washes over each other may be justified only in the endeavour to obtain that tenderness and delicacy of tints which are conducive to faithful representation of clouds; for continuing to wash the same tint in successive applications, will produce an effect that is termed *woolly*, from its being deficient in that *sharpness* or spirit which is obtained by a few decided tints applied in just gradations. These varieties may be adapted to the nature of the scene, and may, by their judicious contrasts of form and tint, contribute very materially to the general effect of a subject, as in a stormy sky, bright horizons, and beams of light. The effect of moonlight may readily be given by strong tints, softened off in the circular direction of the moon, and repeated till the gradation is obtained; then give a wash over the whole sky. *Take out* the clouds to a half-tint by dabbing, and *take out* the moon to the clean paper, with crumbs of bread. A few catching lights on the clouds near the moon may be *taken out*, but made less bright than the moon.

HUMAN FIGURES.

A knowledge of drawing the human figure is to be gained by a careful study of the outlines of the different parts composing the trunk, limbs and members. All such integral portions of the human figure, if time and other circumstances permit, may be first studied from casts conveniently placed on the table, so as to give a facility to the hand in this department of sketching.* It must, however, be borne in mind, that exercises of this nature, under the guidance of a master, do not obviate the necessity for studying the human figure from life neither do they supersede the acquisition of a knowledge of figure-drawing on a small scale, for the purpose of ornamenting and giving effect to a scene from nature. The introduction of human figures is of considerable utility in drawing a landscape, in order to serve as a scale by which a spectator may know the probable measurements of objects near which the figures are situated; figures also give animation to a scene, and, by the touches of light or of dark which they justifiably offer, communicate valuable relief to a mass, or assist in the keeping of the subject.

There are several well-known rules with respect to the drawing of human figures; they are as follows.—

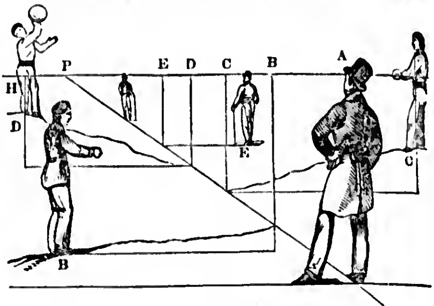


Fig. 16.

The height of a figure should be eight times that of its head; half its height is at the lower part of the body; a quarter of its height is at the knee. This division of the human figure can readily be put on the memory by the following method: Draw a perpendicular line, then divide it into eight equal parts; give one for the head, and, placing dots at each part in succession, give a second part for the breast, a third part for the centre of the abdomen, a fourth part for the lower portion of the body, a fifth part for the midway of the thigh, a sixth part just beneath the knee, a seventh part just beneath the calf of the leg, and the eighth part to the sole of the foot. The shoulders are two heads in width; the elbow is a head and a half from the shoulder; and the arm, with straightened fingers, is three heads and a half from the shoulder; that is, the fingers will reach down to the fifth division of the perpendicular. The measurements of the human figure, according to the highest standards of art, are exceedingly minute; but such are not necessary where a mere sketch of the form is required to enliven a landscape.

Fig. 16 exhibits the mode of ascertaining the heights of figures, wherever they may be placed in a scene, according to the rules of perspective. A is a figure on the base line; the eyes determine the height of the horizontal line H. Draw the visual rays from the head and feet of the figure A to the point of sight P, and the receding diminutions are determined, supposing the space to be a level surface. Where the situation of a figure is below the visual rays, as B, draw a parallel line from the feet of the figure towards the ray, and raise the perpendicular line B. Now, the measurement between the visual rays at B is the height of the figure required. When the situations of figures are above the rays, as at C and D, draw the parallels and the perpendiculars to their intersections beneath the elevations, and the measurements between the visual rays at C and D will give the respective heights of the figures required. The figure E being on a level with the base, a parallel line drawn from the lower ray will determine the height of a figure so situated.

* Stucco casts of figures and their subordinate parts may be had from different manufacturers of models of this description in London, Edinburgh, and other large towns.

PHOTOGENIC DRAWING.

Representations of landscape scenery have for many years been made by mechanical means, with the aid of the *camera lucida*, a species of box provided with a mirror and lens, in which the representations fall, and are therefrom copied by an attending artist into his sketch-book. The idea of fixing representations of this nature on the surface on which they fall, so as to save the trouble of copying, appears to have been entertained by ingenious men both in France and England; and at length the possibility of doing so was made known at Paris in the month of January, 1839. The discoverer was M. Daguerre, aided, however, by one or two other persons; and he was rewarded by the French government for making known the process which he pursued in the art, which was henceforth called Daguerreotype Drawing, or, as frequently, Photogenic Drawing (that is, drawing by the action of light).

The material on which photogenic drawing is performed is a thin and perfectly smoothed piece of copper coated with silver, and its preparation is a matter of extreme delicacy, for the surface must be rendered sensitive to the faintest shadows thrown upon it. Having been properly prepared by means of a spirit-lamp and the fumes of iodine, to give the silvered face a golden tinge, the plate is placed in the camera, a darkened box, and the focus adjusted. The camera being set in a position to catch the reflection of the object upon which the sun is shining, the aperture is opened, and the process of catching and retaining the reflection goes on of itself. A few minutes generally serve to give the representation. When taken from the camera, nothing is visible on the plate, and it must instantly, without any light being allowed to fall upon it, be placed in a box, and then subjected to fumes from mercury acted upon by a spirit-lamp. The formerly invisible figures are now developed. The next operation is to fix the images, by removing the coating of iodine, on which the light would still act. A saturated solution of common salt, filtered and warmed, or, what is better, a weak solution of hyposulphite of soda, not heated, some cold distilled water, and some warm distilled water, with two (sheet copper) troughs, are the chief materials required in this process. The plate, when removed from the mercurial box, is freed from the board attached to it, and plunged into one of the troughs, containing cold distilled water, care being taken not to touch the centre of the plate. It is again *immediately* removed, and plunged into the saline solution in the other trough, and, being laid there face upwards, is stirred about by means of a little copper-wire hook. The yellow tinge now leaves the plate; and when this is seen to have taken place, the plate is placed on an inclined plane (of japanned white iron), and distilled water, hot, but not boiling, poured freely over it. All these operations are but the work of a minute or two; and when the last is finished, the plate must be dried rapidly by blowing on it, and moving it in the air, else stains will be left on the drawing. After this, the drawing cannot be washed out; but rubbing, or the continued action of vapours, would destroy it.

In order to preserve the sketches from vanishing, a glass is put closely over them, and they are framed. When finished in a perfect way, the design on the plate is exquisitely beautiful, and though impressions of it cannot be multiplied as from a graven plate, it is in a perfect state for the engraver to copy, and he can do this with far more ease and correctness than in the case of ordinary drawings. There are no colours in the sketches. They show only a neutral tint, or dull shades relieved by lighter parts. And all, as a matter of course, are the *reverse* of the original. There are now several able practitioners of the art in London; and in Edinburgh, some very beautiful specimens of photogenic drawing of street scenes have been effected by Mr. Howe, miniature painter.

Various attempts have been made to adapt photogenic drawing to the sketching of miniature portraits from life; but, though likenesses are obtained, they have a dull, leaden hue, and the countenance has a death-like, unpleasant appearance. Besides, as the slightest movement of the head, while sitting, or even the winking of the eyes, causes derangement in the action of the sun's rays, all representations from life have less or more a *muzzy* or confused appearance. We have seen miniature likenesses taken on paper prepared for the purpose, instead of plates, but they wanted the liveliness and force of likenesses executed with the pencil. To all appearance, photogenic drawing will be limited in its utility to the taking of representations of buildings, or scenes in still nature, to be afterwards copied at leisure; the perfect faithfulness of the delineation being altogether unapproachable by artistic skill.

STUDY OF PAINTING AND SCULPTURE.

Drawing with black-lead pencils, chalk, or crayons, and Indian ink, constitute the first steps in a study of the fine arts. The more advanced studies refer to drawing in water-colours, paintings in oil-colours, and sculpture—three separate branches, individually followed as professions. It is not our intention to offer any instructions in these advanced departments of art, but to say only a few words as to the manner in which they are performed, and the advantages derivable from a contemplation of their varied products.

Drawings in water-colours are executed on thick hard paper, the outlines being lightly sketched with black-lead pencil. The colours are prepared in small oblong cakes; when required, a portion is rubbed down with water in a small saucer, and applied with a camel-hair pencil. Great care is necessary in laying on the respective colours; for the nature of the material wrought upon, and the transparency of the tints, prevent that freedom in rubbing out or obliterating one colour by another, which may be resorted to in oil-painting. For directions how to proceed, we refer to a small and accessible work on Water-Colour Drawing, by Mr. John Clark. (W. S. Orr & Co., London.)

Oil-paintings are executed on a variety of materials, but chiefly canvas, stretched on a frame; less frequently on wood, copper, and slate. The canvas or other material requires to be prepared with a coat of paint, to give it a smooth surface, and to prevent the absorption of the colours afterwards laid on. The colours are ground and prepared with fine nut, poppy, or linseed oil, and are ordinarily purchased by painters in bladder-bags, in a state ready for use. For convenience in using, a small portion of each colour required in the piece is placed on a thin oval board, called a *pallet*, which is held in the left hand, by passing the thumb through a hole at one extremity; the canvas frame is generally placed on a stand, called an *easel*, in front of the artist, and the colours are applied with brushes of fine elastic hair. The colours being opaque, the painter has the opportunity of retouching his work, by putting one colour over another, when the previous colour has been thoroughly dried. Oil-paintings are sometimes executed on walls and the roofs of buildings; but paintings of water-colours on walls are the most ancient. These, known by the name of *fresco* painting, are done while the surface of the plaster is moist, and admit of no retouching when the plaster dries. Specimens of fresco painting have been found in Herculaneum and Egypt, still, after thousands of years, maintaining their brilliant colouring.

The greater number of sculptures, ancient and modern, are executed in single blocks of white marble; a few are in bronze. A sculptor commences by drawing his design on paper; when satisfied with this, he pro-seeds to form a model of his proposed figure in moist clay, supporting it partly by irons and frame-work. Having, as he thinks, brought his model to perfection as respects attitude and surface, it is ready to form a copy to work from; but as it is a perishable material, he takes a cast from it in plaster, and this cast serves as a mould for a fac-simile model in plaster of Paris. The plaster cast being hard and durable, it is used as the permanent copy by the different workmen. The first operative employed on it, by means of a machine, takes off the rougher parts of the marble, and gradually diminishes the block in the required directions. The next is an able assistant, who brings the figure still nearer in form to the copy; and it lastly passes under the hands of the sculptor, who gives that tasteful finish and spirit which the nature of the subject requires. Statues in bronze are cast in moulds taken from finished models.

With respect to the advantages derivable from a contemplation of the higher objects of art, they may be defined as the education of the eye and of taste, which is of particular importance to the draughtsman.

Addressing ourselves again to the pupil—you will observe that nature, though truthful, is not always consistently beautiful or graceful. We see living human figures less or more deformed, some tall and slender, others short and ungainly, and a third class out of proportion in the different parts of their person. Now, to set about copying figures possessing any of these defects, would be absurd; and you must in all cases endeavour to imitate only what is allowed to be nearest to perfection. Taking mankind in the gross, exceedingly few individuals come up to any thing like a perfect standard. Fashions of dressing and habits of living, independently of original defects of form, conspire to throw the figure out of just proportion; so that a perfect man or woman, as respects bodily form and carriage, is practically out of the reach of all ordinary students. In London and elsewhere, there are *life* academies, in which draughtsmen study from the best-formed living figures that can be hired to exhibit themselves; and studies of this kind are indispensable for all who design following out the higher walks of art. Studies from sculptured figures are, nevertheless, desirable, because these are formed upon the highest ideality of grace, beauty, and perfection; and a contemplation of their exquisite proportions is believed to refine and discipline the tastes of the student. It is on this account that we append the present observations on this branch of the art.

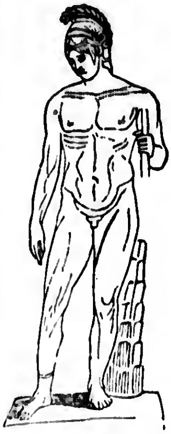
The figures which afford a recognised standard of perfection, are for the most part works of ancient Grecian art. The period in which the highest conceptions of personal perfection were formed, was during the administration of Pericles (about 440 years before the Christian era.) In this age flourished Phidias, the greatest sculptor of ancient or modern times, who raised art from a comparatively rude to a very high condition. With him commenced what is called the *ideal style* of sculpture, in other words, a style aiming at an exalted conception of simple truth and grace. The religion of the Greeks, which was the idolizing of deified heroes and heroines, offered the utmost scope for these lofty conceptions. His masterpieces were the figures of Pallas Athene and Jupiter, his Venus Urania, his Nemesis in the temple at Marathon, and his Amazon. He taught a number of others, among whom Alcamenes of Attica, and Agoracrites of Paros, were his favourite pupils. Both these sculptors executed several works which attained a high reputation. A contemporary was the famed Myron of Eleutheris in Bœotia, who represented highly finished athletic forms. His Runner, his Slinger, and his Pancratists, are celebrated. His ideal of Hercules completed this class of forms. His Heifer and his Sea-monster, are famous among his animal forms. But one thing was wanting to this great sculptor—grace of expression; in

Apollo Belvidere.

this he was surpassed by a rival sculptor, who adopted the undulating line of beauty, and first expressed the sinews and veins with accuracy. He created the ideal of Apollo in the position of an archer, who had just shot the serpent Python—the figure indicating in its expression a placid satisfaction and assurance of victory. This splendid work of art was found at Antium, the modern Capo d'Anzo, at the end of the fifteenth century. It was purchased by Pope Julius II., then a cardinal, and placed in that part of the Vatican called the Belvidere, whence it has been commonly named the Apollo Belvidere. The fore part of the right arm and the left hand, which had been destroyed, were restored by Angelo du Montorsoli, a pupil of Michael Angelo. The ease of the attitude and excellent proportions of the figure are universally admired. Our small outline engraving affords but an imperfect idea of the majestic original.

After the ideal style of Phidias and his disciples, succeeded the period in Grecian art distinguished for the *beautiful*. Praxiteles and Scopas were the great leaders of this improved style, in which beauty was united with grace. The most celebrated works of Scopas are his furious Bacchante—the head bending backwards, uniting the highest beauty with Bacchanalian frenzy; his Cupid, his Venus, and his Achilles, who is placed in a mournful attitude, contemplating as if lamenting the loss of his friend Patroclus. Praxiteles, the most feeling of all sculptors, created the perfect ideals of Diana and of Bacchus; the latter being designed by him as a contrast to the satyrs and fauns, whose figures express rudeness and licentiousness. The figure of Bacchus was soft and tender, without being effeminate, and expressed perpetual gayety and sport. He effected, also, the admired statue of a Satyr, and the ideal of Eros, or Cupid, which was that of a playful boy. Praxiteles was the first to represent Venus entirely naked, thus giving to the world a new ideal of the goddess. His most celebrated works are his Venus of Cos and of Cnidos; the former covered from the hip downwards, the latter entirely naked, holding her garment with her left hand over the bath. The group of Niobe is also ascribed to this master.

To the epoch which followed that of Praxiteles is usually ascribed the statue of Venus, styled the Venus de Medicis, from having been placed in the gallery of the Medici at Florence, after its discovery at Tivoli in 1695. It is of pure white marble, and measures, according to one authority, 4 feet 11 inches, and according to another 5 feet 2 inches, in stature. Some small portions have been restored. It is not ascertained who was the sculp-


Achilles.


Venus de Medicis.

tor of this exquisitely designed figure. The pedestal exhibits the name of Cleomenes; but the inscription is modern. It has been the object of the artist to represent Venus either as just coming from the bath, on the point of dressing herself, taken by surprise, and full of modesty, or as appearing before Paris for his judgment in the contest with Juno and Minerva for the prize of beauty. By many, the countenance is thought unintellectual, or at least unexpressive. The graceful waving lines of the body have never been surpassed: and, taken in different points of view, they offer a most advantageous study for ideal grace and beauty.

In this latter age, appeared Lysippus of Sicyon, Euthycrates, Apollodorus, and others, among whom stand pre-eminent Polydorus, father and sons, of Rhodes, who formed the celebrated group of Laocoon. A number of great works of this era were executed by Greek sculptors at Rome, to whom we are indebted for many busts of distinguished Romans.

Among the numerous ancient sculptures, which, like those already mentioned, have survived until modern times, and been preserved in museums, may be mentioned the following, as useful studies: The Dying Gladiator, a naked manly figure, reclining on his shield, his weapon broken, and expiring from a mortal wound in the side. The Three Graces, a group of female figures in different attitudes, calculated to show the symmetry of the form in various positions. Antinous, the figure of a graceful youth, in a simple attitude, expressive of melancholy, and executed with great correctness of proportion. Adonis, a figure somewhat more slender and elegant. Venus Genetrix, a figure draped, and possessing a noble simplicity of expression: the drapery, hanging in the most elegant folds, is in itself a study. Cleopatra, meditating in a reclining position. Laocoon, a group of figures, above referred to, consisting of a father and his two sons, struggling in the folds of serpents, and strongly characteristic of the distraction and suffering which may be conceived to be endured in that dreadful situation. Hercules, a figure expressive of robust muscular strength.

After a lapse of nearly ten centuries, the art of sculpture was revived in Italy, and thence spread to France and other modern nations. Germany has latterly produced various sculptors of eminence; among these may be mentioned Dannecker of Stuttgard, and Tieck of Berlin. Dannecker has executed, in pure white marble, a figure of Ariadne seated on a tigress, in an attitude of inexpressible elegance, and equal to the works of ancient art. It is contained in a private museum at Frankfort on the Maine. Thorwaldsen, a Danish sculptor, has likewise produced several works of striking grandeur and beauty; not the least imposing of his designs is the colossal figure of a lion carved in the solid rock at Lucerne in Switzerland. The animal is supposed to be dying from the effects of a wound from a spear, and reclining over a shield emblazoned with fleurs de lis: it is a monument emblematic of the fidelity of the Swiss Guards who perished in defending their master Louis XVI., on the 10th of August, 1792, from the brutality of the Parisian mob.

Canova, an Italian (born 1757, died 1822), has been justly esteemed the restorer of the graceful and lovely in sculpture. All his works display a surprising degree of softness and delicacy, and will form admirable studies to the young artist. His Cupid; Psyche, standing half dressed, with a butterfly; the repentant Magdalene; Hebe, smiling and animated; a Venus, partially draped; Beneficence (several figures); Graces rising from the bath—are only a few of the works by which Canova gained his great reputation. Modern sculpture has likewise been distinguished by various works executed in England, by Flaxman, Chantrey, Westmacott, Baily, and others. Modern art has almost reached the ancient in the figure of Eve at the Fountain, which is conceived in a style of pure simplicity and grace, with somewhat more intellectuality in the features than is generally to be found in the Grecian sculpture of female figures.

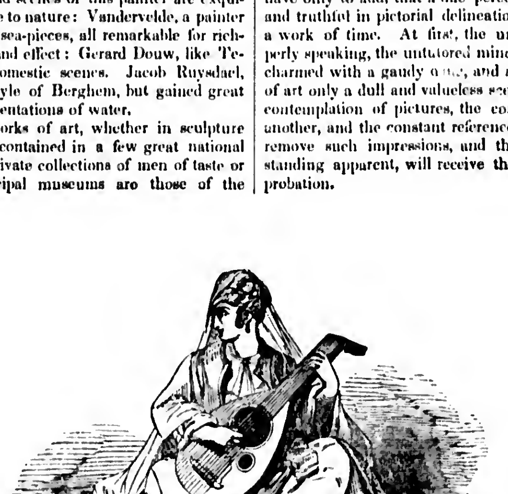

Eve at the Fountain.

Besides studying the manifold graces of ancient and modern sculpture, with the view of improving the taste in reference to figures, you are recommended to study the styles and compositions of the more celebrated painters, as nothing could be more suitable for imparting correct ideas respecting drawing, disposal of groups of objects, and colouring. Another great benefit will consist in making you feel your own deficiency, and how much you require to attain by diligent study. Painting, you will learn, has, since the revival of art, taken the character of *schools*, or peculiar styles, each of which has had its leaders and followers; for example, there is the Florentine school, commenced by Michael Angelo Buonarotti (born 1474, died 1564), who delighted in representations of the grand and terrible. The Roman school, of whom Raphael (1483–1520) was the head. The great characteristics of this school are, truthful representations of nature, a just expression of the passions, a chaste nobleness of design, and correctness of drawing. The Venetian school, headed by Titian (1477–1576), the characteristics of which were the harmony of colours, delicacy of tints, and a judicious contrast of light and shade. This school was improved by Corregio and Tintoretto. The German school, led by Albert Durer (1471–1528) and Holbein. The second Lombard school, distinguished by the works of the three Caracci (1555–1609). The French school, founded by Nicholas Poussin (1594–1665), Vouet, and Charles Le Brun. The Flemish school was founded by Peter Paul Rubens (1577-1640), whose design is dignified, his drawing of anatomy and perspective correct, and his colouring brilliant. The only objection to some of his figures is, that they are too heavy; and certainly they want the grace of those of Raphael. The Dutch school, ct which the most prominent painter is Rembrandt (1606-1668), is less distinguished for taste than the faithful adherence to nature.

The works of the eminent masters in these various schools were chiefly scriptural and historical; and scenes of a miscellaneous kind, embracing landscapes, figures, animals, sea-pieces, architecture, and other subjects, were painted by contemporary artists, who followed no particuar school. Among these great masters may be named Claude Gelee of Lorraine (1600-1682), whose landscapes are exceedingly beautiful, his colouring delicate, his tints tender, and his lights and shades unrivalled; Salvator Rosa (1615-1674), whose taste was for the wild, rugged, and romantic aspects of nature; Gaspar Poussin (1613-1675), whose pictures are grand, and remarkably true to nature. The sixteenth and seventeenth centuries produced the following masters, all of whose works are esteemed:—Paul Veronese, Guido, Carlo Muratti, and Spagniolletto—historical; Murillo (Spanish)—figures; Hobbima—landscape; Canaletti—buildings; and De Wit—the interior of churches. Vernet, a Frenchman of the eighteenth century, was celebrated for his sea-pieces and figures. In the course of the seventeenth century, Holland produced, but cannot be said to have encouraged, many distinguished painters. Among these are included David Teniers, celebrated for his representations of domestic and familiar scenes: Paul Potter, renowned for his cattle pieces, the most remarkable of which is his picture of a bull; it is contained in the royal museum at the Hague, and valued at £5000: Philip Wouvermans, noted for his landscapes, beautiful skies, and scenes with groups of figures hunting, or otherwise engaged in field sports: Berghem, also noted for his landscapes, his foliage, cattle finely drawn and coloured; the woodland scenes of this painter are exquisitely finished and true to nature: Vandervelde, a painter of naval victories and sea-pieces, all remarkable for richness of composition and effect: Gerard Douw, like Teniers, famed for his domestic scenes. Jacob Ruysdael, who painted in the style of Berghem, but gained great celebrity for his representations of water.

All the eminent works of art, whether in sculpture or painting, are now contained in a few great national museums, or in the private collections of men of taste or opulence. The principal museums are those of the Vatican at Rome, the Gallery of the Medici at Florence, the royal galleries at Munich (now the head school of painting and other fine arts in Germany), the Louvre at Paris, the British Museum and National Gallery in London, and the Royal Museum at the Hague. If at all within the means of young men desirous of pursuing professions in which taste in drawing is requisite, we strongly recommend them to visit the museum of the Louvre, which is rich in ancient sculpture and modern paintings; the sight of the many fine works of art in Paris would scarcely fail to inspire a high degree of refined taste. If unable to accomplish this desirable object, we advise you to pay occasional visits to any private collection to which you can gain admission, and also to exhibitions and museums open to the public. Among recent works of English art, generally accessible, the historical pieces of Haydon and Hilton, the historical and pathetic pieces of Allan, the grand architectural idealities of Martin, the church and other architecture of Roberts, the landscapes of Gainsborough, Calcott, Mulready, Thompson, and the Nasmyths, the animals of Landseer, the sea-views of Stanfield, Turner, and Williams, and the faithful delineations of humble life by Wilkie, and many other works of art which might be mentioned, will afford much pure pleasure and instruction, and show what can be accomplished by a cultivated observation, and a persevering desire to excel.

In the course of your observations you will learn, that in the delineation of human figures great care requires to be paid to historical costume and the fashion of artificial objects represented. A person who lived in the eighteenth century, for instance, should not be dressed as an ancient Roman; nor should the interior of a house of the fifteenth be decorated like one of the sixteenth century. On this account, every student of the fine arts requires to be well instructed in history, archaiology, and other branches of learning. With respect to statues, it is so important to give an easy and graceful effect, that a departure from exact costume is allowable, so far as to place a loose garment over or about the person. We have only to add, that a due perception of the beautiful and truthful in pictorial delineation must be in all cases a work of time. At first, the unpractised eye, or, properly speaking, the untutored mind, will perhaps be most charmed with a gaudy one, and see in the finest work of art only a dull and valueless scene. But the repeated contemplation of pictures, the comparison of one with another, and the constant reference to actual nature, will remove such impressions, and the work of true merit standing apparent, will receive the highest meed of approbation.



ARITHMETIC—ALGEBRA.

In the present and succeeding article, an attempt is made to convey to the comparatively unlearned mind some knowledge of Mathematical science, both as regards measurement by numbers (Arithmetic) and measurement of dimensions (Geometry). The sketch we offer of each is necessarily brief and imperfect; but our end will be gained if we afford that amount of information on the subject which is generally possessed by persons of moderately well-cultivated intellect.—*Ed.*

A recognition of the value of *numbers* is coeval with the dawn of mental cultivation in every community; but considerable progress must be made before methods of reckoning are reduced to a regular system, and a notation adopted to express large or complex quantities. An inability to reckon beyond a few numbers is always a proof of mental obscurity; and in this state various savage nations have been discovered by travellers. Some are found to be able to count as far as five, the digits of the hand most likely familiarizing them with that number; but any further quantity is either said to consist of so many fives, or is expressed by the more convenient phrase, "a great many." Among the North American Indians, any great number which the mind is incapable of distinctly recognising and naming is figuratively described by comparing it to the leaves of the forest; and in the same manner, the untutored Negro of Africa would define any quantity of vast amount by pointing to a handful of sand of the desert.

On the first advance of any early people towards civilization, it would be found impossible to give a separate name to each separate number which they had occasion to describe. It would therefore be necessary to consider large numbers as only multiplications of certain smaller ones, and to name them accordingly. This is, no doubt, what gave rise to classes of numbers, which are different in different countries. For instance, the Chinese count by *twos;* the ancient Mexicans reckoned by *fours.* Some counted by *fives*, a number which the fingers would always be ready to suggest. The Hebrews, from an early period, reckoned by *tens*, which would also be an obvious mode, from the number of the fingers of the two hands, as well as of the toes of the two feet. The Greeks adopted this plan; from the Greeks it came to the Romans, and by them was spread over a large part of the world.

NOTATION.

The representation of numbers by written signs is an art generally believed to have taken its rise after the formation of alphabets. One of the earliest sets of written signs of numbers of which we have any notice, is certainly the series of letters of the Hebrew alphabet which was used by that people—Aleph, beth, gimel, daleth, he, vau, zain, cheth, teth, standing respectively for the numbers one, two, three, four, five, six, seven, eight, nine. The Greeks directly adopted this plan from the Hebrews, forming their numbers thus:—1 alpha, 2 beta, 3 gamma, 4 delta, 5 epsilon—here having no letter corresponding with the Hebrew *vau*, they put in the words *επισημον βαυ* to denote six; after which they proceed with 7 zeta, 8 eta, &c. Before adopting this plan, they had indicated one by iota ι, probably because it was the smallest of their letters, five by Π (P) being the first letter of *pente*, five; ten by Δ (D) being the initial of *deka*, ten. After having for some time adopted the Hebrew plan, they divided their alphabet into three classes; the first ten letters expressing the numbers from one to ten, while twenty, thirty, forty, and so on up to a hundred, were signified by the next *nine*, ninety being expressed by a figure formed for the purpose, and resembling the Arabic 5 inverted. The remaining seven letters expressed 200, 300, 400, 500, 600, 700, 800; and for 900 there was another inverted figure. Larger numbers were represented by letters accented in various ways.

The Romans, from an early period, had a plan of expressing numbers, which seems to have been at first independent of the alphabet. The following clear account of it was given a few years ago by Professor Playfair:—"To denote one, a simple upright stroke was assumed |; and the repetition of this expressed two, three, &c. Two cross strokes X marked the next step in the scale of enumeration, or ten; and that symbol was repeated to signify twenty, thirty, &c. Three strokes, or an open square [, were employed to denote the hundred, or the third stage of enumeration; and four interwoven strokes M, sometimes incurved ⅭⅠↃ, or even divided CIↃ, expressed a thousand. Such are all the characters absolutely required in a very limited system of numeration. The necessary repetition of them, however, as often occasionally as nine times, was soon found to be tedious and perplexing. Reduced or curtailed marks were therefore employed to express the intermediate multiples of five; and this improvement must have taken place at a very early period. Thus, five itself was denoted by the upper half V, and sometimes the under half Λ, of the character X for ten; L, or the half of [, the mark for a hundred, came to represent fifty; and the incurved symbol ⅭⅠↃ, or CIↃ, for a thousand was put into IↃ, to express five hundred.

These important contractions having been adopted, another convenient abbreviation was introduced. To avoid the frequent repetition of a mark, it was prefixed to the principal character, and denoted the effect by counting backwards. Thus, instead of four strokes, it seemed preferable to write |V; for eight and nine, the symbols were ||X and |X; and ninety was expressed by X[. This mode of reckoning by the defect was peculiar to the Romans, and has evidently affected the composition of their numerical terms. Instead of *octodecem* [eight and ten—for eighteen], and *novemdecem* [nine and ten—for nineteen], it was held more elegant, in the Latin language, to use *undeviginti* [one from twenty], and *duodeviginti* [two from twenty].

But the alphabetical characters now lent their aid to numeration. The uniform broad strokes were dismissed, and those letters which most resembled the several combinations were adopted in their place. The marks for one, five, ten, and fifty, were respectively supplied by the letters I, V, X, and L. The symbol for a hundred was aptly denoted by C, which had originally a square shape, and happened, besides, to be the initial of the very word *centum*. The letter D was very generally assumed as a near approximation to the symbol for five hundred; and M not only represented the angular character for a thousand, but was likewise, though perhaps accidentally, the first letter of the word *mille*."—*Edin. Rev.* xviii. 193.

The Hebrew, improved Grecian, and Roman numerals, were perhaps sufficient to express any single number with tolerable precision; but it is easy to see that they must have been nearly unfitted for use in the process of arithmetic. The Greeks certainly contrived to overcome many obstacles in the business of calculation, and even could express fractions—though, from a practice of adding from left to right, and ignorance of the plan of *carrying* tens to the higher places, their problems were at all times awkward and complicated. The Romans, however, careless of old inconveniences, were still more awkwardly situated than the Greeks. Let any reader just suppose, for instance, even so simple a question as the amount of XLVIII added to XXXIV! It is evident that placing the figures below each other, as we do with the Arabic numerals, would serve little to facilitate such a calculation. In fact, the Romans were obliged, where mental calculation would not serve, to resort to a mechanical process for performing problems in arithmetic. A box of pebbles called *loculus*, and a board called *abacus*, constituted their means of calculation; and of these every schoolboy, and many other persons, possessed a set. The word calculation claims no higher descent than from *calculus*, a stone or pebble. The board was divided from the right to the left hand by upright columns, on which the pebbles were placed, to denote units, tens, hundreds, thousands, &c. The labour of counting and arranging the pebbles was afterwards sensibly abridged by drawing across the board a horizontal line, above which each single pebble had the power of five. In the progress of luxury, *tali*, or dies made of ivory, were used instead of pebbles; and afterwards the whole system was made more convenient by substituting beads strung on parallel threads, or pegs stuck along grooves; methods of calculation still used in Russia and China, and found convenient in certain departments of Roman Catholic devotion, and in several familiar games in more civilized countries. With such instruments, problems in addition and subtraction would not be very difficult; but those in multiplication and division, not to speak of the more compound rules, must have been extremely tedious and irksome. So disagreeable, indeed, was the whole labour, that the Romans generally left it to slaves and professional calculators.

The numerals now in use, with the mode of causing them by peculiar situation to express any number, and whereby the processes of arithmetic have been rendered so highly convenient, have heretofore been supposed to be of Indian origin, transmitted through the Persians to the Arabs, and by them introduced into Europe in the tenth century, when the Moors invaded and became masters of Spain. Such in reality appears to have been in a great measure the true history of the transmission of these numerals; but as it has been lately found that the ancient hieroglyphical inscriptions of Egypt contain several of them, learned men are now agreed that they originated in that early seat of knowledge, between which and India there exists more points of resemblance, and more traces of intercourse, than is generally supposed. In the eleventh century, Gerbert, a Benedictine monk of Fleury, and who afterwards ascended the papal throne under the designation of Sylvester II., travelled into Spain, and studied for several years the sciences there cultivated by the Moors. Among other acquisitions, he gained from that singular people a knowledge of what are now called the *Arabic numerals*, and of the mode of arithmetic founded on them, which he forthwith disclosed to the Christian world, by whom at first his learning caused him to be accused of an alliance with evil spirits. The knowledge of this new arithmetic was about the same time extended, in consequence of the intercourse which the Crusaders opened between Europe and the East. For a long time, however, it made a very slow and obscure progress. The characters themselves appear to have been long considered in Europe as dark and mysterious. Deriving their whole efficacy from the use made of the cipher, so called from the Arabic word *tsaphara*, denoting *empty* or *void*, this term came afterwards to express, in general, any secret mark. Hence, in more troublous times than the present, a mode of writing was practised, by means of marks previously concerted, and called *writing in cipher*. The Arabic characters occur in some arithmetical tracts composed in England during the thirteenth and fourteenth centuries, particularly in a work by John of Halifax, or De Sacrobosco; but another century elapsed before they were generally adopted. They do not appear to have settled into their present forms till about the time of the invention of printing.

It would be impossible to calculate, even by their own transcendent powers, the service which the Arabic numerals have rendered to mankind.

NUMERATION.

The Arabic numerals take the following well-known forms:—1, 2, 3, 4, 5, 6, 7, 8, 9, 0. The first nine of these, called *digits* or digital numbers, represent, each, one of the numbers between *one* and *nine*, and when thus employed to represent single numbers, they are considered as *units*. The last (0), called a *nought*, nothing or cipher, is in reality, taken by itself, expressive of an absence of number, or nothing; but, in connection with other numbers, it becomes expressive of number in a very remarkable manner.

The valuable peculiarity of the Arabic notation is the enlargement and variety of values which can be given to the figures by associating them. The number ten is expressed by 1 and 0 put together—thus, 10; and all the numbers from this up to a hundred can be expressed in like manner by the association of two figures—thus, twenty, 20; thirty, 30; eighty-five, 85; ninety-nine, 99. These are called decimal numbers, from *decem*, Latin for ten. The numbers between a hundred and nine hundred and ninety-nine inclusive, are in like manner expressed by three figures—thus, a hundred, 100; five hundred, 500; eight hundred and eighty-five, 885; nine hundred and ninety-nine, 999. Four figures express thousands; five, tens of thousands; six, hundreds of thousands; seven, millions; and so forth. Each figure, in short, put to the left hand of another, or of several others, multiplies that one or more numbers by ten. Or if to any set of figures a nought (0) be added towards the right hand, that addition multiplies the number by ten; thus, 999, with 0 added, becomes 9990, nine thousand nine hundred and ninety. Thus it will be seen that, in notation, the *rank* or place of any figure in a number is what determines the value which it bears. The figure third from the right hand is always one of the hundreds; that which stands seventh always expresses millions; and so on. And whenever a new figure is added towards the right, each of the former set obtains, as it were, a promotion, or is made to express ten times its former value.

1,	2	3	4	5	6	7,	8	9	0
Thousands of millions.	Hundreds of millions.	Tens of millions	Millions.	Hundreds of thousands.	Tens of thousands.	Thousands.	Hundreds.	Tens.	Units.

A large number is thus expressed in the Arabic numerals, every set of three from the right to the left hand being divided by a comma for the sake of distinctness.

The above number is therefore one thousand two hundred and thirty-four millions, five hundred and sixty-seven thousands, eight hundred and ninety. Higher numbers are expressed differently in France and England. In the former country, the tenth figure expresses billions, from which there is an advance to tens of billions, hundreds of billions, trillions, &c. In our country, the eleventh figure expresses ten thousands of millions, the next hundreds of thousands of millions, the next billions, &c. The two plans will be clearly apprehended from the following arrangement:—

ENGLISH METHOD.	FRENCH METHOD.
Units.	Units.
Tens.	Tens.
Hundreds.	Hundreds.
Thousands	Thousands.
Tens of thousands.	Tens of thousands
Hundreds of thousands.	Hundreds of thousands.
Millions.	Millions.
Tens of millions.	Tens of millions.
Hundreds of millions.	Hundreds of millions.
Thousands of millions.	Billions.
Ten thousands of millions.	Tens of Billions.
Hundreds of thousands of millions.	Hundreds of Billions.
Billions.	Trillions.
Tens of billions.	Tens of trillions.
Hundreds of billions, &c.	Hundreds of trillions, &c.

SIMPLE OR ABSTRACT NUMBERS.

There are four elementary departments in arithmetic—Addition, Multiplication, Subtraction, and Division.

Addition.

Addition is the adding or summing up of several numbers, for the purpose of finding their united amount. We add numbers together when we say, 1 and 1 make 2; 2 and 2 make 4; and so on. The method of writing numbers in addition, is to place the figures under one another, so that units will stand under units, tens under tens, hundreds under hundreds, &c. Suppose we wish to add together the following numbers—27, 5, 536, 352, and 275; we range them in columns one under the other, as in the margin, and draw a line under the whole. Beginning at the lowest figure of the right-hand column, we say 5 and 2 are 7—7 and 6 are 13—13 and 5 are 18—18 and 7 are 25; that is, 2 tens and 5 units. We now write the 5 below the line of units, and carry or add the 2 tens, or 20, to the lowest figure of the next column. In carrying this 20, we let the cipher go, it being implied by the position or rank of the first figure, and take only the 2; we therefore proceed thus—2 and 7 are 9—9 and 5 are 14—14 and 3 are 17—17 and 2 are 19. Writing down the 9, we proceed with the third column, carrying 1, thus—1 and 2 are 3—3 and 3 are 6—6 and 5 are 11. No more figures remaining to be added, both these figures are now put down, and the amount or sum of them all is found to be 1195. Following this plan, any quantity of numbers may be summed up. Should the amount of any column be in three figures, still only the last or right-hand figure is to be put down, and the other two carried to the next column. For example, if the amount of a column be 127, put down the 7 and carry the other two figures, which are 12; if it be 234, put down the 4 and carry 23.

```
  27
   5
 536
 352
 275
----
1195
```

For the sake of brevity in literature, addition is often denoted by the figure of a cross, of this shape +. Thus, 7+6 means 7 added to 6; and in order to express the sum resulting, the sign =, which means *equal to*, is employed, as 7 + 6 = 13; that is, 7 and 6 are equal to 13.

Multiplication.

Multiplication is a short method of addition under certain circumstances. If we wish to ascertain the amount of twelve times the number 57, instead of setting down twelve rows of 57, and adding them together, we adopt a shorter plan by which we come to the same conclusion. For ascertaining the amount of all simple numbers as far as 12 times 12, young persons commit to memory the following Multiplication Table, a knowledge of which is of great value, and saves much trouble in after-life:—

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

This table is so well known, that it is almost superfluous to explain that, when any number in the top row is multiplied by any number in the left-hand side row, the amount is found in the compartment or square beneath the one and opposite the other. Thus, 2 times 2 are 4, 5 times 6 are 30; 12 times 12 are 144.

The multiplying of numbers beyond 12 times 12 is usually effected by a process of calculation in written figures. The rule is to write down the number to be multiplied, called the *multiplicand*; then place under it, on the right-hand side, the number which is to be the *multiplier*, and draw a line under them. For example, to find the amount of 9 times 27, we set down the figures thus—

```
 27 (Multiplicand.)
  9 (Multiplier.)
---
243 (Product.)
```

Beginning with the right-hand figure, we say 9 times 7 are 63; and putting down 3 we carry 6, and say 9 times 2 are 18, and 6 which was carried makes 24; and writing down these figures next the 3, the product is found to be 243.

When the multiplier consists of two or more figures, place it so that its right-hand figure comes exactly under the right-hand figure of the multiplicand; for instance, to multiply 5463 by 34, we proceed as here shown. Here the number is multiplied, first by the 4, the product of which being written down, we proceed to multiply by 3, and the amount produced is placed below the other, but one place further to the left. A line is then drawn, and the two products added together, bringing out the result of 185742.

```
  5463
    34
------
 21852
16389
------
185742
```

We may, in this manner, multiply by three, four, five, or any number of figures, always placing the product of one figure below the other, but shifting a place further to the left in each line. An example is here given in the multiplying of 76843 by 4563.

```
      76843
       4563
-----------
    230,529
  4,610,58
 38,421,5
307,372
-----------
350,634,609
```

Multiplication is denoted by a cross of this shape ×: thus, 3 × 8 = 24, signifies, that by multiplying 8 by 3, the product is 24. A number which is produced by the multiplication of two other numbers, as 30 by 5 and 6, leaving nothing over, is called a *composite* number. The 5 and 6, called the *factors* (that is, workers or agents), are said to be the *component parts* of 30, and 30 is also said to be a multiple of either of these numbers. The equal parts into which a number can be reduced, as the twos in thirty, are called its aliquot parts. A number which cannot be produced by the multiplication of two other numbers, is called a *prime number*. When the multiplicand and multiplier are the same, that is, when a number is multiplied by itself once, the product is called the *square* of that number: 144 is the square of 12.

Subtraction.

Subtraction is the deducting of a smaller number from a greater, to find what remains, or the difference between them. We subtract when we say, take 3 from 5, and 2 remains. To ascertain what remains, after taking 325 from 537, we proceed by writing the one under the other as here indicated, and then subtracting. Commencing at 5, the right-hand figure of the lower and smaller number, we say, 5 from 7, and 2 remains; setting down the 2, we say next, 2 from 3, and 1 remains; and setting down the 1, we say, 3 from 5 and 2 remains; total remainder, 212

```
537
325
---
212
```

To subtract a number of a higher value, involving the *carrying* of figures and supplying of tens, we proceed as in the margin. Commencing as before, we find that 5 cannot be subtracted from 2, and therefore supply or lend 10 to the 2, making it 12; then we say, 5 from 12, and 7 remains. Setting down the 7, we take 1, being the decimal figure of the number which was borrowed, and give it to the 1,

```
8432
6815
----
1617
```

making it 2, and taking 2 from 3, we find that 1 remains Setting down the 1, we go to the 8, and finding it cannot be taken from the 4 above it, we lend 10 to the 4, making it 14, and then we say, 8 from 14, and 6 remains. In the same manner as before, adding the first figure of the borrowed number (1) to the 6, we say, 7 from 8, and 1 remains; thus the total remainder is found to be 1617. From these explanations, which apply to all calculations in subtraction, it will be observed, that when the upper figure is less than the figure directly under it, 10 is to be added, and for this *one* is carried or added to the next under figure.

Subtraction is denoted by a small horizontal line, thus — between two figures; as, for example, 9 — 5 = 4, which means, 5 subtracted from 9, and 4 remains.

Division.

Division is that process by which we discover how often one number may be contained in another, or by which we divide a given number into any proposed number of equal parts. By the aid of the Multiplication Table, we can ascertain without writing figures how many times any number is contained in another, as far as 144, or 12 times 12; beyond this point notation is employed. There are two modes of working questions in division, one long and the other short. Let it be required to divide 69 by 3: according to the long method, write the figures 69 as annexed, with a line at each side, and the divisor, or 3, on the left. The question is wrought out by examining how many times 3 is in 6, and finding it to be 2 times, we place 2 on the right side; then, placing 6 below 6, we draw a line and bring down the 9, and proceed with it in the same manner. The quotient is found to be 23.

```
3)69(23
  6
  —
   9
   9
```

But we take a more difficult question—the division of 7958 by 6. In commencing we find that there is only one 6 in 7, and 1 over; we therefore place the 6 below the 7, and subtract it, in order to bring out the 1. The 1 being written, we bring down the 9 to it, and this makes 19. There being 3 times 6 in 18, we place the 3 to the product (which in division is called the *quotient*, literally, How many times?) and 18 below the 19, leaving 1 over as before. To this 1 we bring down the 5, and trying how many sixes there are in 15, it appears there are only 2. We place 2 to the quotient, and 12 below the 15. This leaves 3 over, and bringing down 8 to the 3, we have 38, in which there are 6 sixes. Six sixes make 36; therefore, placing 6 to the quotient, and 36 below the 38, we find that there are 2 over. Here the account terminates, it being found that there are 1326 sixes in 7958, with a remainder of 2 over. In this question, 6 is called the *divisor*; the 7958 is the *dividend*, and 1326 is the *quotient*.

```
6)7958(1326
  6
  —
  19
  18
  —
   15
   12
   —
    38
    36
    —
     2
```

Skilful arithmeticians never adopt this long method of division; they pursue a plan of working out part of the question in the mind, called short division. They would, for example, treat the above question as here shown. The over number of 1 from the 7 is carried in the mind to the 9, making 19; the 1 from 19 is in the same manner carried to the 5; and the 3 from it is carried to the 8, leaving the overplus of 2.

```
6)7958
  ————
  1326–2
```

Division is denoted by the following character ÷; thus, 75 ÷ 25, signifies that 75 is to be divided by 25.

These explanations conclude the subject of simple or abstract numbers. On the substructure of the few rules in Addition, Multiplication, Subtraction, and Division, which we have given, whether in reference to whole numbers or fractions, every kind of conventional arithmetic is erected, because these rules are founded in immutable truths. Mankind may change their denominations of money, weights, and measures, but they can make no alteration in the doctrine of *abstract* numbers. That 2 and 2 are equal to 4, is a truth yesterday, to-day, and for ever; but as to how many pence are in a shilling, or how many inches in a foot, these are altogether matters of arbitrary arrangement, and the treatment of them forms an inferior department of arithmetical study, taking a different form in different countries: this *local* arithmetic, as we may call it, is comprehended in the term

COMPOUND NUMBERS OR QUANTITIES.

The calculation of the value of any number of articles, or a summation of values, in relation to money, would be comparatively simple, if the scale of money were constructed on a principle of decimals, or advancing by tens —as, for example, 10 farthings one penny, 10 pence 1 shilling, 10 shillings 1 pound. By making both weights and measures on the same plan, as, 10 ounces 1 pound, 10 pounds one stone, 10 stones 1 hundredweight; 10 inches 1 foot, 10 feet 1 yard, &c., ordinary calculations would be rendered exceedingly easy. Thus, if an ounce cost 1d., a pound would cost 1s., and a hundredweight would cost 100s. or £10; or, reversing the question, if we were asked £10 per hundredweight for any article, we should know in an instant that it was at the rate of 1d. an ounce. In short, the greater number of arithmetical calculations would be accomplished by little more than a momentary reflection, without the aid of pen or pencil.

This very convenient system of decimal arithmetic is established in France and Belgium, and it is there carried to a most enviable degree of perfection: as, for example, in money reckoning, the *franc* (equal to our 10d.) is the standard coin of account, and is divided into 100 parts called *centimes*. There is an equal simplicity in the money reckoning of the North American Union, in which the dollar (equal to our 4s. 3d.) is divided into 100 centimes; but as weights and measures are not on the same decimal scale, the advantage is of comparatively small moment.

In the United Kingdom, the pound or sovereign is the standard in money. It consists of a series of inferior coins, advancing irregularly from a farthing upwards; as, 2 farthings 1 halfpenny, 2 halfpence or 4 farthings 1 penny, 12 pence 1 shilling, 20 shillings 1 pound. While, therefore, the French compute values in money by francs and centimes, and the Americans by dollars and centimes, we compute by pounds, shillings, and pence; and to ascertain the value of irregular quantities in these irregular denominations of money, there is a complex set of rules to be obeyed; indeed, it may be said that the principal part of the time usually spent by youth at school on arithmetic, is consumed in learning to work questions in this arbitrary and local department of the science. We have only room to give a few examples in this species of computation.

L is the initial letter of the Latin word *libra*, a pound, and is used to denote pounds; *s* from the Latin word *solidus*, for shillings; and *d* from *denarius*, for pence: £ *s. d.* are therefore respectively placed over columns of pounds, shillings, and pence. The mark for a halfpenny is ½, for a farthing ¼, and for three farthings ¾. To find the number of farthings, pence, and shillings, in any number of pounds, we multiply by 20, which brings the pounds into shillings; next by 12, which brings the shillings into pence; and lastly by 4, which brings the pence into farthings, as, for example, Required the number of farthings in £5—we proceed as in the margin. The result is observed to be 4800 farthings.

```
   £5
   20
 ————
  100
   12
 ————
 1200
    4
 ————
 4800
```

Compound Addition.

In ordinary transactions of business, and making up of accounts, Compound Addition, that is, the addition of moneys, is principally required. In the margin is an account of sums to be reckoned up. The first thing done is to add together the halfpence and farthings on the right-hand side; and in doing so we throw all into farthings. Thus, 2 and 1 are 3, and 3 are 6, and 2 are 8, and 2 are 10. Ten farthings are 2 pence, and 2 farthings, or one halfpenny, over. We set down ½ for the halfpenny, and carry the 2 to the pence column; this being added, we find there are 31 pence, which make 2 shillings and 7 pence. We write down the 7, and carry the two shillings to the shillings column; adding them to the under figure at the right-hand side, we reckon up thus—2 and 2 are 4, and 5 are 9, and 7 are 16, and 4 are 20, and 2 are 22; we put down 2 aside, and carrying 2 to the second row of the shillings column, we find, on summing it up, that it amounts to 7; this 7 and the 2 set aside make 72 shillings, that is, £3, 12s.; 12, therefore, is written down under the shillings column, and the 3 pounds are carried to the pounds column, which is added up as in Simple Addition, making 320. Thus, the sum-total is £320, 12s. 7½d. All accounts in Compound Addition, referring to British money, are performed in the same manner. We recommend young persons to acquire facility in writing; and it will save much time if they learn to sum up the columns by a glance of the eye, without naming the numbers; for instance, instead of saying 2 and 2 are 4, and 5 are 9, and 7 are 16, and 4 are 20, and 2 are 22, acquire the knack of summing the figures in the mind, thus—2, 4, 5, 9, 16, 20, 22.

£31	12	7½
73	14	8½
69	17	5¾
87	15	6¼
57	12	3½
£320	12	7½

Compound Multiplication.

Questions in Compound Multiplication are determined in the following manner:—Having written down the number to be multiplied, place the multiplier under the lowest denomination, and proceed as in this example. We wish to multiply the sum of £37, 16s. 8¾d. by 6. We begin by multiplying the farthings by the 6; this makes 18 farthings, or 4½d. Setting down the ½, we carry the 4 to the pence, saying 6 times 8 are 48, and 4 are 52, which is equal to 4 shillings and 4 pence. Setting down the 4 pence, we carry the 4 shillings onwards, and multiplying 16 by 6 find 96, which, added to the 4 shillings, gives 100. This is equal to £5, so we set down 0, and carry the 5 to the 37. The amount is 227. The answer of the question is therefore £227, 0s. 4½d.

£37	16	8¾
		6
£227	0	4½

Compound Subtraction.

Compound Subtraction is performed as in the following question:—If we take £27, 17s. 8¾d. from £36, 14s. 5½d., how much remains? The first thing we are called on to do, is to take 3 farthings from 2 farthings or ½d., and as this cannot be done, we borrow a penny, or 4 farthings, and adding these to the 2 farthings, we have 6. We now take 3 from 6, and find that 3 remains, which is therefore written down. It is now necessary to account for the borrowed penny, and a means of doing this would be to consider the pence of the upper line of figures as so much less, or 4d. instead of 5d. It is found, however, to be the most convenient plan to add 1 to the pence of the lower line, which comes to the same thing. Adding 1 to 8, in this case, we have 9 to subtract from 5. As this cannot be done, we borrow 1s., which is 12d., and adding that 12 to the 5 makes 17, from which taking 9, there will remain 8, which is placed under the pence. The borrowed 1s. is also repaid by adding 1 to the 17, making thus 18 to be taken from 14; but as we cannot do this either, we borrow £1, which is 20s. Adding 20s. to 14 makes 34; then 18 from 34 leaves 16. This is placed under the shillings, and 1 is carried to the lower amount of pounds, which are then subtracted as in Simple Subtraction; thus, 1 to 7 is 8; 8 from 6, cannot, but 8 from 16, there remains 8; carry 1 to 2 is 3, and 3 from 3, nothing remains. Total sum remaining, £8, 16s. 8¾d.

£36	14	5½
27	17	8¾
£8	16	8¾

Compound Division.

Compound Division is performed as follows:—We wish to divide £87, 14s. 9¾d. into 7 equal parts. Dividing 87 by 7, as in Simple Division, the answer is 12, and 3 remain, that is, 3 pounds are over. We set down the 12, and taking the 3 which is over, we reduce it to its equivalent in shillings, that is 60; we then add the 60 to 14, making 74, which being divided by 7 gives 10 shillings, and 4 shillings over. Setting down the 10, we carry forward the 4; 4 shillings are 48 pence, which, added to 9, makes 57. This divided by 7 gives 8 and 1 penny over; a penny is 4 farthings; add to these the 3 in the dividend, thus making 7; 7 divided by 7 gives 1, that is ¼d. The sum desired, then, is £12, 10s. 8¼d.

£	s.	d.
7)87	14	9¾
12	10	8¼

If the divisor is a composite number—the product of two numbers individually not exceeding 12—we can divide first by one and then by the other, as follows: Divide £376, 11s. 1½d. by 63: 63 is a composite number; its component parts are 7 and 9 (seven nines are 63). The given amount, therefore, is first divided by 7, and the quotient, £53, 15s. 10½d., is divided by 9. The result is the same as if the original sum had been divided by 63. £5, 19s. 6½d. is the quotient.

£	s.	d.
7)376	11	1½
9)53	15	10½
5	19	6½

When the divisor is a prime number above 12, the work is in every respect similar to the former; but it is performed by long division, as in the annexed example:—Divide £484, 19s. 7¾d. by 73. The amount being written down as in long division of simple numbers, the pounds are first divided by 73: the answer is 6. The remainder 46 is reduced to shillings by multiplying by 20, and the 19s. in the sum we are dividing being taken in, makes together 939s., which, divided by 73, gives 12, and 63 of a remainder. These 63 shillings are now reduced to pence by being multiplied by 12, and the 7 being taken in, makes 763; this, divided by 73, gives 10, and 33 over, which, being reduced to farthings by being multiplied by 4, and the three taken in, makes 135; and this, divided by 73, gives one, and 62 over. The whole answer is £6, 12s. 10¼d. and a fraction $\frac{62}{73}$ over.

```
  £    s.  d.
73)484 19 7¾(6
   438
    46
    20
73)939(12
   73
   209
   146
    63
    12
73)763(10
   73
    33
     4
73)135(1
    73
    62
```

British Weights and Measures.

The working of accounts in weights and measures, as respects addition, multiplication, subtraction, or division, proceeds on principles similar to those which have now been explained. The only real difference is that, for example, in reduction, instead of multiplying by 20, by 12, and by 4, to reduce a sum to farthings, if the question refer to ordinary weights we multiply to bring out the number of hundredweights, 112 for pounds, and 16 for ounces. Suppose we wish to know how many ounces are in 15 tons: we multiply 15 by 20, and the result is 300, that is, 300 hundredweights; a hundred weight is 112 pounds, so we now multiply 300 by

112, and the result is 33,600 pounds; this multiplied by 16, the number of ounces in a pound, gives 537,600 ounces. In the addition of quantities, each denomination is set down in its own column, as in money, and the summation is made also as we add money, with the difference, that we carry forward ounces, pounds, or whatever it may be, to the next column. The mark *cwt.* is usually employed to indicate hundredweights, *lb.* pounds, and *oz.* ounces.

The following are the principal tables of weights and measures established by law in the United Kingdom, and hence called *imperial*. That which is entitled *avoirdupois weight* is the table in use for all ordinary purposes:—

I.—MEASURE OF LENGTH.

Inches.						
12	1 Foot.					
36	3	1 Yard.				
198	16½	5½	1 Pole or Perch.			
7,920	660	220	40	1 Furlong.		
63,360	5280	1760	320	8	1 Mile	

The hand = 4 inches; the English ell = 45 inches; the pace = 5 feet; and the fathom = 6 feet. The geographical degree = 20 nautical leagues, or 69,121 miles. In land measure, the chain of 100 links = 66 feet.

II.—MEASURE OF SURFACE.

Sq. Inches.					
144	1 Sq. Foot.				
1,296	9	1 Sq. Yard.			
39,204	272¼	30¼	1 Sq. Pole.		
1,568,160	10,890	1210	40	1 Rood.	
6,272,640	43,560	4840	160	4	1 Acre.

And 640 acres make 1 square mile.

III.—MEASURES OF CAPACITY.

1. *Solidity.*

1728 cubic inches = 1 cubic foot.
27 cubic feet = 1 cubic yard.
The ton measurement = 8 barrel bulk, or 40 cubic feet.

2. *Measure for Liquids, Corn, and Dry Goods.*

Cubic Inches.	Wat. lbs. av.						
8·665	5/16	1 Gill.					
34·659	1¼	4	1 Pint.				
69·318	2½	8	2	1 Quart.			
277·274	10	32	8	4	1 Gal.		
554·548	20	64	16	8	2	1 Peck.	
2218·19	80	256	64	32	8	4	
17745·5	640	2048	512	256	64	32	

4 pecks = 1 bushel; 8 bushels = 1 quarter.

The peck, bushel, and quarter, are used for dry goods only. There are, besides, the coom = 4 bushels, the wey or load = 5 quarters; and the last = 2 loads or 16 quarters.

According to the system introduced January 1, 1826, the imperial gallon contains 277,274 cubic inches, or 10 lbs. avoirdupois of distilled water at 62° Fahrenheit, the barometer being at 30 inches. Heaped measures (formerly used for dry goods) were abolished in 1835.

IV.—MEASURES OF WEIGHT.

1. *Avoirdupois.*

Troy Grains.						
27·34375	1 Drachm.					
437·5	16	1 Ounce.				
7000	256	16	1 Lb.			
98000	3,584	224	14	1 Stone.		
196000	7,168	448	28	2	1 Qr.	
784000	28,672	1,792	112	8	4	1 Cwt.
15680000	573,440	35,840	2240	160	80	20 — 1 Ton.

FLOUR WEIGHT.—1 Peck = 14 pounds; 1 boll = 140 pounds; 1 sack = 280 pounds, or 2½ cwt.; 1 barrel = 196 lbs.

2. *Troy Weight.*

Grains.			
24	1 Pennyweight.		
480	20	1 Ounce.	
5760	240	12	1 Pound.

This weight is used in weighing gold, silver, platina, &c. The fineness of gold is expressed in carats and grains, the pound or other weight being divided into 24 carats, and the carat into 4 grains. Thus the carat pound is the 24th part of the troy pound, or 10 dwts., and the carat grain the 96th part, or 60 troy grains.

In Beer Measure, the barrel contains 4 firkins, or 36 gallons; and the hogshead 1½ barrel or 54 gallons.

In Wine Measure, besides the gallon and its subdivisions, various denominations are used, as the butt, pipe, &c.; but these are now to be considered rather as the names of casks than as expressing any definite number of gallons. The *standard gauges* in trades are as follows:—Pipe of port, 115 imp. galls.; pipe of Lisbon, 117 do.; pipe of Cape or Madeira, 92 do.; pipe of Teneriffe, 100 do.; butt of sherry, 108 do.; hogshead of claret, 46 do.; aum of hock, 30 do.

Herrings are measured by the barrel of 26⅔, or cran of 37½ gallons.

Apothecaries' Weight.—20 troy grains make 1 scruple, 3 scruples make 1 drachm, and 8 drachms make 1 ounce. The ounce and pound are the same as in troy weight. This weight is used in medical prescriptions only.

The Scottish acre, formerly a standard in Scotland, and now abolished, consisted of 54937·15 imperial square feet; 23 Scots acres were very nearly equal to 29 imperial acres. The Scottish *choppin* was very nearly the English wine quart, and the *mutchkin* was rather more than the English pint. Previous to the Union with England, the Scottish money pound was equal to one shilling and eightpence English. Hence £100 Scots was equal to the sum of £8, 6s. 8d. in our present money.

French Weights and Measures.

As French weights and measures are now frequently referred to in literature, we think it proper to offer the following particulars on the subject.

The French system of weights and measures is established on a principle much more simple and unerring than that in use in England—the former is of universal application, the latter can never be any thing but local. The French unity of length and weight is based on an invariable dimension of the terrestrial globe, which is recognisable in all countries. It is independent of all extrinsic notions, such as gravity and the arbitrary subdivisions of duration, an advantage which the length of a seconds pendulum certainly does not present. The admeasurement of a fourth of the earth's meridian—an ideal circle going round the globe from pole to pole at right angles with the equator—constitutes the basis of the French system. The length of this fourth of the meridian is divided into 10,000,000 parts: a single ten-millionth part is the *metre*, or the unity of long measure. (A metre is equal to 39⅜ British inches.)

A square, measuring on each side 10 metres, forms the *are*, or the unity of the mensuration of surface. (40½ ares are nearly equal to one British acre.)

A cube, measuring on each of its sides one metre, constitutes the *stère*: used for dry measure.

A cube, measuring on each of its sides the tenth part of a metre, is the unity of volume. A vessel gauging such a cube, is the unity of liquid measures, and is called the *litre*. (A litre is equal to about a pint and three quarters, or nearly a quart, British measure.)

The weight of a cube of water, measuring on each of its sides the 100th part of a metre, is the unity of weight, and is called the *gramme*. A thousand grammes of pure water at its greatest density (about 40° of Fahrenheit's thermometer), are of course equivalent to the litre. (A thousand grammes, forming 1 kilogramme, weigh about 2¼ pounds British.)

These unities being often too great or too small for common use, they constitute the basis of new unities on the simple decimal principle. The names of these new unities are formed from Greek and Latin words. If to express multiplication of the original unity, Greek is used; if to express division of the original unity, Latin is used, or words slightly modified from it. The Greek words are *deka*, for ten, *hecto* a hundred, *kilo*, a thousand, and *myria* ten thousand. The Latin words are *decem* for ten, *centum* a hundred, and *mille* a thousand. These various words are placed before, or prefixed to, the principal unity. Thus, the *decametre* is equal to ten metres, and the *decimetre* is the tenth part of a metre; the *hectolitre* is equal to 100 litres, and the *centilitre* is the hundredth part of a litre; the *kilogramme* is equal to a thousand grammes, and the *milligramme* is, the thousandth part of a gramme.

The connection between these weights and measures will now be clearly seen. The *are* is the square decametre; the *litre* is the cubic decimetre; and the kilogramme is the weight of a litre of pure water at its maximum density.

The currency of the country being assimilated by decimal reckoning to the weights and measures, it may be safely averred that the whole world cannot produce a more simple and immutable plan of calculation than that now in use in France and in Belgium.

FRACTIONS.

Hitherto we have spoken only of whole numbers which in arithmetic are called *integers*. We have now to treat of fractions, or the parts into which integers may be broken. The more ordinary fractions of any single article or number are a half, third, quarter, &c.; but a number admits of being divided into any quantity of equal parts. All such fractions are called *vulgar fractions*, from their being common. It is the practice to write vulgar fractions with two or more small figures, one above the other, with a line between, as follows:— $\frac{1}{2}$ (one-half), $\frac{1}{3}$ (one-third), $\frac{1}{4}$ (one-fourth or quarter), $\frac{1}{8}$ (one-eighth), $\frac{4}{5}$ (four-fifths), $\frac{9}{10}$ (nine-tenths), and so on. In these and all other instances, the upper number is called the *numerator*, the lower the *denominator*.

It may happen that it is necessary to add together different fractions to make up whole numbers. In working all such questions, we must, in the first place, bring all the fractions into one kind; if we have to add $\frac{1}{2}$, $\frac{1}{4}$ and $\frac{1}{8}$ together, we make all into eighths, and see how many eighths we have got; thus, $\frac{1}{2}$ is $\frac{4}{8}$; then $\frac{1}{4}$ is $\frac{2}{8}$, that is 2 and 4, which make 6, and $\frac{1}{8}$ makes a total of $\frac{7}{8}$. The same plan is to be pursued in the subtraction of vulgar fractions.

It is necessary sometimes to speak of the tenths, hundredths, or thousandths of a number, and for this arithmetic has provided a system of *decimal fractions*. Where great exactness of expression is required, decimals are indispensable. It has been already shown that, in writing common numbers, the value of a figure increases by ten times as we proceed from right to left; in other words, we ascend by tens. Now, there is nothing to prevent us in the same manner descending by tens from unity. This is done by decimal fractions. We place a dot after unity, or the unit figure, which dot cuts off the whole number from its fractional tenths; thus 120·3 means 120 and 3-tenths of a whole; if we write 120·31, the meaning is 120 and 31-hundredths of a whole, that is, 31 parts in 100 into which a whole is supposed to be divided. If we go on adding a figure to the right, we make the fraction into thousands; as for instance, 120·315, which signifies 120 and 315 out of a thousand parts.

Tables of specific gravities, population, mortality, and many matters of statistics, are greatly made up of decimal fractions, and therefore it is proper that all should comprehend the principle on which they are designed. In many cases, it would answer the purpose to write the fractions as vulgar fractions; but there is a great advantage in reducing all broken parts to the decimal notation, for it allows of adding up columns of decimals all of the same denomination. Their great excellence, indeed, consists in the uniformity which they give to calculation, and the easy methods which, by these means, they present of pursuing fractional numbers to any degree of minuteness.

The method of reducing a vulgar to a decimal fraction is a simple question in division. For instance, to reduce $\frac{3}{4}$ to a decimal, we take the 3, and putting two ciphers after it, divide by 4, thus— $\frac{4)300}{\cdot 75}$; therefore, .75 is the decimal, or, what is the same thing, 75-hundredth parts of a whole are equal to the three quarters of a whole.

SERIES AND RATIOS OF NUMBERS.

A *series* of numbers is a succession of numbers that increase or decrease according to some law. Of the two kinds of series usually treated of in arithmetic, the simpler is one whose terms increase or decrease by some constant number called the *common difference*. This common difference or rate of increase is only *one*, when we say, 4, 5, 6, 7, 8; it is *two*, when we say 7, 9, 11, 13; and *four*, when we say 6, 10, 14, 18, and so on. Every advancement of this nature, by which the same number is added at every step, is called *arithmetical progression*. There is a different species of advancement, by which the last number is always multiplied by a given number, thus causing the series to mount rapidly up. Suppose 4 is the multiplier, and we begin at 2, the progression will be as follows:—2, 8, 32, 128, 512, 2048, and so on. It is here observed, that multiplying the 2 by 4 we have 8; multiplying the 8 by 4, we have 32; and multiplying the 32 by 4, we have 128, &c., till at the fifth remove we attain 2048. This kind of advancement of numbers is called *geometrical progression*. The very great difference between the two kinds of progression is exemplified in the following two lines, the number 3 being added in the one case and being used as the multiplier in the other:—

5, 8, 11, 14, 17,—Arithmetical Progression.
5, 15, 45, 135, 405,—Geometrical Progression.

In the case of arithmetical progression, as above or in any other manner exemplified, it may be noticed that the amount of the first and last term is always the same as twice the amount of the middle term; thus, 5 and 17 being 22, are equal to twice 11, or 22. The cause of this is, that as the numbers increase or decrease in equal degrees, the last number is just as much more as the first is less than the number in the middle; and the two being added, the amount must consequently be double the central number. The same rule holds good with respect to any two numbers at equal distances from the number in the middle. If the series be an even number, and do not possess a middle term, then the two terms nearest the middle (called the mean terms) must be added together; thus in the natural series from 1 to 24, 12 and 13 are the two nearest the middle, and one being added to the other makes 25, the sum of the first and last term.

In geometrical progression, each term is a factor of all the numbers or terms that follow, and a product of all that go before, so that there is an harmonious ratio pervading the whole. Each term bears an exact proportion to its predecessor, because the multiplier is the same. Supposing, as above, the multiplier to be 3, the term 15 is proportionally greater than 5, as 45 is greater than 15. In the technical language of arithmetic, as 15 is to 5, so is 45 to 15. To save words, such a proposition is written with dots, thus—15 : 5 :: 45 : 15. The two dots mean *is to*, and four dots mean *so is*. The same formula is applicable to any series of proportional terms, though not in continued proportion to each other.

In order to discover the ratio between any two terms, we divide the largest by the least, and the quotient is the ratio: 45 divided by 15 gives 3 as the ratio. By thus ascertaining the ratio of two terms, we are furnished with the means of arriving at the ratio of other terms. We cannot do better than explain the method of working out this principle in the ratio of numbers, by giving the following passages from the admirable *Lessons on Arithmetic*, by Mr. T. Smith of Liverpool. Taking the four regularly advancing terms, 15, 45, 405, and 1215, he proceeds—"Suppose that we had only the first three, and that it were our wish to find the fourth, which term bears the same proportion to the third as the second does to the first. The thing we have first to do, is to discover the ratio between the first and second terms, in order to do which, as before shown, we divide the larger by the smaller, and this gives us the ratio 3, with which, by multiplying the third term, we produce the fourth; or, let the three terms be these, 405, 1215, 5, and let it be our wish to find a fourth which shall bear the same relation to the 15 as 1215 does to 405. We divide and multiply as before, and the fourth term is produced. And in this manner, having *two* numbers, or two quantities of any kind, bearing a certain proportion towards each other, and a *third*, to which we would find a number or quantity that should bear a like proportion, in this manner do we proceed, and thus easily may we find the number we require."

Referring to the discovered ratio of 45 to 15 to be 3, or the fifteenth part—"Now (continues this author), what would have been the consequence had we multiplied the third term (405) by the whole, instead of by a fifteenth part of the second? The consequence would have been, that we should have had a term or number fifteen times larger than that required. But this would be a matter of no difficulty; for it would be set right at once and our purpose gained, by dividing the over-large product by 15. Let us write this process down: $405 \times 45 = 18225$, and $18225 \div 15 = 1215$,—which 1215 bears the same proportion to 405 as does 45 to 15. And this is the rule, when the terms are properly placed—*Multiplying the second and third terms together, and dividing the product by the first*: this avoids all the difficulties arising from the occurrence of fractions in the course of the process, and gives us, in all cases, any proportional terms we may require."

Rule of Three.

On the principle now explained, we can, in any affairs of business, ascertain the amount of an unknown quantity, by knowing the amount of other three quantities, which, with the unknown quantity, bear a proportional relation. The word *quantity* is here used, but any *sum of money* is also meant.

Let it be remembered, that the *ratio* of one number to another is the number of times that the former contains the latter; for example, the ratio of 6 to 3 is 2, that of 12 to 4 is 3, and that of 8 to 12 is $\frac{2}{3}$. When two numbers have the same ratio as other two, they constitute a *proportion*. Thus, the ratio of 8 to 6 is the same as that of 12 to 9, and the equality of these two ratios is represented thus:—

$$8:6 = 12:9, \text{ or } 8:6::12:9.$$

The following is the rule for stating and working questions:—Make that term which is of the same kind as the answer sought, the *second* or *middle* term. Consider, from the nature of the question, whether the answer should be more or less than this term; if *more*, make the *smaller* of the other two terms the *first*, and the *greater* the *third*; if the answer should be *less* than the middle term, make the *greater* of the two terms the *first*, and the *smaller* the *third*; then multiply the second and third terms together, and divide the result by the first term. The quotient found will be the answer to the question, and it will be found to bear the same proportion to the third term as the second does to the first. Suppose the question be this: If 3 lbs. of tea cost 9s., how many pounds may be purchased for 21s.?—state the terms, with the larger sum last. Should the question, however, be the reverse—If 7 lbs. of tea cost 31s., how much may be purchased for 3s.?—then the sum to be ascertained is less, and is put last. Suppose another plain example: If 10 men can execute a piece of work in 8 days, how long will 4 men take to do the same?

```
9 : 3 :: 21
          3
       9)63
       7 lbs.

21 : 7 :: 3
          7
      21)21
       1 lb.

4 : 8 :: 10
          8
       4)80
       20 days.
```

Such is the principle of working Rule of Three questions, whatever be their apparent complexity. If either the first or third term, or both, include fractional parts, they must be reduced to the denomination of the fractions before working: thus, if one be reduced to shillings, the other must be made shillings also; if to pence, both must be pence, and so on. If the middle term be also a compound quantity, it may either be reduced to its lowest term, before multiplying and dividing by the other terms, or you may multiply and divide by Compound Division and Multiplication.

If the middle term be reduced to its lowest term, the answer will be in that denomination to which it was reduced; thus, if it were brought to farthings, the answer would be in farthings; if to ounces, the answer would be in ounces.

Example.—If 2 cwts. 1 qr. 7 lbs. sugar cost £8, 14s. 4d., what will 14 cwts. 3 qrs. cost?

```
cwt. qr. lb.     L.  s.  d.     cwt. qr. lb.
 2    1   7   :  8  14   4   ::  14   3   0
 4              20                4
---             ---              ---
 9             174               59
28              12               28
---             ----             ---
259            2092              472
                                118
                                ----
                                1652
                                2092
                                ----
                                3304
                               14864
                              33040
                              -------
                        259)3455984(12)13343
                            259       --------
                            ---       20)1111.11
                            865       ----------
                            777        £55 11 11¼
                            ---
                             889
                             777
                             ----
                             1128
                             1036
                             ----
                              924
                              777
                              ---
                              147
                                4
                              ---
                          259)588(2
                              518
                              ---
                               70
```

Here, in order to make the first term a simple number, it is reduced to its lowest term, namely, pounds. The third term is therefore reduced to pounds also, that both may be alike. The second or middle term is reduced to its lowest term, pence. After multiplying and dividing, according to rule, the quotient is 13343 pence, which are brought to shillings and pounds. The remainder, 147, being further reduced to farthings, and divided by the first term, gives 2 farthings. The answer is £55, 11s. 11½d. $\frac{70}{259}$.

The following is a kind of question which often occurs in business:—A person is unable to pay his debts. He owes to A, £540, to B, £260, to C, £200, being in all £1000. On examining his affairs, it is found that he possesses property only to the value of £370. How, then, is this to be divided proportionally among the three creditors, so that each may receive a fair share? The way to arrive at an answer, is to work out each creditor's share as a distinct account. Thus, first, as to A's share:—The answer is £199 16s. Following a similar calculation, we find that B will receive £96, 4s., and C, £74. Another method of computation would consist in ascertaining how many shillings per pound the effects would yield. In this case we state the terms as annexed.—Answer 7s. 4¾d. ⅕, or a fraction more than seven shillings and fourpence three farthings in the pound. By allotting this rate of dividend to each creditor, their respective shares would be liquidated as above. Instead of dividing 7400 by 1000, the same result will be found if 74 be divided by 10.

```
   £         £       £
 1000  :   370  ::  540
                    370
                  -----
                  37800
                  1620         £   s.
             1000)199800(199  16
                  1000
                  ----
                  9980
                  9000
                  ----
                  9800
                  9000
                  ----
                   800
                    20
                 -----
            1000)16000(16
                 16000
```

```
   £         £       £
 1000  :   370  ::   1
            20
          ----
     1000)7400(7s. 4¾d. ⅕
          7000
          ----
           400
            12
          ----
     1000)4800(4
          4000
          ----
           800
             4
          ----
     1000)3200(3
          3000
          ----
          200/1000 = 1/5
```

Questions in arithmetic arise in which a sixth term is required, bearing a proportion to five terms already known. This, which involves what is called *Double Rule of Three*, is exemplified as follows:—If I give 16 men £45 for 28 days' work, what must I give, at the same rate, to 20 men for 35 days' work? The answer, according to the plan of working here shown, is £70, 6s. 3d.

```
 Men.     £      Men.
  16  :   45  ::  20
  28              35
 ---             ---
 128             700
  32              45
 ---             ----
 448             3500
                 2800        £  s. d.
           448)31500(70     6  3
               3136
               ----
                140
                 20
               ----
           448)2800(6
               2688
               ----
                112
                 12
               ----
           448)1344(3
               1344
```

Practice and Mental Arithmetic.

Under these names are comprehended short practical methods of working arithmetical questions, partly or wholly by the mind, or by the jotting of a few figures. Ordinary business questions are seldom solved by the Rule of Three, and principally by Practice or Mental Arithmetic. The kind of questions most commonly occurring are computations of the aggregate value of a certain number of articles at a certain price, and the adding of the whole together to find the sum-total. The plan usually adopted is to calculate the value of any number of articles by the nearest round sum, and then to apply the difference. For instance, a lady is buying a gown from a haberdasher; she has received 15 yards at 5½d. per yard; the haberdasher tells her in an instant she has to pay 6s. 10½d. He knows it is so by saying internally to himself—15 yards at 6d. would be 7s. 6d. then, if I take 15 halfpence, that is, 7½d., from the 7s. 6d., I find that 6s. 10½d. will remain.

Another principle followed in this practical arithmetic is to work by aliquot parts. By remembering that a penny is the 12th of a shilling, or the 240th of a pound; that 6s. 8d. is the third of a pound; that 3s. 4d. is the sixth of a pound, and so on, we are able to save much of the ordinary figuring. As an illustration, let it be required to find the value of 3567 articles at 3s. 4d. each. By the usual rules of arithmetic, this question would be performed by multiplying the 3567 by 40 (there being 40 pence in 3s. 4d.), and then dividing by 12 to bring it into shillings, and by 20 to bring it into pounds. The practical method is much shorter; 3s. 4d. being the sixth of a pound, if we divide 3567 by 6, we at once obtain the amount, thus—

```
6)3567
 £594, 10s.
```

Interest.

Interest is an allowance for the use of money, paid by the borrower to the lender. The amount of allowance on £100 is called the *rate of interest*. The amount of money lent is styled the *principal*. In the United Kingdom, it is customary to reckon the interest at a certain rate per hundred pounds per annum, or for the whole year. The hundred pounds, for shortness, is called *cent.*, a contraction of *centum* (Latin), a hundred. If the money is lent for a less term than a year, then it becomes a question in arithmetic what is the proportion of interest chargeable. According to the existing laws (1842), £5 per cent. is the highest legal interest that is chargeable on money lent in any other form than by a bill or promissory note. The interest, commonly called *discount*, that may be taken for advances on bills or promissory notes, is left unlimited. In general, it varies from about 4 to 6 per cent., according to the state of the money market or trustworthiness of the borrower. £5, being equal to 100 shillings, the interest on £1 for a year at 5 per cent. is consequently 1s.; and if the interest be £2, 10s., or 2½ per cent., the charge will of course be 6d. per £1. This is so very simple a matter of calculation, that interests of 5 or 2½ per cent. per annum may in most instances be calculated mentally, or at least with a few figures. When the interest is 3, 3½, 4, or 4½ per cent., and for a less period than a year, the calculation is more complex, and will require to be wrought as a question in Rule of Three, or the amount may be determined by an appeal to Interest Tables.

The following is an example of the mode of working a question of interest for a whole year. What is the amount of interest payable on £649, at 4½ per £100 or per cent. per annum?

```
  £      £       £
 100  :  4½  ::  649
                  4½
                ----
                2596
                 324-10        £  s. d
          100)2920-10(29     4  1⅕   Or shorter, as under—
              200                      £
              ---                     649
               920                     4½
               900                    ----
               ---                    2596
                20                     324-10
                20                    --------
              ----                    29,20-10
          100)410(4                      20
              400                      ----
              ---                      4,10
               10                        12
               12                      ----
              ----                     1,20 = £29  4  1⅕
          100)120(1
              100
              20/100 = 1/5
```

Interest on broken periods is not calculated by calendar months, but for days—the exact number of days from the day of lending to the day of paying; and therefore the calculation of the number of days is an important preliminary in the transaction. Bankers and merchants, to save the trouble of calculation, appeal to a table which shows the number of days from one day to another in the different months of the year.

When the period consists of less than a year (365 days), multiply the principal by the number of days, and by twice the rate, and divide by 73000. (We get this 73000 by multiplying 365 by 2 and by 100.) For example —What is the interest of £235, 10s. for 28 days, at 3 per cent. per annum? Here, for convenience, we begin by multiplying by 7 and by 4, instead of 28. The 6 is twice the interest, 3.

	£	s.		
	235	10		
		7		
	1648	10		
		4		
	6594	0		
		6	s.	d.
73000)	39564	0	(10	$10\frac{134}{1825}$
	20			
	791280			
	730000			
	61280			
	12			
	735360			
	730000			
	$\frac{5360}{73000} = \frac{134}{1825}$			

When partial payments are made, it is necessary to deduct them from the principal, care being taken not to confuse principal with interest. The following is a rule to follow in such a case:—Calculate the interest on the principal up to the time at which the first partial payment is made, and add it to the principal; from this sum subtract the money paid, and the remainder is a new principal; compute the interest on this principal from the time of the first payment up to the time of the second payment, add it to the latter principal; from the sum subtract the second sum paid, and the remainder is again a new principal; and continue this process till the last payment.

MENSURATION.

Mensuration refers to the measurement of objects, and is of three kinds—*lineal*, or measuring by mere length; *superficial*, which respects breadth as well as length; and *solid*, which includes, length, breadth, and thickness. In the United Kingdom, the foot of twelve inches is the common standard of measurement. A draper measures cloth with a rod of three feet or one yard, and workmen usually measure the dimensions of walls, or the superficies of apartments, by a ribbon marked in feet and inches. In common usage, the inch is divided into eighths and sixteenths.

As lineal measurement requires no explanation, we pass to a consideration of superficial measurement, or that of both length and breadth. A *superficial foot*, which is the basis of this kind of measurement, is either a square of a foot in length and a foot in breadth, in other words, a foot each way, or it is any dimension in which the length multiplied by the breadth will form a foot. For example, the surface of a piece of wood, 2 feet in length and 6 inches in breadth, is a superficial foot. A superficial foot is generally called a square foot, and is a superficies consisting of 12 times 12, or 144 square inches. Sometimes the term *square feet* is confounded with that of *feet square*, which is quite a different thing. A piece of cloth said to measure six square feet, consists of six squares of a foot each; but a piece said to measure *six feet square* would be six feet along each side, and comprise thirty-six squares of a foot each. Inattention to these distinctions has often led to awkward errors and disputes.

The method of finding the superficial contents of any oblong surface, is to multiply the length by the breadth; but other points require attention in the calculation. To arrive at exactness, the inch is reckoned to contain 12 seconds or parts each second contains 12 thirds, and each third contains 12 fourths. Feet multiplied by feet, give feet; feet multiplied by inches, give inches; feet multiplied by seconds, give seconds; inches multiplied by inches, give seconds; inches multiplied by seconds, give thirds; seconds multiplied by seconds, give fourths. *Rule* for working questions—1. Write the multiplier under the multiplicand, feet under feet, inches under inches, seconds under seconds, &c. 2. Multiply each denomination of the length by the feet of the breadth, beginning at the lowest, and place each product under that denomination of the multiplicand from which it arises, always carrying 1 for every 12. 3 Multiply by the inches, and set each product one place farther to the right hand. 4. Multiply by the seconds or parts, and set each product another place toward the right hand. 5. Proceed in this manner with all the rest of the denominations, and their sum will be the answer.

Example.—Multiply 6 feet 3 inches by 3 feet 2 inches. In working, we begin by multiplying the 3 inches by 3, and then the 6 feet also by the same 3 below it; this gives 18 feet 9 inches. This makes 18, 9. We now multiply by the 2 inches, placing the 6 one remove to a side. By then multiplying the 6 by 2, we have 12 inches or 1 foot, and setting down the 1 below the 18, we add up. The answer is 19 feet, 9 inches, and six seconds. Questions of this kind may also be wrought by decimals.

Ft	in.	
6	3	
3	2	
18	9	
1	0	6
19	9	6

To measure the *solid* contents of an object, a different process is pursued. Suppose we take a piece of wood measuring a square foot, and cover it with dice, each die an inch square and an inch high, the wood will be covered with exactly 144 dice. Let us now put a second layer of dice on the first, and the number will be doubled, or 288 dice; and if we thus go on adding layer above layer till we have 12 layers, the number of dice will be finally 12 times 144, or 1728 dice; in other words, we shall have formed a cube consisting of 1728 solid inches. Such is solid measure.

Solid measure is computed arithmetically, by multiplying the length by the breadth, and the product by the thickness. Civil engineers, who require to calculate the solid contents of masses of earth, with a view to excavation, resort to this simple rule; it is likewise followed by builders in reference to walls, plumbers to cisterns, and other artificers. The following is a question not unlikely to occur. Required the contents of a cistern 9 yards 2 feet in length, 6 yards 2 feet in breadth, and 4 yards 2 feet in depth. Analyze these dimensions—9 yards 2 feet are 29 feet; 6 yards 2 feet are 20 feet. Multiply the 29 by 20, and then multiply by 14 (14 feet being equal to 4 yards 2 feet); next divide by 27, which is the number of solid feet in a solid yard. The question is thus wrought in the margin. The answer is seen to be 300 yards 20 feet.

	29
	20
	580
	14
	2320
	580
27)	8120
	300 y. 20 f.

EVOLUTION.

The extraction or discovery of the square and cube roots of numbers, forms a department of arithmetic called *Evolution*, and is useful in some kinds of measurement. In the following table, the squares, cubes, and fourth and fifth powers of the nine units are given. The square of any number, it will be observed, is gained by multiplying the number by itself; the cube, by multiplying the square by the number; the biquadratic by multiplying the cube by the number; and the sursolid by multiplying the biquadratic by the number:—

Root, or 1st power, -	1	2	3	4	5	6	7	8	9
Square, or 2d power,	1	4	9	16	25	36	49	64	81
Cube, or 3d power, -	1	8	27	64	125	216	343	512	729
Biquad., or 4th power,	1	16	81	256	625	1296	2401	4096	6561
Sursolid, or 5th power,	1	32	243	1024	3125	7776	16807	32768	59049

The powers of numbers are usually expressed by adding a small figure to them; thus, 3^2 signifies the second power or square of 3, that is, $3 \times 3 = 9$; 3^3 signifies the third power or cube of 3, or $3 \times 3 \times 3 = 27$. The small figure thus added is called an *index* or *exponent*, because it indicates or exposes to view the powers of the quantity to which it is affixed. The square root of any small quantity may easily be ascertained by means of the multiplication table; for instance, 6 is at once seen to be the square root of 36, because $6 \times 6 = 36$; but when larger numbers occur, it is requisite to have recourse to another process.

Supposing it were required to find the length of the side of a square which contains 59,049 square inches on its surface, it is evident that it cannot at once occur to the mind what number, by being multiplied into itself, produces this quantity. It is therefore requisite to find the square of one part of the number, and then the square of the other part. To effect this, the whole number is divided into parts, by a dot being placed over each alternate figure, beginning at the unit. The reason for thus separating it into periods of two figures each, is because the square of a single figure never consists of more than two places, the square of a number of two figures of not more than four places, &c.

After the whole number has been thus divided, the root whose square comes nearest to the first period must be placed in the quotient, and its square subtracted from the first period. Thus, 5 being the first period, 2, as being the root of 4, is placed in the quotient, and the square of 2 ($2 \times 2 = 4$) is subtracted from 5, because 5 here forms the first period. The next period (90) is then annexed to the remainder for a new dividend. The root is doubled for a divisor, and after ascertaining how often it is contained in the dividend, omitting its last figure, the result (4) is placed both in the quotient and also in the unit's place of the divisor; the whole number (44) thus formed, must be multiplied by 4, and the product must be subtracted from the dividend. The same process must be repeated until there is no remainder, and the quotient will contain the root sought, which in this case is 243.

```
      59049(243
      4
  44) 190
      176
 483) 1449
      1449
```

The rule for extracting the cube root is equally tedious, and indeed almost too complex for practical purposes. The methods of extracting the roots of higher powers are so complicated, that they are usually omitted in arithmetical works. The 4th, or biquadratic root, may be ascertained by extracting the square root twice, because it is the square root of the square root. The 6th root is the square root of the cube root, or the cube root of the square root.

The 8th root, being the square root of the biquadratic root, may be found by extracting the square root three times. In the same way the 9th root may be called the cube root of the cube root, and may be found by extracting the cube root twice. But the common arithmetical operations furnish no method of obtaining the 5th, 7th, 10th, 13th, 14th, 15th, 17th, 19th, 20th, and most other roots; and this part of arithmetic continued, therefore, involved in practical difficulties, until the invention of logarithms.

LOGARITHMS.

Logarithms (from two Greek words, signifying the number of the ratios or proportions) is a branch of arithmetic of comparatively modern invention, the discoverer having been John Napier of Merchiston, near Edinburgh, in the early part of the seventeenth century. The principles upon which logarithms are founded, may perhaps be rendered familiar by the following illustration:—Supposing that 1 is the first term of a geometrical progression, and that the ratio or multiplier is 2, the terms stand in the following manner:—

1	is the first term.	
2	..	ratio.
4	..	square of the ratio.
8	..	cube of the ratio.
16	..	4th power of the ratio.
32	..	5th power of the ratio.
64	..	6th power of the ratio.

All this might, however, have been conveyed far more concisely by substituting signs for words, thus—

1	..	2^0
2		2^1
4	.	2^2
8	.	2^3
16	..	2^4
32	.	2^5
64	..	2^6

It is evident that this might have been expressed still more concisely by omitting the number signifying the ratio (2) throughout, retaining only the indices or exponents, they alone being sufficient to indicate the degree of power to which the ratio is raised in each term. Exponents thus placed in order, opposite to a series of numbers in geometrical progression, are, as we have said, called Logarithms, or, literally, *number of the ratio*.

The most tedious sums in multiplication can, by means of logarithms, be solved simply by addition. For instance, if it were required to multiply 256 by 32, it would merely be requisite to add the logarithms standing opposite to those two numbers—their sum (13) stands opposite the product required, namely, 8192:—

Num.			Log.	Num.			Log.
1	..	..	0	128	..	..	7
2	..	..	1	256	..	..	8
4	..	..	2	512	..	..	9
8	..	..	3	1024	..	..	10
16	..	..	4	2048	..	..	11
32	..	..	5	4096	..	..	12
64	..	..	6	8192	..	..	13

Again, to multiply 128 by 16, we take the 7th + 4th, or 11th power of 2, because 128 is the 7th and 16 the 4th power of 2; opposite to the sum of 7 and 4 (11) is 2048, equal to the result of the multiplication of the two numbers. This also affords a quick and easy method of dividing one number by another; thus, if it be required to divide 4096 by 16, it is only requisite to ascertain the difference between the logarithm of these two numbers, which in this case being 8, the figure opposite to 8 is the required quotient, indicating how often 16 is contained in 4096, namely, 256 times.

The indices or exponents, 1, 2, 3, 4, &c., might, however, denote the powers of any other number or ratio. Every different ratio or geometrical progression gives a different system of logarithms. Soon after the invention of logarithms by Lord Napier, it occurred to Briggs, then professor of geometry at Oxford, that a system whose base or ratio is 10 is preferable to all others, on account of its being analogous to the general method of notation. In A. D. 1624, Briggs published the tables of logarithms which are now in common use. In this system, 10 being the ratio or multiplier, the terms may be thus expressed—

1	10	100	1000	100,000,	&c.
10^0	10^1	10^2	10^3	10^4	&c.

The exponents, 1, 2, 3, 4, are, as was shown in the previous table, the logarithms of the opposite numbers, and might therefore have been written in the following manner:—

1	10	100	1000	100,000,	&c.
0	1	2	3	4	&c.

The logarithms of all intermediate numbers, such as those between 1 and 10, 10 and 100, &c., are found by ascertaining the geometrical mean proportion between any two numbers, and likewise the corresponding arithmetical means between the indices of those numbers. In every system, 0 is the logarithm of 1. Hence, the logarithm of any number between 1 and 10 must be less than a whole number, and therefore a decimal fraction; and the logarithm of any number between 10 and 100 must be one with a fraction. In the same way, the logarithm of any number between 100 and 1000 must be 2 and a fraction, and so on, through the rest of the series. The integers, 0, 1, 2, 3, &c., to the left of the decimals it logarithms, are called the *characteristics* of those logarithms. Thus, 0 is the characteristic of all numbers between 1 and 10; 1 is the characteristic of all between 10 and 100; 2 that of all between 100 and 1000, &c. In tables of logarithms the characteristics are generally omitted.

The method of using a table of logarithms is the following:—To ascertain, in the most common tables, the logarithm of a number less than 10,000, it is merely necessary to find the first three figures of the number in the left-hand column, and the fourth figure in the horizontal line at the top; then opposite to the former and under the latter is the required logarithm. If the given number consists of five figures, find, as before, the logarithm belonging to the first four figures; the difference between it and the next logarithm may be ascertained from the margin; this difference is to be multiplied by the fifth figure of the given number, and one figure cut off from the right of the product; and the other figures of this product being added to the preceding logarithm and the index 3 prefixed, the sum will be the required logarithm.

The process of finding the natural number of any given logarithm is precisely the converse of that just described. The given logarithm must be sought in the table, and against it, in the left-hand column, will be found the natural number. It has already been shown that tables of logarithms afford an easy method of finding the product in multiplication, and the quotients in division, by means of simple addition and subtraction. Logarithms are equally applicable to the solution of questions in proportion or the rule of three, it being merely requisite to add the logarithms of the second and third terms together, and from the sum to subtract the logarithm of the first; the remainder is the logarithm of the fourth term.

A number may, by means of logarithms, be raised to any required power, by multiplying the logarithm of the number by the index of the power. Thus to square any number, multiply its logarithm by 2; to cube a number, multiply its logarithm by 3; and so on.

To extract the root of any given number, the logarithm of the number must be divided by the proposed index, and the quotient is the logarithm of the required root. Thus, to find the square root of 169, it is only necessary to divide its logarithm, which is 2·2278867 by 2; opposite to the quotient will be found the number 13, which is the square root of 169, because $13 \times 13 = 169$.

ALGEBRA.

We have seen that logarithmic tables may be used as a substitute for many lengthened operations in arithmetic. It is evident that the value of all methods of computation lies in their brevity. Algebra must be considered as one of the most important departments of mathematical science, on account of the extreme rapidity and certainty with which it enables us to determine the most involved and intricate questions. The term *algebra* is of Arabic origin, and has a reference to the resolution and composition of quantities. In the manner in which it is applied, it embodies a method of performing calculations by means of various signs and abbreviations, which are used instead of words and phrases, so that it may be called the system of symbols. Although it is a science of calculation, yet its operations must not be confounded with those of arithmetic. All calculations in arithmetic refer to some particular individual question, whereas those of algebra refer to a whole class of questions. One great advantage in algebra is, that all the steps of any particular course of reasoning are, by means of symbols, placed at once before the eye; so that the mind, being unimpeded in its operations, proceeds uninterruptedly from one step of reasoning to another, until the solution of the question is attained.

Symbols are used to represent not only the known, but also the unknown quantities. The present custom is to represent all known quantities by the first letters of the alphabet, as a, b, c, &c., and the unknown quantities by the last letters, x, y, z.

The symbols used in arithmetic to denote addition, subtraction, &c., belong properly to algebra. Thus the sign $+$ *plus*, denotes that one quantity is to be added to another, and is called the positive or additive sign; all numbers to which it is prefixed are called *positive*. The sign $-$ *minus*, denotes that one quantity is to be subtracted from another; it is called the negative or subtractive sign, and all quantities to which it is prefixed are called *negative*. If neither $+$ nor $-$ be prefixed to a quantity, then the sign $+$ *plus* is understood.

The general sign to denote that one number is to be multiplied by another, is $\times$; but it often occurs that one letter has to be multiplied by another, and this is represented by placing those letters one after the other, generally according to the order in which they stand in the alphabet; thus a multiplied by b, is expressed by ab. The multiplication of quantities consisting of more than one term, as for instance $a + b$ by $c + d$, may be represented by any one of the following methods:—$\overline{a+b} \times \overline{c+d}$, or $\overline{a+b}.\overline{c+d}$, or $(a+b)(c+d)$. The bar drawn over $a + b$ and $c + d$, which in the two first examples marks them as distinct quantities, is called a *vinculum*, but brackets or parentheses for the same purpose, as in the last example, are now in more frequent use.

When a letter is multiplied by any given number, it is usual to prefix that number to the letter. Thus, twice a, three times b, four times c, six times x, &c., are expressed thus: $2a$, $3b$, $4c$, $6x$; and the numbers 2, 3, 4, 6, thus prefixed, are called the *coefficients* of the letters before which they stand.

The sign $\div$ between two numbers shows, as in arithmetic, that the former of those numbers is to be divided by the latter; thus $a \div b$, means that a is to be divided by b. It is, however, more usual to place the number to be divided above that by which it is to be divided, with a small line between, in the form of a fraction; thus $\frac{a}{b}$ denotes that a is divided by b.

It has been shown in Arithmetic that the powers of quantities are denoted by a small figure, called the exponent or index of the power. Thus, $a \times a$, or the square of a, is expressed by a^2; $b \times b \times b$, or the cube of b, is expressed by b^3, &c. The cube of $a + b$, or of $(a + b)(a + b)$ is expressed thus: $(a + b)^3$.

The roots of quantities are represented by the sign $\surd$ with the proper index affixed; thus $\sqrt[2]{a}$, or, more simply, $\sqrt{a}$, expresses the square root of a; $\sqrt[3]{a}$ the cube root of a; $\sqrt[4]{a + b}$ represents the 4th or biquadratic root of $a + b$. Fractional indices are also frequently used to denote the roots of quantities, thus:

$a^{\frac{1}{2}}$ is the square root of a.
$a^{\frac{1}{3}}$ is the cube root of a.
$a^{\frac{1}{4}}$ is the 4th root of a &c.

Again, $a^{\frac{2}{3}}$ is the cube root of a^2, or of the square of a.
$a^{\frac{3}{2}}$ is the square root of a^3, or of the cube of a.
$a^{\frac{2}{5}}$ is the 5th root of a^2.

When two or more letters or quantities are connected together by signs, the combination is called an algebraic expression, and each letter or quantity is called a *term*.

Quantities of one term are called simple quantities; as a, $2a$, $3b$, &c.

A quantity of two terms, as $b + c$, is called a *binomial*.

When a binomial expresses the difference between two quantities, it is called a *residual*, as $a - b$.

A quantity consisting of 3, 4, or many terms, are called respectively *trinomials*, *quadrinomials*, *multinomials*.

The sign $=$ placed between two quantities shows, as in arithmetic, the *equality* of those quantities.

When quantities are connected by this sign, the expression is called an *equation*: thus, $2+4=6$, is an equation, as also, $a+b=c-f$.

The symbol $>$ or $<$ is called that of *inequality*, it being placed between two quantities, of which one is greater than another; the open part of the symbol is always turned towards the greater quantity: thus, $a>b$ denotes a to be greater than b; and $c<d$ denotes d to be greater than c. The sign of difference is $\backsim$, only used when it is uncertain which of two quantities is the greater; thus $e \backsim f$ denotes the difference between e and f when it is uncertain which is the greater.

The word *therefore*, or *consequently*, often occurring in algebraical reasoning, the symbol $\therefore$ has been chosen to represent it: thus, the sentence "Therefore $a+b$ is equal to $c+d$," is thus expressed in algebra, $\therefore a+b=c+d$.

Like quantities are such as consist of the same letter or letters, or power of letters: thus, $6\,a$ and $2\,a$ are like quantities, and also $4\,abc$ and $9\,abc$. *Unlike* quantities are such as consist of different letters: as, $4a$, $5b$, $6\,ax^2$, $4\,cd$, which are all unlike quantities.

Addition.

The operation of addition in arithmetic consists, as has been shown, simply in joining or adding several quantities together: thus, $4+8+7+6=25$. This same process is always used in algebra, whenever *like* quantities with *like* signs are required to be added: thus, $2\,a+3\,a+6\,a=11\,a$; and $-7\,b-4\,b-6\,b=-17\,b$. But as it often happens that like quantities which are to be added together have unlike signs, addition has in algebra a far more extended signification than in arithmetic. Thus, to add $7\,a+4\,a$ to $8\,a-3\,a$, it is evident that, after $7\,a+4\,a+8\,a$ have been added according to the usual method, $3\,a$ must be subtracted. Hence the general rule for the addition of *like* quantities with *unlike* signs is to add first the coefficients of the positive terms, and then to add those of the negative terms; the less sum must be subtracted from the greater, and to this difference the sign of the greater must be annexed, with the common letter or letters. Thus, let it be required to add $7\,a-3\,a+4\,a+5\,a-6\,a-2\,a$ and $9\,a$; $25\,a$ will be found the sum of the positive terms, and $11\,a$ that of the negative; $11\,a$ being the less number, must therefore be subtracted from $25\,a$, the greater, leaving a remainder of $14\,a$, which is the required amount. The reason of this mode of procedure may be shown by a simple illustration:—As a letter may represent any quantity, let a represent £5; and suppose that a gentleman has in one bank $7\,a$, or seven five pounds; in another bank $4\,a$, and in another $9\,a$, or nine five pounds: let us suppose, too, that his tailor's bill is $6\,a$, or six five pounds; his baker's $3\,a$, or three five pounds; and his butcher's $2\,a$, or two five pounds; it is evident that, to ascertain how much money is really his own, he must first compute the whole value of his property dispersed in the different banks, then the amount of the bills of his creditors, and then find the difference between the two sums by subtracting the less from the greater. When the aggregate of the positive terms is equal to that of the negative ones, the sum of the two quantities will be equal to 0: thus if a man possesses £2000, and owes £2000, it is evident that when his debts have been deducted from his property, nothing will remain. Unlike quantities can only be added by collecting them in one line, and prefixing the proper sign of each; thus, the sum of $3\,a+2\,b+4\,c-2\,d$ can only be rendered $3\,a+2\,b+4\,c-2\,d$; this will be evident by reflecting that different letters in the same algebraical expression always represent different quantities, which cannot of course be added into one sum unless their precise value be known. Thus, the addition of a and b cannot be represented by $2\,a$ or $2\,b$, because that would imply that a is equal to b, which it is not necessarily; neither could it be represented by ab, because ab denotes the multiplication of the two quantities; the only method then of expressing these sums is thus, $a+b$. When like and unlike quantities are mixed together, as in the following example, the like quantities must first be collected together according to the method above described, and all unlike quantities must be annexed in order:—

$$\begin{array}{rrrr} & 9\,a & +\ 5\,xy & -\ 8\,ay \\ - & 8\,xy & -\ 10\,x & +\ 2\,xy \\ & 3\,x & -\ 7\,ay & -\ 5\,x \\ & 5\,ax & -\ 6\,ax & +\ 11\,y \\ - & xy & -\ 4\,a & +\ 9\,ax \\ & 2\,ay & +\ 12\,x & -\ 2\,a \\ - & 10\,y & -\ 3\,xy & +\ 13\,ay \\ \hline & 3\,a & -\ 8\,ax & -\ 5\,xy+y \end{array}$$

Subtraction.

When two like quantities, having like signs, are to be subtracted the one from the other, the process is precisely the same as that already described in arithmetic: thus, $3\,a$ subtracted from $7\,a$, leaves as a remainder $4\,a$. From $8\,a+5\,a$ take $6\,a+2\,a$, and the remainder will be $2\,a+3\,a$, or $5\,a$.

But supposing it were required to subtract $6\,a-4\,a$ from $9\,a$, it is evident that some other process must be adopted; because, if $6\,a$ be subtracted from $9\,a$, the proposed operation will not be performed; for it is not $6\,a$, but $6\,a-4\,a$, that is, $2\,a$, which is required to be subtracted from $9\,a$; $6\,a$ subtracted from $9\,a$ leaves $3\,a$, which is $4\,a$ less than would result from subtracting $2\,a$ from $9\,a$; but if to $3\,a$ we add the other term, namely, $4\,a$, the sum will be the remainder sought, because $3\,a+4\,a=7\,a$; and if $2\,a$ be subtracted from $9\,a$, which is just the same question in another form, for $6\,a-4\,a$ is $=2\,a$, the remainder is just $7\,a$ as before. So, if $a-b$ is to be subtracted from c, the remainder would be $c-a+b$, and for the same reason. It may therefore be given as a general rule, that all the signs of a quantity which is required to be subtracted from another, must be changed: thus, when $4\,x-3\,y$ is subtracted from $7\,a+5\,b$, the remainder is written thus, $7\,a+5\,b-4\,x+3\,y$.

When like quantities are to be subtracted from each other, it is usual to place them in two rows, the one above the other; the signs of the quantities to be subtracted must, for the reason above adduced, be conceived to be changed; and the several quantities must be added, as shown in the following examples:—

$$\begin{array}{rl} \text{From} & 5\,ax+7\,xy-2\,y \\ \text{Take} & 3\,y+3\,ax-6\,xy \\ \hline \text{Remainder,} & 2\,ax+13\,xy-5\,y \end{array}$$

Multiplication.

The multiplication of two quantities is performed by multiplying, as in arithmetic, the coefficients of the quantities, and then prefixing the proper sign and annexing letters: thus, the product of $3\,a$, multiplied by $5\,b$, is $15\,ab$, and $7\,a\times 4\,ab=28\,ab^2b$.

When the signs of both quantities are alike, the sign $+$ is to be prefixed; but when unlike, the sign $-$ must be prefixed, which may be thus shown at one view:—

1. $+$ multiplied by $+$ produces $+$
2. $-$ multiplied by $-$ produces $+$
3. $+$ multiplied by $-$ produces $-$
4. $-$ multiplied by $+$ produces $-$

Hence the technical rule generally given is, that "like numbers produce *plus* $+$, and unlike produce *minus* $-$." This, however, is not perfectly true when more than two quantities are to be successively multiplied; because although the product of an even number of negative quantities is positive, yet the product of an odd number of negative quantities is always negative; thus,

$$-a\times -b\times -d=-abd$$
$$\text{and } -a\times -b\times -d\times -c=abde.$$

When the same letter occurs in both quantities, the indices must be added; thus, $a^2 \times a^3 = aaaaa = a^5$. In the multiplication of compound quantities, it is usual to commence from the left-hand figure; the multiplication, for instance, of $8ab - 4ac + x$ by $2a$, is thus performed:—

$$\begin{array}{l} 8ab - 4ac + x \\ 2a \\ \hline 16a^2b - 8a^2c + 2ax \end{array}$$

To multiply two compound quantities, each term of the one must, as in arithmetic, be multiplied by each term of the other; these particular or partial products must be added according to the rules of addition, and their sum will give the whole product, as shown in the following instance:—

$$\begin{array}{lr} \text{Multiply} & 3a + 8b \\ \text{By} & a - b \\ \hline & 3a^2 + 8ab \\ & -3ab - 8b^2 \\ \hline \text{Product,} & 3a^2 + 5ab - 8b^2 \end{array}$$

Division.

The operations of division being in algebra, as in arithmetic, merely the converse of those of multiplication, the same rules respecting signs apply in both. Thus, $6ab^2$, divided by $2b$, is equal to $3ab$,

$$\text{And } -8cx^2 \div 4x, \text{ or } -\frac{8cx^2}{4x} = -2cx$$

In division, all letters common to both quantities must be omitted in the quotient; and when the same letters occur in both with different indices, the index of the letter in the divisor must be subtracted from that in the dividend; thus,

$$abx \div ab, \text{ or } \frac{abx}{ab} = x: \text{ and}$$

$$6a^5 \div 2a^3 \text{ or } \frac{6a^5}{2a^3} = 3a^2$$

When the exponent of any letter in the divisor exceeds that of the same letter in the dividend, the latter exponent must be subtracted from the former, and the quotient will be in the form of a fraction; thus,

$$-12a^3x^2 \div 8ax^5 = -\frac{12a^3x^2}{8ax^5} = -\frac{3a^2}{2x^3}$$

When the number to be divided is a compound quantity, and the divisor a simple one, then each term of the dividend must be divided separately, and the result will be the answer; thus,

$$\frac{6a + 24ab + 8a^2 + 12ac}{2a} = 3 + 12b + 4a + 6c$$

When the divisor and dividend are both compound quantities, the rule is the same as that of long division in arithmetic. When there is a remainder, it must be made the numerator of a fraction, under which the divisor must be put as the denominator; this fraction must then be placed in the quotient, as in arithmetic. The compound quantities must, however, be previously arranged in a particular way, namely, according to the descending powers of some letter, as of b in the following example; and this letter is called the *leading* quantity. The following is an example of the division of compound quantities:—

$$\begin{array}{l} b - x)\; b^3 - 3b^2x + 3bx^2 - x^3\; (b^2 - 2bx + x^2 \\ \quad\quad\; b^3 - b^2x \\ \hline \quad\quad\; * - 2b^2x + 3bx^2 \\ \quad\quad\;\;\;\, - 2b^2x + 2bx^2 \\ \hline \quad\quad\quad\quad * \quad\;\; bx^2 - x^3 \\ \quad\quad\quad\quad\quad\;\;\; bx^2 - x^3 \\ \hline \quad\quad\quad\quad\quad * \end{array}$$

Fractions.

The rules regulating the management of fractions in algebra are similar to those in arithmetic.

A mixed quantity is reduced to a fraction by multiplying the whole or integral part by the denominator of the fraction, and annexing the numerator with its proper sign to the product; the former denominator, if placed under this sum, will give the required fraction. Thus, the mixed quantity $2x + \frac{5ab}{6c}$ may be thus reduced to a fraction: $2x \times 6c = 12cx$, and as $5ab$ must be added to form the numerator, and the former denominator be retained, the required fraction is the following: $\frac{12cx + 5ab}{6c}$. An operation exactly the reverse of this would of course be requisite, were it proposed to reduce a fraction to a mixed quantity. Thus, the fraction $\frac{12cx + 5ab}{6c}$ may be reduced to a mixed number by dividing the numerator by the denominator; the numerator of the fractional part must be formed by that term which is not divisible without a remainder; the following is therefore the required mixed quantity: $2a + \frac{5ab}{6c}$. A fraction is reduced to its lowest terms, in algebra as in arithmetic, by dividing the numerator and denominator by any quantity capable of dividing them both without leaving a remainder. Thus, in the fraction $\frac{10a^3 + 20ab + 5a^2}{35a^2}$, it is evident that the coefficient of every term can be divided by 5, and as the letter a enters into every term, $5a$ may be called the greatest common measure of this fraction, because it can divide both the numerator and the denominator. The numerator, $(10a^3 + 20ab + 5a^2) \div 5a = 2a^2 + 4b + a$; and the denominator, $35a^2 \div 5a = 7a$; hence the fraction, in its lowest terms, is $\frac{2a^2 + 4b + a}{7a}$. Sometimes the greatest common measure of two quantities is not so obvious as in the example just adduced, in which case recourse must be had to the following operation:—The quantity, the exponent of whose leading letter in the first term is not less than that in the other, must first be divided by the other; the divisor must then be divided by the remainder; each successive remainder is made the divisor of the last divisor, until nothing remains; when the divisor last used will be the greatest common measure. Quantities which have no common measure or divisor except 1, are called *incommensurable*; thus, 7, 5, 3, and 11, are incommensurable quantities, and are also said to be *prime* to each other. When fractions are required either to be added or to be subtracted, they must necessarily be first reduced to a common denominator, which is effected by multiplying each numerator by every denominator but its own, to produce new numerators, and all the denominators together for the common denominators. The new numerators can then be either added or subtracted according as the case may require, and the new denominator must be left unchanged. Multiplication of fractions is performed by multiplying all the numerators together for a new numerator, and their denominators together for a new denominator; it is then usual to reduce the resulting fraction to its lowest terms. Division of fractions is effected by multiplying the dividend by the reciprocal of the divisor. The reciprocal of any quantity is unity, or 1 divided by that quantity, or simply that quantity inverted: thus, the reciprocal of a or $\frac{a}{1}$ is $\frac{1}{a}$, and the reciprocal of $\frac{a}{b}$ is $\frac{b}{a}$: therefore, to divide a fraction as $\frac{8a^2}{2}$ by $\frac{4a}{5}$ the dividend [illegible] must be multiplied by the reciprocal of $\frac{4a}{5}$, which is $\frac{5}{4a}$; therefore, $\frac{8a^2}{4} \times \frac{5}{4a} = \frac{40a^2}{16a}$; this last fraction, divided by its greatest common measure $8a$, is the fraction required, namely, $\frac{5a}{2}$.

Involution and Evolution.

The raising of a quantity to any required power is called involution, and is performed by multiplying the quantity into itself as often as it is indicated by the given power. When the quantity has no index, it is only necessary to place the given power above it, in order merely to indicate the power: thus, the 4th power of a is a^4, and the cube or 3d power of $a + b$ is $(a + b)^3$.

When the quantity has an index, that index must be multiplied by the given power; thus, the fourth power of a^2 is a^8, because $2 \times 4 = 8$. If the quantity required to be raised be a fraction, both the numerator and the denominator must be multiplied by the given power: thus, the square of $\frac{a^2}{d^3}$ is $\frac{a^4}{d^6}$. When the sign of the quantity is +, then all the powers to which it can be raised must be +; if —, then all the even powers will be +, and all the odd powers —. Thus $x \times x = x^2$; $-a \times -a = +a^2$; $-a \times -a \times -a = -a^3$.

A compound quantity, that is, one consisting of more than one term, is raised to any given power by multiplying it into itself the number of times denoted by the power. This is done according to the method already described in multiplication. Thus, the square of $x + 4y$, is thus found:

$$\begin{array}{rl} \text{Multiply} & x + 4y \\ \text{By} & x + 4y \\ \hline & x^2 + 4xy \\ & \qquad\; 4xy + 16y^2 \\ \hline \text{Square} = & x^2 + 8xy + 16y^2 \end{array}$$

The operations of evolution are the reverse of those of involution, being designed to discover the square root, cube root, &c., of any given quantity. The roots of numerical coefficients are found as in arithmetic: thus, the square root of $49a^2$, is $7a$, because $7 \times 7 = 49$. The index of the given quantity must be divided by 2 for the square root, by 3 for the cube root, by 4 for the 4th root, &c.: thus, the cube root of a^6 is a^2.

The square root of compound quantities may be extracted by a method very similar to that described in arithmetic, and of which an example was there given. The cube root may likewise be extracted by a similar process.

Irrational Quantities, or Surds.

Some numbers have no exact root; for instance, no number multiplied into itself can produce 5. The roots of such quantities are expressed by fractional indices, or by the sign $\surd$, which is called the radical sign, from the Latin *radix*, a root: thus, the square root of 5, and the cube root of $(a + b)^2$, may be expressed either by $\sqrt{5}$, $\sqrt[3]{(a+b)^2}$, or by $5^{\frac{1}{2}}$, $(a+b)^{\frac{2}{3}}$.

The approximate value of such quantities can be ascertained to any required degree of exactness by the common rules for extracting roots: thus, the square root of 2 is 1 and an indefinite number of decimals; but as the exact value can never be determined, the name of *irrational* is given to such quantities, to distinguish them from all numbers whatever, whether whole or fractional, of which the value can be found, and which are therefore termed *rational*. Irrational numbers are generally called *surds*, from the Latin *surdus*, deaf or senseless.

Equations.

When two quantities are equal to each other, the algebraical expression denoting their equality is called an *equation*. Thus, $x - 2 = 4 + 3$ is an equation, denoting that if 2 be deducted from some unknown quantity represented by x, the remainder will be equal to $4 + 3$, that is, to 7; therefore, the value of x in this equation is evidently $7 + 2$, or 9.

The doctrine of equations constitutes by far the most important part of algebra, it being one of the principal objects of mathematics to reduce all questions to the form of equations, and then to ascertain the value of the unknown quantities by means of their relations to other quantities of which the value is known.

Many problems, which are now quickly and readily determined by being reduced to equations, used formerly to be solved by tedious and intricate arithmetical rules; and they may still be found in old treatises on arithmetic, arranged under the titles of Double and Single Position, False Position, Allegation, &c. Equations receive different names, according to the highest power of the unknown quantities contained in them. An equation is said to be *simple*, or of the *first degree*, when it contains only the first power of the unknown quantity: thus, $x \times b = 35a - 2$ is a simple equation, the unknown quantity being represented by x, as it generally is in other equations, and the known quantities by the other letters and figures. $x^2 + 4 = 8a$, is a *quadratic* equation, because x, the unknown quantity, is raised to the second power. $x^3 = a + 3b$ is a *cubic* equation, the unknown quantity being raised to the third power. $x^4 - a = 25c$ is a *biquadratic* equation, because x is raised to the 4th power. If equations contain unknown quantities raised to the 5th, 6th, or higher powers, they are denominated accordingly.

The quantities of which an equation is composed, are called its *terms*; and the parts that stand on the right and left of the sign =, are called the *members* or *sides* of the equation.

When it is desired to determine any question that may arise respecting the values of some unknown quantity by means of an equation, two distinct steps or operations are requisite; the first step consists in translating the question from the colloquial language of common life into the peculiar analytical language of the science. The second step consists in finding, by given rules, the answer to the question, or in other words, the solution of the equation. Expertness and facility in performing the former operation cannot be produced by any set of rules; in this, as in many other processes, practice is the best teacher. Every new question requires a new process of reasoning; the conditions of the question must be well considered, and all the operations, whether of addition, subtraction, &c., which are required to be performed on the quantities which it contains, are to be represented by the algebraic signs of +, —, &c.: the whole problem must be written down as if these operations had been already performed, and as if the unknown quantities were discovered, which can be done very briefly by substituting the first letters of the alphabet for the known quantities, and the last letters for the unknown, prefixing to each the signs of addition, multiplication, &c., which may be denoted in the question. Thus, suppose a farmer wished to divide £1, 15s. between his two sons, allowing 9s. more to the elder than to the younger, what would each receive? To express this question in algebraic language, the share of the younger son may be represented by x, and then that of the elder son will be $x + 9$. The steps of reasoning by which this question may be solved, are the following:—The share of the elder + the share of the younger is £1, 15s., equal to 35s. therefore, $x + 9 + x = 35$, or $2x + 9 = 35$ ∴ $2x = 35 - 9$, or $2x = 26$ ∴ x (share of the younger son)

$x = \frac{26}{2} = 13$, and $x + 9$ (the share of the elder son) $= 13 + 9 = 22$.

The second operation in determining a question may be said to consist in contrivances to get x, or the unknown quantity, to stand alone on one side of the equation, without destroying the equality or balance between the two sides; because, in such an equation, for instance, as the following, $x = 4 + 2$, the value of x is at once seen; if 6 were to be put in the place of x, the question would be said to be *fulfilled*, because then it would stand thus, $6 = 6$; therefore, 6 is the *root* or solution of the equation, $x = 4 + 2$. In some questions, the unknown quantity is so much involved with known quantities, that it is often a difficult, although always a highly interesting process, to separate it from them. Many rules for effecting this are given in most algebraical treatises, but they may all be comprised in one general observation, namely, that any operation, whether of addition, subtraction, &c., may be performed on one side of an equation, provided only that the very same operation be performed on the other side, so as not to destroy their equality. Thus, in the equation $x + 5 = 12$, it is evident that, if 5 could be removed from the left to the right side of the equation, x would stand alone, and its value at once be ascertained; it having been already stated that any operation may be performed on one side of the equation, provided only the same operation be performed on the other, it follows that 5 may be subtracted from the left side, if subtracted likewise from the right; therefore, $x + 5 - 5 = 12 - 5$; but $5 - 5$ being equal to 0, the equation would more properly be expressed thus, $x = 12 - 5$; that is to say, the value of x is 7. Again, in the equation, $x - 10 = 27$, add 10 to each side of the equation; then, $x - 10 + 10 = 27 + 10$; but $-10 + 10 = 0$; therefore, $x = 27 + 10$. When the same quantity is thus subtracted from both sides of an equation, or added to both sides, the operation is technically, though perhaps incorrectly, termed, "*transposing* quantities from one side of an equation to the other."

The reason why the same operation performed upon both sides of an equation does not alter their equality, is simply because "if equal quantities be added to, or subtracted from, equal quantities, the value of the quantities will still be equal." To illustrate this, supposing a wine-merchant has 2 casks of wine, each cask containing 36 gallons, it is evident that, if he draws off the same number of gallons from each cask, the quantity of gallons remaining in each cask will still be equal; so, if he were to replace the same number of gallons of wine in each cask, the number of gallons contained in each would still be equal to each other. For the same reason, if the two sides of an equation were either multiplied or divided by the same number, their equality to each other would still remain; in the equation $3x = 27$, the value of x may be discovered by dividing both sides of the equation by its coefficient 3; thus, $\frac{3x}{3} = \frac{27}{3}$; but $\frac{3x}{3} = x$, and $\frac{27}{3} = 9$; $\therefore x = 9$. In the same way, if the unknown quantity in an equation is required to be divided by some known quantity, each side of the equation may be multiplied by the divisor; thus, in the equation $\frac{x}{4} = 32$, if each member be multiplied by 4, the result will be $x = 32 \times 4 = 128$. This is technically called clearing an equation of fractions.

On Simple Equations Containing two or more Unknown Quantities.

It may be given as a general rule, that when a question arises as to the value of two or more unknown quantities, each of these quantities must be represented by one of the last letters of the alphabet, and as many separate equations must be deduced from the question as there are unknown quantities. A group of equations of this kind is called a *system of simultaneous equations*.

If it be required to solve a system of two simple equations, containing two unknown quantities, the most natural method seems to be to determine first the value of one of the unknown quantities by means of both the equations. Then, as "things which are equal to the same thing are equal to each other," it follows that the two sets of numbers or letters in the two equations, which have been ascertained to be equal to the value of x, will also be equal to each other, and may be reduced to an equation, which will contain only one unknown quantity. This process is technically called *elimination*. Let it, for instance, be required to find the length of two planks of wood: the length of both planks together is 20 feet, and one plank is 8 feet longer than the other plank. This is evidently a question involving two unknown quantities, namely, the length of each of the two planks of wood. To translate this question into algebraical language, call the longer plank x, and the shorter plank y, then the facts above mentioned may be thus stated: $x + y = 20$, and $x - y = 8$. The value of x may be ascertained by means of both the equations, in the following manner:—

The first equation gives $x = 20 - y$
And the second, $x = 8 + y$

The two values of x, thus ascertained, must form a new equation, thus:

$$20 - y = 8 + y$$
$$20 = 8 + 2y$$

So that it is evident from this last equation that $2y$ is equal to 12, because $20 - 8 = 12$; therefore $y = 6$, and $20 - 6 = 14$. The length of both the planks is thus ascertained, the longer being 14 feet in length, and the shorter 6 feet.

This problem is not only given as an example of *elimination*, but also as an illustration of the general theorem, that "the greater of two numbers is equal to half their sum, *plus* half their difference; and that the less number is equal to half the sum, *minus* half the difference." Thus the above question might have been solved in the following manner:

$$\frac{20}{2} + \frac{8}{2} = 14, \text{ and } \frac{20}{2} - \frac{8}{2} = 6$$

The following is the method of demonstrating this curious theorem algebraically:—Let a and b be any two numbers of which a is the greater, and let their sum be represented by s, and their difference by d;

Then, $a + b = s$
and $a - b = d$

$$2a = s + d$$
$$\text{and} \quad a = \frac{s}{2} + \frac{d}{2}$$
$$\text{Also, } 2b = s - d$$
$$\text{and} \quad b = \frac{s}{2} - \frac{d}{2}$$

Quadratic Equations.

A quadratic equation literally means a *squared equation*, the term being derived from the Latin *quadratus*, squared; a quadratic equation, therefore, is merely an equation in which the unknown quantity is squared or raised to the second power. Quadratic equations are often called equations of two dimensions, or of the second degree, because all equations are classed according to the index of the highest power of the unknown quantities contained in them.

There are two kinds of quadratic equations, namely, pure and affected. *Pure* quadratic equations are those in which the first power of the unknown quantity does not appear: there is not the least difficulty in solving such equations, because all that is requisite is to obtain the value of the square according to the rules for solving simple equations, and then, by extracting the square root of both sides of the equation, to ascertain the value of the unknown quantity. For instance, let it be required to find the value of x in the equation $x^2 + 4 = 29$. By deducting 4 from each side of the equation, the value of x^2 is at once seen to be as follows: $x^2 = 29 - 4 = 25$; the square root of both sides of this equation will evidently give the value of x, thus, $x = \sqrt{25} = 5$. *Adfected* or *affected* quadratic equations are such as contain not only the square, but also the first power of the unknown quantities.

There are two methods of solving quadratic equations; we are indebted to the Hindoos for one of these methods, of which a full account is given in a very curious Hindoo work entitled *Bija Ganita*. The other method was discovered by the early Italian algebraists. The principle upon which both methods are founded is the following. It is evident that in an adfected equation, as for instance, $ax^2 + bx = d$, the first number, $ax^2 + bx$, is not a complete square; it is, however, necessary for the solution of the equation that the first side should be so modified as to be made a complete square, and that, by corresponding additions, multiplications, &c., the equality of the second side should not be lost; then, by extracting the square root of each side, the equation will be reduced to one of the first degree, which may be solved by the common process.

The following illustration from Bridge will perhaps tend more to simplify the subject, and show its practical utility, than any mere abstract rules which might be advanced. A person bought cloth for £33, 15s., which he sold again at £2, 8s. per piece, and gained by the bargain as much as one piece cost him. Required the number of pieces.

Let x = the number of pieces, £33, 15s. $\times$ 20 = 675; therefore, $\frac{675}{x}$ = the number of shillings each piece cost, and 48 x is equal to the number of shillings for which he sold the *whole*, because £2, 8s, or 48 shillings was the price he obtained for each piece. Therefore, $48x - 675$ was what he gained by the bargain. Hence, by the question, $48x - 675 = \frac{675}{x}$. This equation, after having been submitted to the usual operations of transposition and division which have been already described, assumes the form of

$$x^2 - \frac{225}{16}x = \frac{225}{16}.$$

The next step is to complete the square; this is done by adding to each side of the equation *the square of half the coefficient of the second term.*

$$x^2 - \frac{225}{16}x + \left(\frac{225}{32}\right)^2 = \frac{225}{16} + \frac{50625}{1024} = \frac{65025}{1024}$$

then, extracting the square root,

$$x - \frac{225}{32} = \frac{225}{32} \text{ and } x = \frac{480}{32} = 15.$$

Therefore, 15 pieces of cloth was the quantity sold.

It is often requisite, for the more easy solution of equations, to change them into other equations of a different form, but of equal value; and this is technically termed Transformation. Our limits will not permit us to enter on any explanation of this rule, or of the rules farther advanced in the science, as Permutations, Undetermined Coefficients, Binomial Theorem, Exponential Equations, &c. To those who desire to possess a thorough knowledge of algebra, we refer to the complete and accessible treatise of Mr. Bell, in Chambers's Educational Course.

GEOMETRY.

GEOMETRY (from two Greek works signifying the *earth*, and *to measure*) is that branch of mathematical science which is devoted to the consideration of form and size, and may therefore be said to be the best and surest guide to the study of all sciences in which ideas of dimension or space are involved. Almost all the knowledge required by navigators, architects, surveyors, engineers, and opticians, in their respective occupations, is deduced from geometry and other branches of mathematics. All works of art are constructed according to the rules which geometry involves, and we find the same laws observed in the works of nature. The study of mathematics, generally, is also of great importance in cultivating habits of exact reasoning; and in this respect it forms a useful auxiliary to logic. As will be observed from even the short sketch which we are able to present, the steps of reasoning from given and exact premises are clear and undeniable, and the results satisfactory. All subjects, it is true, are not susceptible of being brought to the test of mathematical analysis; but, to one acquainted with the process, no fantastic speculations or loose points in any argument will be accepted as proved truths, or passed over without an attempt at refutation.

It has been frequently asserted, though apparently with little truth, that geometry was first cultivated in Egypt, in reference to the measurement of the land. Thales of Miletus, who lived about 600 B. C., is among the first concerning whose attainments in mathematical knowledge we have any authentic information. About two centuries later, the Platonic school was founded, which event is one of the most memorable epochs in the history of geometry. Its founder, Plato, made several important discoveries in mathematics, which he considered the chief of sciences. A celebrated school, in which great improvement was made in geometry, was established about 300 B. C. To this school the celebrated Euclid belonged. After this period, geometrical science, like all general knowledge, gradually declined, and such continued to be the case until about a century after, when it revived among the Arabians.

About the beginning of the fifteenth century, geometry, as well as all other departments of knowledge, became more generally cultivated. In modern times, Kepler, Galileo, Tacquet, Pascal, Descartes, Huygens of Holland, our own Newton, Maclaurin, Lagrange, and many others, have enlarged the bounds of mathematical science, and have brought it to bear upon subjects which, in former ages, were considered to be beyond the grasp of the human mind

As improved by the labours of mathematicians, geometrical science now includes the following leading departments:—Plane Geometry, the basis of which is the Six Books of Euclid's Elements; Solid and Spherical Geometry, Spherical Trigonometry, the Projections of the Sphere, Perpendicular Projection, Linear Perspective, and Conic Sections. But to these main branches of the science there are added Practical Mathematics, which may be defined as an elaboration of the abstract doctrines and rules of general mathematics, in application to many matters of a practical nature in the business of life. For example, among the branches of practical Mathematics, we find Practical Geometry, Trigonometry, Measurement of Heights and Distances, Levelling, Mensuration of Surfaces, Mensuration of Solids, Land-Surveying, Calculations of Strength of Materials, Gauging, Projectiles, Fortification, Astronomical Problems, Navigation, Dialling, &c. In such a limited space as the present sheet, it would be altogether impossible to present even a mere outline of these numerous branches of general and practical mathematics; and all we propose to do is to offer a sketch of a few leading features of the science, in order to show what is meant by various terms in common use, and also to incite the reader to a regular course of study.

DEFINITION OF TERMS AND FIGURES.

In common language, the extremity of any sharp instrument, such as an awl, a pencil, or a penknife, is called a point. A small mark or dot made with such an instrument on wood or paper would also be called a point; but if examined with a magnifying glass, it would appear an irregular spot, having length and breadth. A *geometrical point*, on the contrary, has neither length nor breadth, and may be called an imaginary dot.

The extremities or ends of lines are always considered to be points; and when the two lines intersect, that is, cross each other, the intersection is called a point.

The definition always given in geometry of a *line* is, that it is *length without breadth*. It is therefore evident that a true geometrical line cannot be constructed; for however finely a line may be drawn, it will be always found to have some breadth; this will at once appear by examining it through a microscope.

In practical geometry, it is necessary to draw points and lines; but it is impossible to approach to mathematical exactness unless they be drawn as finely as possible, always bearing in mind that such lines and points are merely *symbols* of the true geometrical lines and points.

A *superficies* or *surface* has only length and breadth, and is bounded by lines. By the word surface is generally understood the outside of any thing; as, for instance, the exterior of the lid or of the sides of a box. It is also used in geometry to convey the very same idea, always supposing that it has no thickness.

A geometrical surface, like a line and a point, cannot be constructed. The thinnest sheet of paper is not a superficies but a solid, having the three kinds of bulk, technically called dimensions, which are possessed by a solid body, namely, length, breadth, and thickness.

Solids are bounded by surfaces. Geometry considers the dimensions of space as abstracted or separated from any solid body which might occupy that space: a body always occupies a space exactly equal to itself in magnitude. This will be better understood by imagining a cast to be taken of some solid body: when the body is removed, a cavity remains, and we can reason concerning the dimensions of that cavity, knowing that it is of the same length, breadth, and thickness, as the solid body from which it was cast. In this way, we reason concerning the dimensions of any given space, and with the same precision as if geometrical lines, surfaces, and solids, were really drawn in that space; and it is the business of theoretical geometry to examine the properties and relations of these forms or magnitudes. We learn from practical geometry how to form representations of the ideas thus acquired. Therefore, the common meaning usually attached to the words *point line, surface* and *solid*, is admissible in practical geometry; the object of this branch of science being to show how to draw upon paper, or construct in wood or metal, correct representations of those forms or magnitudes which are conceived to exist in space.

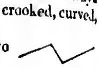
As there are three kinds of magnitudes, lines, surfaces, and solids, it follows that the natural division of the science of geometry is into three primary departments; namely, 1. Geometry of Lines; 2. Geometry of Surfaces; 3. Geometry of Solids, or Solid Geometry. The term *Plane Geometry*, however, is usually applied to the geometry of straight lines, rectilineal figures, and circles described on a plane.

Lines are named by two letters placed one at each extremity. Thus, the line drawn here is named the line A B.

A B

It is obvious that lines can be drawn in different ways and in various directions. A line can be crooked, curved, mixed, convex, concave, or straight.

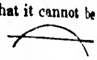
1. A *crooked* line is composed of two or more straight lines.



2. A line, of which no part is a straight line, is called a *curve line*, a *curved line*, or *curve*.

3. A *mixed line* is a line composed of straight and curved lines.

4. A *convex* or *concave* line is such that it cannot be cut by a straight line in more than two points; the *concavity* of the intercepted portion is turned towards the straight line, and the *convexity* from it.



A straight line is in geometry called a *right* line, from the Latin *rectus*, straight. If two lines are such, that when any two points in the one touch or coincide with two points in the other, the whole of the lines coincide, each of them is called a *straight* or *right* line. Thus, a line which has been carefully ruled on a sheet of paper, will be found to coincide with the edge of a ruler.

A straight line, therefore, may be said to lie evenly between its extreme points. If a straight line, as A B, turn round like an axis, its two extremities A and B remaining in the same position, any other point of it, at C, will also remain in the same position.

A C B

Any point in a line is called a *point of section*, and the two parts into which it divides the line are called *segments*. Thus, the point C in the above line A B is a point of section, and A C, B C, are segments.

It is evident that two straight lines cannot enclose a space; and that two straight lines cannot have a common segment, or cannot coincide in part without coinciding altogether.

A surface may be concave, like the inside of a basin; convex, like the exterior of a ball; or plane, like the top of a flat table. A plane superficies, or, as it is commonly called, a *plane*, is considered to be perfectly even, so that if any two points are taken in it, the straight line joining them lies wholly in that surface. This cannot, perhaps, be better illustrated than by placing two flat panes of glass the one above the other. If the two surfaces coincide exactly in every part, they may be said to form a geometrical plane; and it is upon a plane equally flat and even that all geometrical lines and figures in plane geometry are supposed to be drawn.

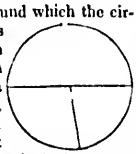
The Circle.

A figure is a part of space enclosed by one or more boundaries; if these boundaries are superficies, it is called a *solid*, and if lines, it is called a *plane* figure, in plane geometry.

The space contained within the boundary of a plane figure is called its *surface*; and the quantity of surface, in reference to that of some other figure with which it is compared, is called its *area*.

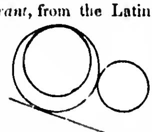
The circle is one of those figures which are most used in the arts and in practical geometry, and therefore claims particular attention. When a line is made to turn round one of its ends or extremities which remains fixed, the extremity which is carried round the other traces a line which is in every part equally distant from the point where the other end is fixed. The line thus traced is a *circle*, and is frequently termed the *circumference*, from the Latin *circum*, round, and *ferens*, carrying.

A pair of compasses are generally used in practical geometry to describe a circle. They consist of two straight and equal legs, generally of brass or iron, and always pointed at the bottom. Their upper extremities are joined together by a rivet or joint, so that they can be opened or closed at pleasure. In order to draw a circle, one end must be firmly fixed, and the other, after being opened proportionately to the required size of the circle, must be made to turn completely round, and a pencil or pen being attached to it, the trace of the circle is left upon the paper. The point in which one of the legs of the compasses is fixed, and round which the circle is described, is called its *centre*, as A. A straight line, as B, drawn from the centre to the circumference of a circle, is called a *radius*, which is a Latin word literally signifying a ray, and of which the plural is radii. A common wheel affords one of the most familiar examples of a circle. The axle is the *centre*, and the spokes are *radii*, while the outer rim of the wheel may be called the *circumference*. It is evident that all the spokes are of equal length; and this is invariably the case with the radii of every circle. A straight line, drawn through the centre of a circle, and terminated at each extremity by the circumference, is called *diameter*, from the Greek *dia*, through, and *metreo*, I measure.



An *arc* of a circle is any part of the circumference; the *chord* of an arc is a straight line joining its extremities. These two words come from the Latin words *arcus*, a bow, and *chorda*, a string, because, as is shown by the annexed figure, a geometrical arc with its chord closely resembles a bow to which a string has been attached for the purpose of shooting. A rainbow is a beautiful example of an arc. A *semicircle* is a segment, having a diameter for its chord, and therefore is just half of a circle.

When a chord is lengthened, and made to extend beyond the boundaries of a circle, it is said to *cut* the circle, and is therefore called a *secant*, from the Latin *secans*, cutting. A straight line A B, which lies wholly *outside* the circle, meeting it only in one point, is called a *tangent*, from the Latin, *tangens*, touching, because it is said to touch the circle in the point C. If the line A B were to remain fixed, and if the circle C D E were made to revolve round a point in its centre, in the same way, for instance, as a fly-wheel turns it would be found that no part of the line A B would be touched by the circle, except the one point C. This property of the circle has been turned to account in various ways. Thus, the grindstone used for sharpening knives is a circle made to revolve on its centre; the blade of the knife is held as a *tangent* to this circle; and, therefore, each time that the grindstone is turned round, it rubs against the blade, producing a finer edge, and giving it a polished appearance.



Circles are said to *touch* one another, when they meet but do not cut one another. Circles that touch one another, as the circle C D E and F G H in the last figure, are called tangent circles.

The point in which a tangent and a curve, or two tangent circles, meet, is called a *point of contact*. When of two tangent circles one is within the other, the contact is said to be *internal*; but when the one is without the other, the contact is said to be *external*. (See figure.) Tangent circles are very frequently applied to useful purposes, in various arts and manufactures. The wheels of a watch are merely so many tangent circles. When by means of the mainspring one of the circles is made to revolve, its motion causes the wheel which touches it to move also, and the motion of that tangent circle causes the wheel which touches it to move likewise; and in this way motion is transmitted or carried through the watch. It will be observed, on examining the inside of a watch, that the circumference of each wheel is indented or toothed; when the watch is going, the teeth of one wheel enters into the indentations of the other, and thus the one wheel is carried round by the other.

Concentric circles are circles within circles, having the same centre. A stone thrown into water produces a familiar instance of concentric circles; the waves at first rush in to supply the place of that portion of water which was displaced by the stone, and then by rapidly flowing back, several circles are formed, one within the other, on the surface of the water; and though these circles are of very various sizes, some being large and others small, yet the spot in which the stone fell is alike the centre of all, and therefore they are called *concentric* circles.

Circles that have not the same centre are called *eccentric*, in reference to each other from the Latin *ex*, out of, and *centrum*, centre. A point which is not the centre of a circle may also be called eccentric in reference to that circle.

Circles are called *equal* when their radii are equal in length, because it necessarily follows that the circumference is also equal: thus, the two wheels of a gig are obviously equal circles, and the spokes or *radii* of one are equal to those of the other.

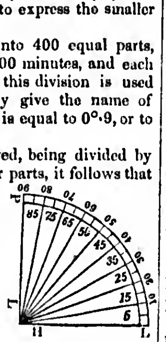
The circle, as we shall hereafter have occasion to show, is of much importance in many operations of practical geometry, and is therefore divided into 360 equal parts, called *degrees*. It would, however, have been possible to have divided the circle into any other number of degrees; the reason why the number 360 was originally fixed upon, is the following. During the early ages of astronomy, the sun was supposed to perform an annual revolution round the earth, while the earth remained perfectly stationary. The first astronomers taught that the orbit or path in which they imagined the sun to move, was a circle, and that the period which elapsed from the moment of his leaving one point in this circle until he returned to it again, was precisely 360 days. Accordingly all circles were divided into 360 degrees.

When it was discovered that the earth moves round the sun, and that she performs an entire revolution, not in 360 days, but in 365 days, 6 hours, 48 minutes, 48 seconds, it was not thought advisable to alter the division of the circle which had previously been established, because the number 360 is found of great convenience in all lengthened calculations, there being many numbers by which it can be divided without a remainder, as 1, 2, 3, 4, 5, 6, 8, 9, 10, 12, 15, 20, &c.

Each of the 360 degrees is subdivided into 60 minutes, and each minute into 60 seconds. The degree is marked thus (°); the minute (′); the second (″); so that, to express 14 degrees, 7 minutes, 5 seconds, we have only to write 14° 7′ 5″. Sometimes the second is again divided into sixty equal parts, called tierces, or thirds, which division is expressed by the sign (‴); but more frequently decimals are used to express the smaller divisions.

The French divide the circle into 400 equal parts, called degrees; each degree into 100 minutes, and each minute into 100 seconds. When this division is used by English writers, they generally give the name of *grades* to the degrees. One grade is equal to 0°·9, or to 54′, or to 3240″.

A circle, as we have just observed, being divided by mathematicians into 360 degrees or parts, it follows that the quarter of a circle includes 90 degrees. Taking, then, a quarter of a circle, and marking it as in the adjoining figure, H L is the horizontal line, and P L the perpendicular line ascending from it. Any line drawn from the centre to any point of the circumference defines the degree of inclination, or slope off the horizontal. Thus, a line ascending from the centre to the 10th degree, is called an inclination or angle of ten degrees; a line ascending to the 45th degree is called an inclination or angle of forty-five degrees; and so on with all the other degrees to the 90th. In this manner a standard of comparison has been established for defining the various slopes or inclinations in planes.

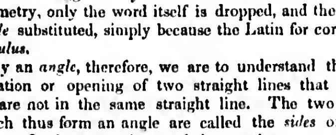


Angles.

Every one is familiar with the meaning of the word *corner:* we are accustomed to call those parts of a room in which the walls meet, the "*corners* of the room," and in the same way, the sharp point in which two sides or edges of a table meet, is also called a corner. The very same idea suggested by the word *corner* is admitted into geometry, only the word itself is dropped, and the word *angle* substituted, simply because the Latin for corner is *angulus*.

By an *angle*, therefore, we are to understand the inclination or opening of two straight lines that meet, but are not in the same straight line. The two lines which thus form an angle are called the *sides* of that angle. In the above figure of the quadrant, or quarter circle, we have an example of a right angle in the corner formed by the junction of the horizontal and upright lines.

An angle which is greater than a right angle, or more than 90° (as O), is called an *obtuse angle*, from the Latin *obtusus*, blunt, because the vertex or angular point has a blunt appearance.

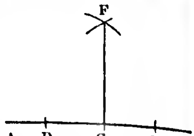


An angle which is less than a right angle, or less than 90° (as A), is called an *acute angle*, from the Latin, *acutus*, sharp, from the vertex being sharp-pointed. The number of degrees by which an obtuse angle exceeds, or by which an acute angle is less than a right angle, is called the *complement* of the angle.

The two lines which form a right angle are said to be *perpendicular* to each other; therefore, whenever a perpendicular is raised either on the ground or on paper, a right angle is formed. Thus, the walls of houses and of all architectural edifices are perpendicular, and form right angles with the ground on which they are built; and when the perpendicular is departed from, as in the Leaning Tower of Pisa, the eye is offended, and an apprehension of danger excited in the mind. It is not, however, essential that a perpendicular line should be vertical, that is to say, in the same direction as a weight falls when suspended by a string: a perpendicular may be in an inclined or even in a horizontal position, provided only that it form an angle of 90 degrees with the line to which it is perpendicular. It is so often requisite in practical geometry to erect a perpendicular, that an instrument called a Carpenter's Square has been invented for the purpose. It consists merely of two flat rulers placed at right angles to each other. As, however, instruments of this description are often made with great inaccuracy, and as it is not, besides, always possible in certain situations to have one at hand, the following methods of raising a perpendicular on a given line and from a given point will be found very useful.

Let A B be the given line, and C the given point.

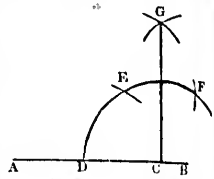
Case 1.—When the point is near the middle of the line.



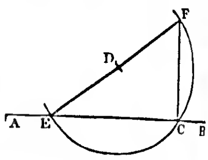
On each side of C lay off equal distances C D, C E; and from D and E as centres, with any radius, describe arcs intersecting in F; draw C F, and this is the required perpendicular.

Case 2.—When the point is near one of the extremities of the line.

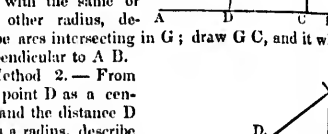
Method 1.—From C as a centre, with any radius, describe the arc D E F, and from D lay off the same radius to E, and from E to F; then from E and F as centres, with the same or any other radius, describe arcs intersecting in G; draw G C, and it will be perpendicular to A B.



Method 2.—From any point D as a centre, and the distance D C as a radius, describe an arc E C F, cutting A B in E and C; draw E D, and produce it to cut the arc in F; then draw F C, and it is the perpendicular.

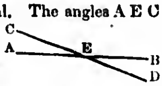


The angles made by a straight line falling on another straight line, are either two right angles, or are together



equal to two right angles. The first of the annexed figures presents an example of two right angles being formed by the meeting of two straight lines. In the second figure it is evident that the angle A C D contains exactly as many degrees more than a right angle as the angle D C B contains less than a right angle; therefore the two angles are together equal to two right angles. Each of these angles is said to be the *supplement* of the other, from the Latin *suppleo*, "I fill up what is deficient," because the numerical value of each angle is exactly what the other wants of 180 degrees, which is the sum of two right angles. Equal angles have therefore invariably equal supplements; and it is scarcely necessary to add, that all angles having equal supplements must be equal.

From this it follows, that when two straight lines cross, the opposite angles are equal. The angles A E C and D E B are called *vertical angles*, because they are opposite to each other; they are evidently equal, simply because they have



equal supplements, as will at once be seen by a careful examination of the figure. The same is true of the angles C E B and A E D. It is manifest from this, that if two straight lines cut one another, the angles which they make at the point of their intersection are together equal to four right angles. Hence, all the angles made by any number of lines meeting in one point are together equal to four right angles.

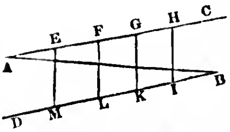
Parallel Lines.

We are surrounded by familiar examples of lines which always preserve the same distance from each other. The ruts made in a muddy road by the wheels of a cart, the iron bars called *rails* of a railroad, upon which the wheels of the steam-carriages run, the five lines upon which the characters of music are drawn, the strings of a harp and of a violin, are all so many instances of lines which are always equidistant from each other; and which, even if prolonged to an infinite extent in the same direction, could never meet. Such lines are in geometry called *parallels*, from the Greek words *para*, beside, and *allelon*, each other.

As the distance between any two parallel lines is always equal at every point, it follows that perpendiculars drawn between such lines must also be equal. Thus, in architecture, the columns which support the upper part of a building are made of equal height, because the roof which they support is parallel with the ground from which they are erected. From the fact that parallel lines cut other lines proportionally, results a mode of dividing a given line into any number of given parts.

Let A B be the given line, and let the number of equal parts be five.

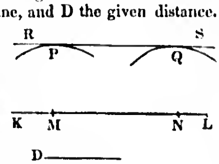
Method 1.—Draw a line A C through A at any inclination to A B, and through B draw another line B D parallel to A C; take any distance A E, and lay



it off four times on A C, forming the equal parts A E, E F, F G, G H; lay off the same distance four times on B D in the same manner; draw the lines H I, G K, F L, and E M, and they will divide A B into five equal parts. or AB, A H, and B M, are cut proportionally.

In this figure, the lines A C and B D being parallel, the parallel lines E M, F L, &c., are equal; and by them the straight line A B is divided into equal parts. In practical geometry, the method of drawing a line parallel to a given line, and at a given distance from it, depends on the fact that the parallel lines are everywhere equidistant, and is the following:—

Let K L be the given line, and D the given distance. From any two points M and N in K L as centres, and a radius equal to D, describe the arcs P and Q; draw a line R S to touch these arcs, that is to be a common tangent to them; and R S is the required line parallel to A B.



Triangles

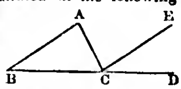
The triangle is one of the most useful figures in geometry; all figures which are bounded by straight lines are capable of being resolved or divided into triangles. A triangle has three sides, and also, as its name imports three angles.

A triangle (as E) in which the three sides are equal is called *equilateral*, from the Latin *æquus*, equal, and *latus*, a side. Such a triangle is also called *equiangular*, (from *æquus*, equal, and *angulus*, corner), because when the sides of a triangle are equal, the angles likewise are invariably equal.

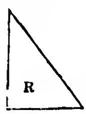
A triangle (as I) having two equal sides, is called *isosceles*, from the Greek *isos*, equal, and *skelos*, leg.

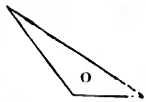
In a *scalene* triangle (as S) the three sides are of unequal length. The word *scalene* literally means unequal, being derived either from *skazo*, to limp, or from *skalenos*, unequal.

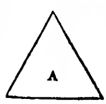
One of the most important properties of triangles is, that the three angles are together equal to two right angles. This fact is demonstrated in the following manner:—Draw a triangle as A B C, and extend one of its sides (B C) as far as D. The obtuse angle thus formed (A C D), is called an *exterior* angle, because it is outside the triangle. From the point C draw a straight line to E, parallel to the line A B. It is an established fact, that all alternate angles formed by a straight line cutting two parallel lines, are equal; the angles B A C, A C E, are alternate, because they are formed by the straight line A C, cutting the two parallel lines A B and C E, and are therefore equal. It is evident that the angles A B C and E C D are equal, because the line A B, which forms a side of one angle, is parallel to the line C E, which forms a side of the other; and the other side of each angle is made by the same line, namely, B D; and an angle being the inclination of one line to another, it is obvious that whenever, as in this case, the inclination of the lines is equal, the angles likewise must be equal. Having now proved that the obtuse exterior angle A C D is equal to the two interior and opposite angles C A B, A B C, we have merely to add A C B, the only remaining angle of the triangle, to the angle A C D; and the angles A C D, A C B, will be found equal to the three angles C B A, B A C, A C B · but the angles A C D, A C B, are equal to two right angles, because, as has been already stated, the angles made by one straight line falling upon another, are either two right angles, or are together equal to two right angles; therefore, the angles C B A, B A C, A C B, are equal to two right angles, or 180 degrees.



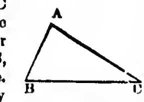
There are several very useful conclusions to be deduced from this property of triangles. 1. There can only be one right angle in a triangle; for, if one angle is 90 degrees, the other angles can only be together equal to 90 degrees; one must be the complement of the other, or what the other wants of 90 degrees. A triangle which has a right angle is called a *right-angled* triangle, as R. The side opposite the righ angle is called the *hypotenuse*. 2. It is equally obvious that a triangle cannot contain more than one obtuse angle. Fig. O is an *obtuse-angled* triangle. 3. All the angles of a triangle may be acute, as A, which is called an *acute-angled* triangle. 4. When two angles of a triangle are known, or even the sum of those angles, the third may be easily discovered; for, if the sum of two angles be deducted from 180 degrees, the remainder must be the number of degrees of which the third angle consists.





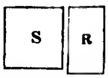


Another property of triangles is, that the greater angle of every triangle has the greater side opposite to it. In the annexed triangle, the angle ABC is greater than the angle BCA. The side AC, being opposite to the larger angle, is longer than the side AB, which is opposite to the smaller angle. There is a kind of natural geometry in the mind even of an uneducated person, according to which he acts without much reflection. Supposing that an untaught peasant had to ascend to the summit of a mountain, he would not commence his ascent from a point where the mountain forms the greatest angle with the ground, and is therefore most precipitous; he would, on the contrary, take the more circuitous road along the opposite side of the mountain, as if he were aware of the property of triangles which has been last mentioned, namely that the largest angles are subtended by the longest sides.

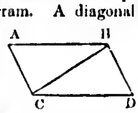


Quadrilateral Figures.

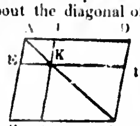
Quadrilateral, or literally four-sided figures, are sometimes called *quadrangles*, because they have four angles; they may be divided into two classes—1. Those in which all the opposite sides are parallel; and, 2. Those in which all the opposite sides are not parallel. Those belonging to the first class are called *parallelograms*, and may be further subdivided into two divisions—namely, those which contain four right angles, and to which the generic name of *rectangle* has consequently been applied; and, secondly, those which do not contain any right angles, two of the angles being obtuse and two acute. A square is the most useful of quadrilateral figures. Having four right angles, it is called a *rectangle*; and all the sides are of equal length. The figure S is a square. The annexed figure R may be called with equal propriety a parallelogram, a rectangle, or an oblong; it will be observed that its sides are not all equal, its length being greater than its breadth. In speaking of a rectangle, it is often found convenient to name it by the lines which compose its base and height, and it is called the rectangle under or contained by these lines. A *rhombus*, or *lozenge*, and a *rhomboid*, form the second division of the first class; because although the sides are parallel, the angles are not right angles. A rhombus has all its sides equal, as B. In a rhomboid, the opposite sides only are equal, as P, the length being either greater than the breadth, or *vice versa*. A *trapezoid* has only two sides parallel, as D. When the sides of a trapezoid that are not parallel are equal, it is sometimes called a *trapezium*, from the Greek word *trapeza*, a table.

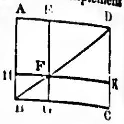


A *diagonal* is a straight line drawn between two opposite angular points of a parallelogram. A diagonal bisects a parallelogram, that is, divides it into two equal parts; thus, let ACDB be a parallelogram, of which BC is a diagonal; the opposite sides and angles of the figure are equal to one another, and the diagonal BC bisects it.



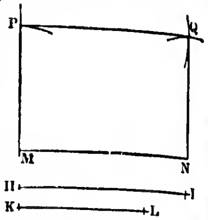
From this it immediately follows, that the complements of the parallelograms, which are about the diagonal of any parallelogram, are equal to one another. It has been shown, that the literal meaning of the term complement is *to fill up*; the application of this term to parallelograms will be understood by carefully comparing the following explanation with the annexed figure. Let ABCD be a parallelogram, of which the diagonal is AC; let EH, FG, be the parallelograms about AC, that is, through which AC passes, and BK, KD, the other parallelograms which make up the whole figure ABCD, which are therefore called the complements. The complement BK is equal to the complement KD. The two complements, joined to any of the parallelograms about a diagonal, form what is called a *gnomon*. Thus the parallelogram HG, together with the complements AF, FC, is the gnomon, which is more briefly expressed by the letters AGK, or EHC, which are placed at the opposite angles of the parallelograms which make the gnomon.





When it is required to describe a rectangle, of which the length and breadth are to be respectively equal to two given lines, the following operation is necessary:—

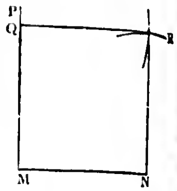
Draw a line MN equal to HI, and draw MP perpendicular to MN, and equal to KL; from P as a centre, with a radius equal to MN, describe an arc at Q; and from N as a centre, with a radius equal to MP, describe an arc cutting the former in Q; draw PQ, NQ; and MQ is the required rectangle.



A square may, for practical purposes, be described in the following manner on any given line.

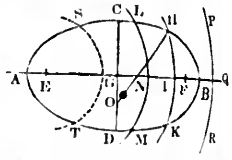
Let MN be the given line.

From M draw MP perpendicular to MN, and from MP cut off a part MQ equal to MN; then from Q and N as centres, with a radius equal to MN, describe arcs intersecting in R; draw QR, and NR, and MR* is the required square.



Ellipse.

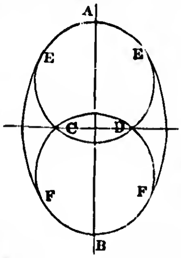
An *ellipse*, or oval, is geometrically constructed as follows, by means of a pair of compasses. Let AB be the major axis or transverse; draw a line bisecting it perpendicularly (which is done by describing from A and B as centres, with any radius, arcs cutting each other in C and D, and then joining C and D), and make GC, GD, each equal to half the minor axis or conjugate; then CD is the minor axis. From C as a centre, with half the major axis AG as a radius, cut AB in E and F, and these points are the foci. Produce AB to Q, till EQ becomes equal to AB; and from E as a centre, with EQ as a radius, describe the arc PQR, and it will be a species of directrix to the ellipse. From the same centre E, with any distance FI, describe the arc HIK, and with IQ, the distance of this arc from PQR, as a radius, and F as a centre, cut the arc HIK in H and K, and these are two points in the curve. Similarly, from E as a centre describe another arc LM; and with the distance of this arc from PQR as a radius, and F as a centre, cut the arc LM



* Quadrilateral figures are concisely named by the letters at two opposite angular points

in L and M, and these are also two points in the curve. Find the other two points S and T in exactly the same manner. Having thus found a sufficient number of points in the curve, join them all carefully, and the ellipse will thus be constructed.

An ellipse may be constructed by the following method, which will be considered sufficiently exact for many practical purposes:—On a given line, as AB, describe two circles of such diameter as may best accord with the required proportions. Whatever size be taken, let the foot of the compasses be placed so as to describe the elongated parts of the figure true on the perpendicular line AB. Then draw a horizontal line so that it intersects the parts C and D, where the circles cut each other. Now, the width of the oval may have



been previously determined; if so, it must regulate the expansion of the compasses, and determine whether the foot shall be placed on the line CD, equidistant from the centre, so as to describe the segment, that it may unite with the lines of the circles on either side, forming a continuous line, as at EE and FF; that is, in such a manner as to form the oval figure as if made by one operation.

Polygons.—Inscribed and Circumscribed Figures.

A plane figure enclosed by more than four straight lines, is called a *polygon*, from the Greek words *polus*, many, and *gonia*, an angle; because, when a figure has many sides, it has necessarily a corresponding number of angles. A regular polygon has all its sides equal, and also all its angles; an irregular polygon has its sides or angles, or both, unequal. A polygon of five sides is called a *pentagon*; of six, a *hexagon*; of seven, a *heptagon*; of eight, an *octagon*; of nine, a *nonagon*; of ten, a *decagon*; of eleven, an *undecagon*; of twelve, a *dodecagon*; and of fifteen, a *quindecagon* or *pentedecagon*. Figures which have more than twelve sides are called polygons of 13, 14, 15, 16, 17 sides, &c.

The centre of a regular polygon is a point equally distant from its sides or angular points. The *apothem* is a perpendicular drawn from the centre to any one of the sides, and analogous to the radius of a circle.

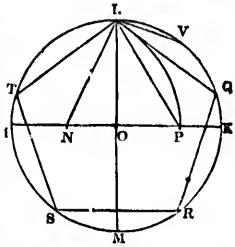
The whole boundary of any figure is called its *perimeter*, from *peri*, around, and *metreo*, I measure. The perimeter of a polygon is, in fact, what the circumference is in a circle, for by it the figure is enclosed. In practical geometry, the usual method adopted for obtaining regular polygons is, in the first place, to draw a circle about equal in size to the required size of the polygon; then the circumference is divided into as many equal parts as the polygon is to have sides; all that then remains to complete the figure is to draw straight lines or chords between each two points of division, and these lines will form the sides of the polygon.

Figures constructed according to this method are said to be *inscribed in* a circle, and all the angles of the inscribed figure will always be found to be upon the circumference of the circle. A reguler pentagon may, by the following process, be inscribed in a circle:—

Let SLR be the given circle.

Draw two perpendicular diameters, IK LM; bisect the radius OI in N; from N as a centre, with NL as a radius, cut OK in P; with radius LP, and centre L, cut the circumference in Q; join LQ, and other four chords equal to it being drawn in succession in the circle, the required polygon will be formed.

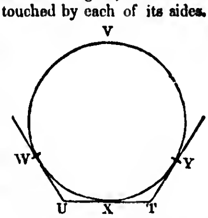
A regular decagon may be inscribed in a circle by a little extension of the same process:—



Let SLR be as before the given circle.

Find a side LQ of the inscribed regular pentagon; bisect the arc LQ in V, and the chord LV being drawn, it is a side of the regular decagon; and ten chords equal to it being successively placed in the circle, will form the polygon.

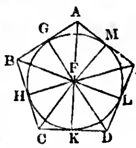
Sometimes a figure is described about a given circle, and is then said to be a circumscribed figure, the circumference of the circle being touched by each of its sides. In practical geometry, the method of describing a regular polygon about a circle is the following:—



Let WVY be the given circle.

Find the angular points of the corresponding inscribed polygon of the same number of sides; let W, X, Y, be three of these angular points; through these points draw the tangents WU, UT; TY; and UT is a side of the required polygon; in the same manner the other sides are found, and the circumscribing polygon is thus described.

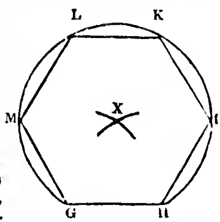
In this manner, the regular pentagon in the adjoining figure is described about the circle; H, K, L, M, and G, being the angular points of the inscribed regular pentagon, and tangents through these points being drawn, the circumscribing regular pentagon is formed.



Practical geometry affords a short and easy method of constructing a regular hexagon upon a given line.

Let GH be the given line.

From G and H as centres, with the radius GH, describe arcs intersecting in X, and this point is the centre of the circumscribing circle; hence, with the radius GH, from the centre X, describe a circle, and apply GH six times along the circumference, and GHKL is the required hexagon.



Another fact relating to the properties of regular figures, and which is of some importance in several of the mechanical arts, is, that there are only three regular figures which can cover a surface completely, so as to leave no intervening interstices; these figures are the square, the equilateral triangle, and the hexagon: we have a familiar example of the fact that squares can completely cover a surface, in a common chess-board—the sides of each square coincide exactly with the sides of the adjoining squares, and no part of the board between the squares is left uncovered. The reason of this is, that all the angles made by any number of lines meeting in one point, are together equal to four right angles, or to 360 degrees; and that, therefore, if it be required to lay any number of figures together, so that the sides may be joined, and that no space may intervene between, it is a necessary condition that the angles contained between their sides be some aliquot part of 360, else their angular points cannot all meet in one point, neither can the surface be covered exactly. The angles of squares being right angles, or angles of 90°, it is obvious that four squares can completely cover any plane surface which is proportionable to their size, because $90 \times 4 = 360$. Six equilateral triangles can be joined without leaving any interstices, because the number of degrees contained in each of their angles is 60, and $60 \times 6 = 360$. Three hexagons can also be placed contiguous to each other, because 120, the number of degrees contained in each of their angles, multiplied by 3, produces 360; but no other figures could by any means be thus placed without leaving interstices; and it is useful to bear this in mind, because in mosaic work, inlaying, paving, and some kinds of ornamental painting, it is often requisite to cover a surface with some regular figure. We sometimes see octagons laid near each other in painted floors, &c., and there is always an empty space between them; but this empty space is a perfect square, because the number of degrees in each angle is 135, and as two angles only meet in one point, the sum of both, $135 + 135$, being equal to 270, there are evidently 90° required to make up the required number 360; and 90° are, as we have shown, contained in the angle of a square.

The honeycombs of a bee-hive afford a familiar illustration of the fact just explained, with respect to the figures which can cover a surface. Of the only three regular figures which can entirely fill up any given space, the bees have selected the hexagon; but here the question arises, Why were the little mathematicians led to choose the hexagon in preference to the square? The reason is cogent and philosophical: the object of the bees was not only to fit in their habitations closely together, so that labour and wax might be saved, and that each little cell might be strengthened by the immediate juxtaposition of other cells, but also to render the interior of each cell as large and commodious as possible; because the young ones are lodged in these cells, and besides, the honey which is to supply the whole hive with food during the winter is stored away in them. Had the square or the equilateral triangle been chosen, the angles of the cell would in that case have certainly been farther from the centre, but the sides would have come nearer to it; for just in proportion to the number of sides is the length of the apothem. When a figure has but few sides, the apothem is comparatively short; and, other things being equal, it increases in length according as the sides are more numerous. The longer the apothem, the farther the sides recede from the centre; therefore, it is clear that a figure of many sides circumscribes a larger space than a figure of equal perimeter, which has fewer sides. This is one of the reasons why a circular form is given to domestic utensils, such as ewers, bottles, casks, culinary vessels, &c., and also to water-pipes, and to the pipes used for conveying gas. A circle is merely a polygon of an infinite number of sides; on account of the infinite smallness of its sides, it is free from all angular projections, and having more sides than any other polygon, it can, with a given perimeter, according to the principle just laid down, enclose the largest possible space. It follows from this, that if, from a given quantity of materials, a vessel is constructed having a circular form, that vessel will be found capable of receiving a larger volume of contents than another vessel wrought into any other form out of the same given quantity of materials would be able to contain. This principle is one of very extensive application, and is constantly acted upon in architecture and in many of the arts.

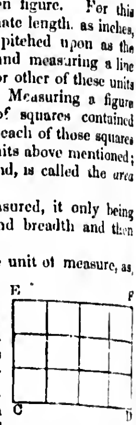
The capacity of a circle, as, for instance, a circular tube, is greatly increased by only a small addition to its diameter, because the increase is all round. The increase of capacity is in the ratio of the squares of the diameter: a tube 8 inches in diameter has four times the capacity of one which is 4 inches in diameter; one 16 inches in diameter has four times the capacity of one 8 inches in diameter; and so on.

MENSURATION OF PLANE FIGURES.

It is often requisite, for many practical purposes, to ascertain the exact size of a given figure. For this purpose certain lines of a determinate length, as inches, feet, yards, miles, &c., have been pitched upon as the *units of measure* or *lineal units;* and measuring a line consists in finding how often one or other of these units of measure is contained therein. Measuring a figure consists in finding the number of squares contained within its boundaries, the sides of each of those squares being equal to one of the lineal units above mentioned; the number of squares, when found, is called the *area* or *superficial content* of the figure.

A rectangle is very easily measured, it only being requisite to ascertain its length and breadth and then to multiply the one by the other.

If CE is a rectangle, and M the unit of measure, as, for example, a foot; and if the base CD contains M 4 times, and the side DE contains it 3 times, the number of squares described on M that are contained in CE is just $= 4 \times 3 = 12$ square feet. For by laying off parts on CD, DE, equal to M, and drawing through the points of division lines parallel to the sides of the figure, it will evidently be divided into 3 rows of squares, each containing 4 squares; that is, $3 \times 4 = 12$ squares or square feet.



If the side CD contained $4\frac{1}{2}$ inches, and DE 3 inches, it would similarly be found that the number of square inches in the figure would be $= 4\frac{1}{2} \times 3 = \frac{9}{2} \times 3 = 13\frac{1}{2}$ square inches; or $4{\cdot}5 \times 3 = 13{\cdot}5$ square inches; and whatever is the length of the sides, the area is found always in the same manner.

The area of a square is at once known by multiplying one of the sides by itself; thus, supposing one side of a square table to measure 4 feet, then 4 multiplied by 4 gives the whole number of square feet contained in the table, namely, 16.

It is demonstrated by Euclid, that parallelograms upon the same base and between the same parallels are equal to each other; from this it follows that the area of a rhombus and a rhomboid can be ascertained by the same easy process adopted for measuring rectangles, namely, by multiplying the length by the perpendicular height or breadth. The area of a triangle is also found in the same way, the base being multiplied by the perpendicular height; but only half the product denotes the content of the triangle, because a triangle is exactly the half of a parallelogram of the same base and altitude.

The area of any quadrilateral may be found by the same method: a diagonal being drawn from two of its opposite angles, it will be divided into two triangles, and by computing as above the area of each triangle, and then adding their areas together, their sum will indicate the whole extent of area comprised within the quadrilateral. The area of a trapezoid is generally found by multiplying half the sum of the two parallel sides by the perpendicular distance between them: the area of a trapezium may likewise be found in the same way. When it is desired to ascertain the area of an irregular polygon, diagonals must be drawn between the opposite angles; this will divide the figure into quadrilaterals or trapezoids, and triangles, and the area of each these must be found separately, according to the above rules; all these areas added together will give the whole superficial content of the polygon.

The area of a regular polygon is found by adding all the sides together, and then multiplying the sum by the apothem: half the product will be equal to the r . The reason of this is, that every regular polygon y be divided into as many equal triangles as it has s, and as the area of a triangle is equal to half the product produced by the multiplication of the base by the perpendicular, so the total amount of all the triangles forming a polygon may be found by multiplying the sides of the polygon, which are the bases of the respective triangles, by half the apothem; because the apothem, as before explained, is only a perpendicular drawn from the centre of the polygon to the middle of one of the sides, and is therefore equal to the perpendicular height of each triangle; half the product, as in the case of a single triangle, therefore, gives the required area.

The rule for finding the area of a polygon leads to that for finding the area of a circle; because, as before observed, a circle may, by approximation, be considered as a regular polygon with an infinite number of infinitely small sides. As the area of a polygon is obtained by the multiplication of its perimeter by its apothem, so it may naturally be inferred that the multiplication of the circumference of a circle by its radius will be the means of discovering the area of the circle. But here a difficulty arises; it is evident that the radius and circumference cannot be multiplied until the exact length of each be known: there is no difficulty of this kind in the measurement of polygons, because their sides, being straight lines, can easily be measured; the radius of a circle, being also a straight line can be measured with equal facility; but how are we to ascertain the length of the circumference? This question has occupied the attention of philosophers from age to age, and was never solved to the entire satisfaction of any till about a century ago. Innumerable attempts have been made to discover what ratio a circumference bears to its diameter. Archimedes, one of the Greek geometricians, who lived more than two thousand years ago, assigned the ratio to be as 7 to 22; nearer ratios have been discovered since his time. A Dutch mathematician carried the ratio to 36 figures, and this was at the time considered so important a discovery, that it was engraved on his tombstone at Leyden. Others subsequently extended the ratio still further; and in a French work published about 1719 A. D., it was carried to no less than 128 figures. The ratio 3·1416 is sufficiently accurate for all common purposes. When very great accuracy is required, the ratio 3·14159 may be used instead of 3.1416. Sometimes the ratio 3.1415926536 is taken, but such a high degree of accuracy is seldom required. The general rule for finding the length of the circumference of a circle is to multiply the diameter by the ratio, and the product is the circumference; or to add the stant logarithm 0·4971509 to that of the diameter, and the sum is the logarithm of the circumference.

THE CONSTRUCTION OF SCALES.—PROPORTION.

In practical geometry, scales of various kinds are used for the construction of figures. Scales are lines with divisions of various kinds marked upon them, according as they are to be used for measuring lines or angles. The name of *scales* is given to lines so divided, because the Latin word for ladder is *scala*, and the divisions are equidistant like the steps of a ladder. A line so divided is for the same reason said to be *graduated*, this word being derived from the Latin *gradus*, a step.

The *values* of the magnitudes of lines or angles are numbers representing the number of times that some unit of the same kind is contained in them.

The *unit of measure* for lines is some line of given length, as a foot, a yard, a mile, and so on.

The unit of measure for angles is, as we have already shown, the ninetieth part of a right angle.

The method of constructing a scale of equal parts is the following:—

Lay off a number of equal divisions, AB, BC, CD, &c., and AE, and divide AE into 10 equal parts.

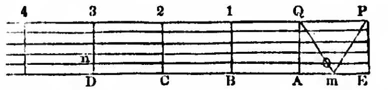
When a large division, as AB, represents 10, each of the small divisions in AE will represent 1. When each of the large divisions represents 100, each of the small divisions in AE represents 10. Hence, on the latter supposition, the distance from C to *n* is 230; and on the former supposition, it is 23.

If the large divisions represent units, the small ones on AE represent tenths, that is, each of them is $\frac{1}{10}$, or ·1. On this supposition, the distance C*n* is 2·3.

To construct a plane diagonal scale

1. A diagonal scale for two figures.

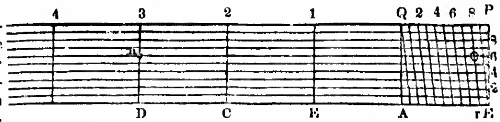
Draw five lines parallel to DE, and equidistant, and



lay off the equal divisions AE, AB, BC, CD, &., and make EP, AQ, B1, C2, &c., perpendicular to DE. Find *m* the middle of AE, and draw the lines Q*m*, *m*P.

The mode of using this scale is evident from the last If the large divisions denote tens, then from *n* to *o* is evidently 34.

2. A diagonal scale for three figures.



Draw ten lines parallel to DE, and equidistant. Lay off the equal parts AB, BC, CD, &c., and AE, and draw EP, AQ, 1, C2, ... &c., perpendicular to DE. Divide QP, into 10 equal parts. Join the 1st 2d, 3d, ... divisions on QP with the 2d, 3d, 4th, ... divisions on AE respectively.

If the divisions on AD each represent 100, each of those on QP will represent 10. Thus from 3 on AD to 8 QP is 380; but by moving the points of the compasses down to the fourth line, and extending them from *n* to *o*, the number will be 384. For the distance of 8 on QP from Q is 80, and of *r* from A is 90; and hence that of *o* from the line AQ is 84.

When the divisions on AD denote tens, those on QP denote units; and from *n* to *o* would then represent $38\frac{4}{10}$ or 30·4.

When the numbers representing the lengths of the sides of any figure would give lines of an inconvenient size taken from the scale, the numbers may be all multiplied or all divided by such a number as will adapt the lengths of the lines to the required dimensions of the figure.

Scales, by enabling us to ascertain the length of lines and magnitudes of figures, are very useful in the investigation of the doctrine of proportion. The import of the term proportion has already been sufficiently dwelt upon in arithmetic; and the reader has only to apply the ideas there developed to lines and to figures.

To prevent any misapprehension on the subject, it is well to understand clearly the distinction between the term *equal* and *similar* figures. Equal figures are those which are precisely the same in every respect, being of the same size and of the same form. Similar figures are those which are precisely of the same form or shape, but of different sizes; the angles of two similar figures are equal, and the homologous sides, that is, the sides which lie in the same relative position in each figure, are proportional.

There is always a difficulty in the demonstration of the doctrine of proportion, on account of the frequent occurrence of incommensurable quantities, that is to say, quantities which have no common measure; the subject is however rendered clear by the higher branches of mathematics.

The applications of the doctrine of proportion are very numerous and important, for it is the very foundation of many arithmetical, algebraical, and trigonometrical operations. It furnishes rules for taking plans in architecture and surveying: a map, whether of an estate or of a country, is merely a proportional representation on a small scale of the exact outline of a district. Sculpture and painting, usually numbered among the fine arts, are really wholly dependent upon the mathematical doctrine of proportion; a statue or bust, for instance, is either equal to some given figure, and is then familiarly termed "large as life," or else it is a similar figure proportionably larger or smaller than the given figure, according as it is constructed on a larger or a smaller scale. In the same way, landscape paintings are merely delineations of the prominent forms in natural scenery, all of which are represented in proportion on a smaller scale; and the value of the painting in a great measure depends on the mathematical exactness of these proportions.

ANALYSIS OF EUCLID'S ELEMENTS.

It is one of the most remarkable facts in the history of science, that, while the great majority of ancient scientific treatises have been altogether cast aside, and their place supplied by more recent productions, destined in their turn to be as entirely superseded by others of still more recent date, yet that one book has weathered every ebb and flow of popular opinion, and still holds as high, if not a higher, place in the public estimation, as when first given to the world. This work was written more than 2000 years ago; and it is surely scarcely necessary to add, that Euclid was the author, or perhaps rather the compiler, of this extraordinary production. There are thirteen books extant written by Euclid, and hence called *Euclid's Elements*. The fourteenth and fifteenth books are supposed to have been added by Hysicles of Alexandria, about 170 A. D. The method of reasoning pursued throughout these Elements, and adopted by all mathematicians, is the following:—In the first place, certain definitions, postulates, and axioms, are laid down, which form the entire basis of all mathematical science. Perhaps it might be advisable to make a few observations on the exact meaning of these terms before we proceed farther.

By a *definition*, is merely meant an explanation or a description of the characteristic properties of the object defined; the assertion, for instance, that "an isosceles triangle is that which has only two sides equal," is a definition, because it conveys to an unlearned person an idea of the meaning of the term isosceles.

A *postulate* is something that is allowed to be done, or to be *imagined* to be done. The postulates given by Euclid are the following:—

1. A line may be drawn from any one point to any other point.
2. A line may be produced (that is, continued or lengthened) at pleasure to any length.
3. A circle may be described about any centre, and at any distance, or with any radius. It will be evident, from a careful examination of these postulates, that when necessary to prove any process of reasoning, it is permitted to draw a line to the moon, and another from the moon to a star, or to any point in the heavens; and although it is of course impossible really to draw such lines, yet by these postulates we are permitted to *imagine* them to be so drawn. It is also evident, that by these postulates we are permitted the use of two instruments in mathematical reasoning, namely the ruler and the compasses.

Mascheroni, an Italian mathematician, endeavouring to render the narrow basis upon which geometry is upreared still more narrow, suggested a method of performing all mathematical problems by the aid of compasses alone, dispensing altogether with straight lines and the ruler: an account of this plan may be seen in a celebrated work published by Mascheroni about A. D. 1797, entitled *Geometria del Compassa* (Geometry of the Compasses).

An *axiom* is a statement of some simple fact which is self-evident, or requires no proof; thus, the 9th axiom is an assertion that the whole is greater than its part. It is impossible to doubt a statement like this; even a child is prepared to admit its truth; for who is not aware that a whole mass of stone, for instance, is greater than any fragment that may be broken off it? and every day's observation is equally confirmatory of all the other axioms, which, as propounded by Euclid in the first book, are the following:

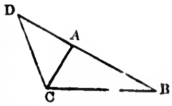
1. Things which are equal to the same thing, are equal to one another.
2. If equals be added to equals, the whole are equal.
3. If equals be taken from equals, the remainders are equal.
4. If equals be added to unequals, the wholes are unequal.
5. If equals be taken from unequals, the remainders are unequal.
6. Things which are double of the same, are equal to one another.
7. Things which are halves of the same, are equal to one another.
8. Magnitudes which coincide with one another, that is, which exactly fill the same space, are equal to one another.
9. The whole is greater than its part.
10. All right angles are equal to one another
11. Two straight lines cannot be drawn through the same point, parallel to the same straight line, without coinciding with one another.
12. It is possible for another figure to exist, equal in every respect to any given figure.

Geometrical facts and suppositions are, by Euclid and all other mathematicians, couched in a form of expression called a *proposition*. There are three kinds of propositions, *theorems*, *problems*, and *lemmas*. A *theorem* is a statement of some truth or class of truths; but as, with the single exception of the axioms, no bare assertion or statement is admitted into geometry unless fully corroborated by proofs, a theorem requires to be demonstrated. There is no way of proving the truth of a theorem, except by reference to some truth or truths already established by previous theorems; which again must have been demonstrated by some preceding theorems; and thus we are led back from theorem to theorem, until we arrive at the foundation upon which they are all found to rest, namely, the definitions and axioms.

A *problem* either proposes something to be effected, as the construction of a figure, or it is a question which ought to be solved; in either case it requires something *to be done*, and therefore depends entirely upon the postulates for its solution. After the *solution* has been stated, its sufficiency for performing all the required conditions still remains to be proved.

A *lemma* is a theorem which properly belongs to some other part of geometry, but which, from the close connection which subsists between all the branches of mathematical science, is often fitly introduced to explain some difficulty which would otherwise arise in the demonstration of the succeeding theorems or problems. As lemmas rather disturb the continuous order of a subject, they are never used by good mathematicians except when absolutely requisite.

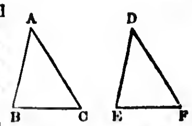
Having now explained the meaning of the terms used in geometrical reasoning, the following observations on the nature of that reasoning, and the method pursued by Euclid and others, will be readily understood:—A proposition is first stated in general terms: take, for instance, the 20th proposition—"Any two sides of a triangle are together greater than the third side." This is but bare assertion: to advance a step farther, Euclid places the figure referred to, namely, a triangle, before the student, and tells him that, in the annexed triangle, namely, ABC, any two sides of it together are greater than the third side; that is to say, the sides BA, AC, are together greater than the one side BC; the sides AB, BC, are greater than AC; and BC, CA, are greater than AB. This is certainly calling off the attention from a mere general observation, and confining it for a time to the examination of one individual case; it is also demanding the assent of the perceptive faculties; for the moment that the eye lights upon the triangle ABC the mind is immediately ready to acknowledge that two of the sides are together greater than only one of its sides: yet the matter cannot rest here. Euclid knew, as well as any of our modern philosophers, that there are *two* primary principles in the human intellect: the eye sees and conveys its impressions directly to the perceptive or observing faculties; but information thus acquired ought to be immediately brought under cognisance of those faculties which enable us to trace the cause as well as the effect, and to compare the relation of things. Euclid, therefore, subjected every proposition he advanced to a double kind of proof, by addressing *both* the sets of faculties which compose the human intellect: perhaps this may alone be sufficient to account for the fact, that his work has from age to age been used as the text-book of elementary geometry, while other works, because less truly philosophical, have engrossed public attention for a moment, and have then sunk into oblivion.



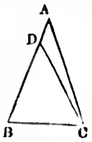
A brief analysis of the several books composing what is called Euclid's Elements, may not be unacceptable to the unlearned reader. The first three propositions in Book I. are problems, and show the several methods of describing an equilateral triangle, of drawing a straight line equal to a given straight line from a given point, and of cutting off from the greater of two given straight lines a part equal to the less. The fourth proposition is the first theorem which occurs in Euclid, and requires to be examined a little in detail, because, in connection with the 8th proposition, it forms the foundation of all that is advanced respecting the comparison of triangles. This important theorem, as stated by Euclid, is as follows:—

If two triangles have two sides of the one equal to two sides of the other, each to each, and have likewise the angles contained by those sides equal to one another, their bases or third sides shall be equal, and the two triangles shall be equal, and their other angles shall be equal, each to each, namely, those to which the equal sides are opposite. Or, if two sides and the contained angle of one triangle be respectively equal to those of another, the triangles are equal in every respect.

Let ABC, DEF, be two triangles, which have the two sides AB, AC, equal to the two sides DE, DF, each to each, namely, AB to DE, and AC to DF, and the angle BAC equal to the angle EDF; the base BC shall be equal to the base EF, and the triangle ABC to the triangle DEF; and the other angles, to which the equal sides are opposite, shall be equal, each to each namely, the angle ABC to the angle DEF, and the angle ACB to DFE. The method adopted for demonstrating this theorem, as well as that contained in the 8th proposition, is a peculiar species of demonstration which has received the name of super-position: it is in reality the same method pursued by tailors and dressmakers when they wish to satisfy themselves as to whether a piece of cloth has been cut correctly from a given pattern; they place their original pattern and the piece of cloth or silk together, the one behind the other, and carefully observe whether the edges of one project beyond those of the other; but if they both coincide in every point, the tailor knows that his cloth has been correctly cut according to the pattern. In the same way, Euclid requires the triangle ABC to be applied to, or placed exactly over, the triangle DEF, so that the point A may be on D, and the straight line AB upon DE, the point B shall coincide with the point E, because AB is equal to DE; and AB coinciding with DE, AC shall coincide with DF, because the angle BAC is equal to the angle EDF; wherefore, also, the point C shall coincide with the point F, because AC is equal to DF; but the point B coincides with the point E, wherefore the base BC shall coincide with the base EF, and shall be equal to it. Therefore, also, the whole triangle ABC shall coincide with the whole triangle DEF, and be equal to it; and the remaining angles of the one shall coincide with the remaining angles of the other, and be equal to them; namely, the angle ABC to the angle DEF, and the angle ACB to the angle DFE. The postulates do not permit one triangle to be cut out and placed over the other, therefore Euclid only *imagines* what would be the result supposing this were to be done. This theorem depends entirely upon the 8th axiom, being, in point of fact, merely what a logician would call the converse of it; for in the 8th axiom it is stated, that magnitudes which coincide with one another, that is, which exactly fill the same space, are equal to one another; and in this theorem, in order to prove them equal, it is proved that they coincide.



The demonstration of the 6th proposition is the first instance in Euclid of a species of reasoning termed by logicians *indirect*, or a *reductio ad absurdum*, and which consists in proving a theorem to be true by showing that an absurdity would follow from supposing it false. The theorem here advanced is, that if two angles of a triangle be equal to one another, the sides which subtend, or are opposite to, those angles, shall also be equal to one another, and it is demonstrated by the following indirect mode of reasoning:—Let ABC be a triangle, having the angle ABC equal to the angle ACB, the side AB is also equal to the side AC. For if AB be not equal to AC, one of them was greater than the other. Let AB be the greater, and from it cut off DB equal to AC, the less, and join DC, therefore, because in the triangles DBC, ACB, DB is equal to AC, and BC common to both; the two sides DB, BC, are equal to the two AC, CB, each to each; but the angle DBC is also equal to the angle ACB; therefore, the base DC of the one is equal to the base AB of the other, and the triangle DBC is equal to the triangle ACB, the less to the greater, which is absurd. Therefore, AB is not unequal to AC; that is, it is equal to it.



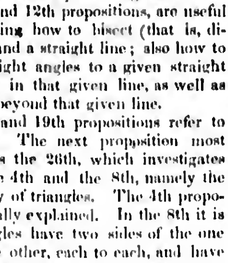
The corollary or inference drawn from this is, that all triangles having equal angles have also equal sides.

The 7th proposition affords another specimen of that kind of indirect demonstration, which logicians call a dilemma. It is stated in the proposition, that, upon the same base, and on the same side of it, there cannot be two triangles that have their sides which are terminated in one extremity of the base equal to one another, and likewise those which are terminated in the other extremity equal to one another. This is proved by examining separately every possible position in which two equal triangles can be imagined to be placed so as to have but one base: it is evident that if they *could* be so placed, the vertex of one triangle must be either without, within, or on one side of the other triangle: each of these suppositions is examined separately, and each proved to be impossible; the reader is thus brought into a dilemma, having no alternative but to admit the truth stated in the theorem. There are many instances in which this species of demonstration is used by Euclid.

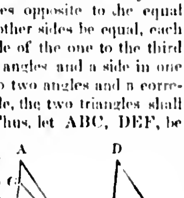
The 8th proposition refers to equal triangles.

The 9th, 10th, 11th, and 12th propositions, are useful practical problems, showing how to bisect (that is, divide in two) an angle and a straight line; also how to draw a straight line at right angles to a given straight line, from a given point in that given line, as well as from a point without or beyond that given line.

The 16th, 17th, 18th, and 19th propositions refer to the angles of triangles. The next proposition most worthy of examination is the 26th, which investigates the same subject as the 4th and the 8th, namely the conditions of the equality of triangles. The 4th proposition has already been fully explained. In the 8th it is proved that if two triangles have two sides of the one equal to two sides of the other, each to each, and have likewise their bases equal, the angle which is contained by the two sides of the one shall be equal to the angle contained by the two sides of the other; or if the three sides of one triangle be respectively equal to those of another, the triangles are equal in every respect. Thus, let ABC, DEF, be two triangles having the two sides AB, AC, equal to the two sides DE, DF, each to each, namely, AB to DE, and AC to DF; and also the base BC equal to the base EF; the angle BAC is equal to the angle EDF, and the angles at B and C of the triangle ABC are respectively equal to those at E and F of the triangle DEF.



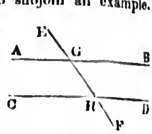
The 26th proposition gives still further information on this useful subject. It shows that if two triangles have two angles of the one equal to two angles of the other, each to each, and one side equal to one side, namely, either the sides adjacent to the equal angles, or the sides opposite to the equal angles in each, then shall the other sides be equal, each to each, and also the third angle of the one to the third angle of the other; or, if two angles and a side in one triangle be respectively equal to two angles and a corresponding side in another triangle, the two triangles shall be equal in every respect. Thus, let ABC, DEF, be two triangles which have the angles ABC, BCA, respectively equal to DEF, EFD; namely, ABC to DEF, and BCA to EFD; also one side equal to one side; and first, let those sides be equal which are adjacent to the angles that are equal in the two triangles, namely, BC to EF; the other sides shall be equal each to each, namely, AB to DE, and AC to DF; and the third angle BAC to the third angle EDF.



This little group of theorems is found very useful in the arts, for it is often requisite to have some rule by which to be able at once to determine whether two given triangles are exactly equal to each other; and if such rules were firmly engraven in the mind of every mechanic, there is no doubt but that there would be far less expenditure of time, labour, and money.

In the 27th proposition, the investigation of the properties of parallel lines is commenced, and this subject is continued through the 28th, 29th, 30th, and 31st propositions, until suddenly broken off by the introduction of one of the most remarkable propositions in the whole book, namely, the 32d, in which it is shown that the three interior angles of a triangle are together equal to two right angles. This important fact has already been examined, and therefore we have only to add that it was discovered by Pythagoras, a philosopher of Samos, about 500 B. C. The doctrine of parallel lines must not be dismissed hastily, for, with the exception perhaps of proportion, no other part of elementary geometry has created so much perplexity and discussion. The first two theorems relating to parallel lines are very simple and easily demonstrated; for the 27th theorem only affirms, that if a straight line falling upon two other straight lines makes the alternate angles equal to one another, these two straight lines shall be parallel. The 28th theorem is equally easy of demonstration, as it merely assumes that if a straight line falling upon two other straight lines makes the exterior angle equal to the interior and opposite angle upon the same side of the line, or makes the interior angles upon the same side together equal to two right angles, the two straight lines shall be parallel to one another. To make this more clear, it may be as well to subjoin an example.

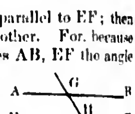
Let the straight line EF, which falls upon the two straight lines AB, CD, make the exterior angle EGB equal to the interior and opposite angle GHD upon the same side; or make the interior angles on the same side, BGH, GHD, together equal to two right angles; AB is parallel to CD.



But the 29th proposition assumes the converse of this, namely, if a straight line fall upon two parallel straight lines, it makes the alternate angles equal to one another; and the exterior angle equal to the interior and opposite upon the same side; and likewise the two interior angles upon the same side together equal to two right angles. Now, the assertion contained in this theorem is both easy of comprehension and evident to the senses; the difficulty lies in subjecting it to that rigorous demonstration to which all theorems must be brought before they can be received as mathematical truths. Euclid has endeavoured to prove it by means of a *reductio ad absurdum*, but this species of demonstration is for many reasons never adopted by good mathematicians, when it is possible to prove the truth of a statement by any other process of reasoning. Almost every succeeding mathematician has devised some particular method of his own to elucidate the doctrine of parallel lines, but no one has ever yet fully succeeded in effecting the required demonstration.

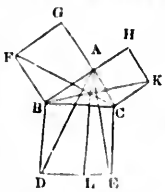
The 30th proposition shows that straight lines which are parallel to the same straight line are parallel to one another. The following demonstration of this fact is founded upon the truths previously advanced in the 29th and 27th propositions:—

Let the two lines AB, CD, be parallel to EF; then AB and CD are parallel to one another. For, because GHK cuts the parallel straight lines AB, EF the angle AGH is equal to the angle GHF. Again, because the straight line GK cuts the parallel straight lines EF, CD, the angle GHF is equal to the angle GKD; and it was shown



that the angle AGK is equal to the angle GHF; therefore, also AGK is equal to GKD, and they are alternate angles; therefore AB is parallel to CD.

The 33d proposition resumes the chain of demonstration, which was suddenly interrupted by the insertion of the famous 32d proposition, and continues the investigation of the properties of parallel lines. This subject naturally leads to the examination of parallelograms; and indeed it may be said, that almost all the succeeding propositions in the first book are devoted to the investigation of parallelograms, and the relation subsisting between the properties of parallelograms and those of triangles. In proposition 35, for instance, it is alleged that parallelograms upon the same base and between the same parallels, are equal to each other; in proposition 37, the same fact is affirmed with respect to triangles, namely, that triangles upon the same base and between the same parallels, are equal. Propositions 36 and 38 are the converse of the preceding. The most celebrated, however, of the succeeding theorems, and the most striking, perhaps, in the whole range of geometrical science, is the 47th proposition. We subjoin the theorem and the example given, and refer those who are curious as to the method of demonstration, to Euclid himself. In any right-angled triangle, the square which is described upon the sides subtending the right angle, is equal to the squares described upon the sides which contain the right angle. Let ABC be a right-angled triangle, having the right angle BAC; the square, described upon the side BC is equal to the squares described upon BA, AC; that is, the square BE is equal to the two squares BG and CH. Pythagoras had also the honour of discovering this important truth. It is related, that immediately upon the discovery, he was so transported with joy at the value of the truth, and with gratitude at being permitted to reveal it to the human race, that he sacrificed a whole hecatomb, that is to say, a hundred oxen, as a testimony of his thankfulness. This story is entirely fabulous; yet something may be gained even from a fable; and from this fictitious narration we learn, that the truth now unfolded in the 47th proposition was held in the highest estimation, not only by the discoverer, but by the ancients who invented the fable and who transmitted it to posterity.



Having now examined Euclid's method of reasoning, and the various forms of logical arguments employed by him, and adopted by others in demonstrations, it now only remains to glance rapidly at the contents of the other books.

In the second book, the properties of rectangles and squares formed under given lines, constitute the principal subject of investigation. All the demonstrations in this book are very simple; many of them consist chiefly in proving that the figure drawn is really composed of the rectangles alluded to in the proposition; and most of the demonstrations are founded upon the self-evident principle, that the whole is equal to all its parts taken together. The first three propositions show the theory of common mathematical multiplication, and also that of the mensuration of rectangles in practical geometry, already explained. The 4th may be called a geometrical demonstration of the rule laid down for extracting the square root of two terms in arithmetic and algebra. The 5th. 6th, 7th, and 8th propositions show the principles upon which some useful operations in algebra are conducted; all the remaining propositions of this book are of great value in trigonometry.

The third book is devoted entirely to the investigation of the circle, and of various lines considered with reference to the circle, and drawn within or without its circumference. The properties of tangents and of tangent circles are fully considered; and also the relation between angles which are made at the circumference and those made at the centre. This book is of great use in various mechanical arts; it is also the foundation of practical geometry, the circle being very frequently used in the construction of complicated figures.

The fourth book may be considered as a continuation of the third, as it treats of such figures as cannot be easily drawn without the circle. It explains the method of describing regular polygons in and about circles; and conversely, to describe circles in and about regular polygons.

The fifth and sixth books may be considered together, being both devoted to the same subject, namely, the doctrine of proportion. The fifth book is introductory to the sixth, for it lays down abstract theorems relative to proportion; and the sixth book shows the application of these theorems to geometry. Every branch of mathematical science is more or less dependent upon the demonstrations contained in these two books.

The seventh, eighth, ninth, and tenth books are never put into the hands of students, being of very little use in any part of mathematics. The doctrine of proportion is more or less dwelt upon in all these four books; and they also treat of the greatest common measure of any two numbers, of square and cube numbers, and of incommensurable quantities. The main, if not the only, object of Euclid, in writing these four books, seems to have been to settle the intricate question of incommensurables.

The remaining books of Euclid are entirely devoted to the examination of solids, and to the investigation of their properties and relations.

SOLID GEOMETRY.

It has been already observed, that all bodies having length, breadth, and thickness, such as wood, timber, &c., are called solids; and that the investigation of the properties and relations of the various figures assumed by such bodies, is the object of solid geometry.

The boundaries of solids are surfaces. Those solids which are bounded by plane surfaces are called *polyhedrons*, from the Greek words *polus*, many, and *edra*, a seat. The planes which contain a polyhedron are called its *sides* or *faces*; the lines bounding its sides are termed its *edges*: and the inclination of any two of the planes is called a *dihedral* angle.

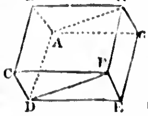
The meaning of parallel lines having been already explained, it is only necessary to say that the word parallel has the same signification when applied to planes as when applied to lines. *Parallel planes*, like parallel lines, would never meet, even if lengthened to any extent. The ceiling and the floor of a room are parallel planes.

A *solid* angle is formed by three or more plane angles meeting in the same point. The corner of a box, for instance, is a solid angle formed by the junction of three angles, namely, the plane angle terminating one side of the upper or under surface of the box, and the two plane angles belonging to its two sides.

The generic name of *prism* is given to all polyhedrons contained between two opposite, parallel, and equal polygons, connected together by parallelograms. The common bricks used in masonry are familiar examples of one species of prism; the little optical instrument used for showing the colours of rays of light, is another kind of prism—it is a glass, bounded by two equal and parallel triangular ends, and three equal and similar sides. The two ends of prisms are generally called the *terminating planes*, and one of them is called the *base*. The edges of the sides are called the *lateral edges*, and those of the terminating planes are called the *terminating edges*

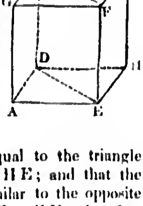
Prisms may be right or oblique, regular or irregular. In *right* prisms, the lateral edges are perpendicular to the base; in *oblique* prisms the sides are in an oblique position with respect to the base. A right prism having regular polygons for its terminating planes, is said to be *regular*; an *irregular* prism is one in which the ends are irregular polygons. The line joining the centre of the terminating planes of a regular prism is called the *prismatic axis*, and the *altitude* or *height* of the prism is equal to the length of this line.

The parallelograms which form the sides of prisms, are always equal in number to the sides of the base, and prisms are classed accordingly. The prisms which have a triangular base are called *triangular* prisms, those which have a quadrangular base are called *quadrilateral* prisms. *Hexagonal* prisms are those having a hexagon for their bases; and *polygonal* prisms are those of which the base is a polygon. The parallelopiped and the cube are two quadrangular prisms, which, being of great importance in the arts, require special attention. The *parallelopiped* is bounded by six four-sided figures, of which every opposite two are parallel. It is called rectangular when its base is a rectangle; and when these six planes are all rectangles placed perpendicularly to each other, it is said to be right, and oblique when the planes are inclined to each other. We can scarcely look round us without seeing rectangular parallelopipedons. Beams of timber, hewn stones, the box of a gardener's wheel-barrow, the bodies of carts, are almost invariably rectangular parallelopipedons; and this form is generally given to houses and to rooms. It is one of the propositions of the 11th book of Euclid, that if a solid be contained by six planes, two and two of which are parallel, the opposite planes are similar and equal parallelograms; thus, let the solid C D G H (which is a parallelopiped), be contained by the parallel planes A C, G F; B G, C E; F B, A E; its opposite planes are similar and equal parallelograms.



Parallelopipeds, when cut by a plane passing through the diagonals of two of the opposite planes, are formed into two equal triangular prisms.

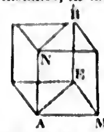
Let A B be a solid parallelopiped, and D E, C F, the diagonals of the opposite parallelograms, A H, G B, namely, those which are drawn betwixt the equal angles in each; and because C D, F E, are each of them parallel to G A, though not in the same plane with it, C D, F E, are parallel; wherefore the diagonals C F, D E, are in the plane in which the parallels are, and are themselves parallels; and the plane C D E F shall cut the solid A B into two equal parts.

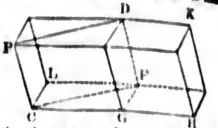


Because the triangle C G F is equal to the triangle C B F, and the triangle D A E to D H E; and that the parallelogram C A is equal and similar to the opposite one, B F; and the parallelogram G E to C H; therefore the planes which contain the prisms C A E, C B E, are equal and similar, each to each; and they are also equally inclined to one another, because the planes A C, E B, are parallel, as also A F and B D, and they are cut by the plane C E; therefore the prism C A E is equal to the prism C B E, and the solid A B is cut into two equal prisms by the plane C D E F.

Def.—The *insisting* straight lines of a parallelopiped, mentioned in the following propositions, are the sides of the parallelograms betwixt the base and the plane parallel to it.

Parallelopipeds are equal when they are upon equal bases and of the same altitude. This fact is very evident, and is constantly acted upon when the solids are right; for instance, in making book-shelves, each shelf is made



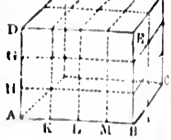


equal to the others—that is, it is made equally long and equally broad, and has the same altitude or thickness. Solid parallelopipeds which have the same altitude, are to one another as their bases; thus, let A B, C D, be solid parallelopipeds of the same altitude; they are to one another as their bases—that is, as the base A E is to the base C F, so is the solid A B to the solid C D.

Whatever can be proved respecting the properties of parallelopipeds, is equally true with respect to those of cubes, because a cube is merely a parallelopiped with square sides. The dice used by gamblers are cubes; and tables, footstools, and rooms often receive a cubic form. Just as the unit of measure for plane surfaces is a square, so the *unit of measure for solids* is a cube, and the length of each side of the cube is an inch, a foot, a yard, or any other lineal unit which may be fixed. To measure the solidity of a solid, is to ascertain how many cubic inches, or cubic feet, &c., are contained therein. The solidity of a parallelopiped is found by multiplying the length by the breadth, and the product by the height; the result gives the number of cubes contained within the figure.

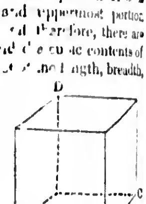
Let l, b, and h, be the length, breadth, or thickness, and the height, and v the volume or solid content, then $v = lbh$.

Let A F be a right rectangular parallelopiped. Let its length A B be 4 lineal units, as 4 inches, its thickness B C 2 inches, and its height A D 3 inches. The solid can evidently be divided into three equal portions by planes through G and H, parallel to the base A C; and into four equal portions by means of planes through K, L, M, parallel to the side B F; and into two equal portions by a plane through I, parallel to B D. Each of the small cubes into which the solid is now divided, is a cubic inch; the number of cubic inches in the lowest portion B C is 4×2, or 8, and in the second and uppermost portion there are as many; and in them all therefore, there are $4 \times 2 \times 3$, or 24—That is, to find the cubic contents of the solid, find the continued product of length, breadth, and height.



The solidity of a cube is found by multiplying the side by itself, and that product again by itself; or, literally, by raising the side to the third power

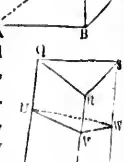
Let e = an edge of a cube; then $v = e^3$.



The reason of the rule is evident, since a cube is just a parallelopiped whose length, breadth, and height, are equal.

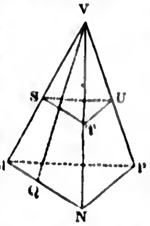
The solidity of all prisms, or of any parallelopiped, may be found by multiplying the area of the base by the height.

Let b denote the base, and h the height; then $v = bh$.



A pyramid is an angular solid, which has a polygon for its base, and triangles for its sides or faces; these sides all meet in one point, and form a solid angle, which is called the vertex of the pyramid. Pyramids, like prisms, may be either regular or irregular

When the base of a pyramid is regular, the line joining its vertex or summit is called its *axis*, and when the axis is perpendicular to the base, it is then a *regular* pyramid. They are also said to be triangular, quadrilateral, polygonal, &c., according as the base is a triangle, a quadrilateral, a polygon, &c. The pyramids of Egypt are quadrilateral, having square bases and four similar and equal triangular sides. An obelisk is also a pyramid, and has a square base and triangular sides; but the height is very great in proportion to the extent of the base. The solidity of a pyramid is found by multiplying the area of the base by the perpendicular height, and one-third of the product is the answer: $v = \frac{1}{3}bh$.

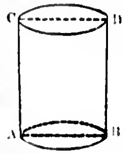


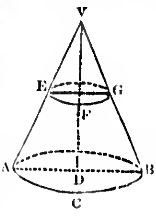
Example.—Find the solidity of a rectangular pyramid, the length and breadth of its base being 6 and 4 feet, and its altitude 20 feet, $v = \frac{1}{3}bh = \frac{1}{3} \times 6 \times 4 \times 20 = 160$ cubic feet.

By a regular solid is meant a solid bounded by regular plane figures, and its solid angles equal; that is to say, a solid in which all the sides are equiangular and equilateral. It has been proved that there can be only five regular solids; these are often called Platonic bodies, because Plato was the first who investigated their properties. The names of these five regular solids are the following: and it will be observed that these names are formed by prefixing the Greek numeral indicating the number of sides to the termination *hedron*, from *edra* (Greek), a seat, that is, a side.

The *tetrahedron* is a regular triangular pyramid, whose sides are equilateral triangles. The *hexahedron* is a cube. The *octahedron* is contained by eight equilateral triangles. The *dodecahedron* is contained by twelve regular pentagons. The *icosahedron* is contained by twenty equilateral triangles. Each side of a regular solid, except the tetrahedron, has an opposite face parallel to it, and the edges of these faces are also respectively parallel.

A cylinder differs from a prism in having a circular instead of a rectilineal base; it is contained between two equal and parallel circles and a convex surface. The line joining the centres of the two circles is called the *axis*. When the axis is perpendicular to the plane of the bases, the cylinder is said to be *right*. Steam-boilers, the shafts of circular pillars, the stone of a common garden roller, the barrel of a gun, and many other familiar objects, are cylinders. Combinations of cylinders are also very frequently used in the arts; telescopes and opera-glasses, for instance, are merely cylinders fitted one within the other, and of which circular lenses form the base. The solidity of a cylinder is found in the same way as that of a prism, namely, by multiplying the area of the base by the perpendicular height. This rule is founded upon the theorem that a cylinder and a parallelopiped, having equal bases and altitudes, are equal to one another. A cone, like a cylinder, has a circular base, but it terminates in a point like a pyramid; sugar-loaves are made in the form of cones. The annexed figure is a cone. A B is the base, V is the vertex, and the straight line V D joining the vertex and the centre of the base is called the axis. A frustum of a solid is a portion contained between the base and a plane parallel to it; thus, the portion E G A B is a frustum of the cone. When the axis of a cone is perpendicular to its base, it is called a *right* cone.





Other cones are said to be *oblique*. A right cone may be described by the revolution of a right-angled triangle about one of the sides of the right angle. It is proved that if a cone and a cylinder have the same base and the same altitude, the cone is equal to the third part of the cylinder. From this fact results the method usually adopted for ascertaining the solidity of a cone. The area of the base is multiplied by the altitude, which, as before shown, is the rule for finding the solidity of a cylinder; one-third of the result, therefore, gives the solidity of the cone.

SPHERICAL GEOMETRY.

A *sphere* or *globe* is a solid having one continued curved surface, and which is conceived to be generated by the revolution of a semicircle about its diameter: balloons and cricket-balls are spheres.

Spherical geometry consists in the investigation of the properties of spheres.

Every point on the surface of a sphere is equally distant from a point in the middle of the sphere called its centre; any line drawn from the centre to the circumference is called a *radius*, and any line drawn through the centre, and terminated at both extremities by the circumference, is termed a *diameter*. When the diameter is perpendicular to the plane of a circle of the sphere, it is termed an axis, and the extremities of the axis are called the poles. Circles of the sphere, whose planes pass through the centre, dividing the sphere into two equal parts, are called *great* circles, and all others are *small* circles. By the distance of two points on the surface of a sphere, is meant an arc of a great circle intercepted between them.

A *spherical angle* is that formed on the surface of the sphere by arcs of two great circles meeting at the angular point, and is measured by the inclination of the planes of the circles.

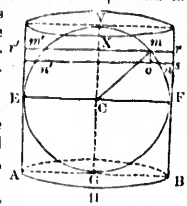
A *spherical triangle* is a figure formed on the surface of the sphere by arcs of three great circles, called its *sides*, each of which is less than a semicircle.

A *quadrangular triangle* is that of which one of the sides is a quadrant.

A *lunary surface* is a part of the surface of the sphere, contained by the halves of two great circles.

A *segment* of a sphere is a part cut off by a plane.

There are several methods of finding the contents or solidity of a sphere; perhaps the most simple and the most easy to be remembered is the following: Find, by the rules previously given, the solidity of the circumscribing cylinder, as E A B F, which is a cylinder equal in diameter and height to the diameter of the sphere; two-thirds of it will be the volume of the sphere, because a sphere is proved to be equal to two-thirds of its circumscribing cylinder.



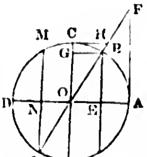
The exterior extent of surface, or convex superficies of a sphere, may be ascertained by multiplying the diameter of the sphere by its circumference. Thus, in a globe of 20 inches diameter, and 62·832 circumference, the convex superficies is 1256·64 inches, because $62{\cdot}832 \times 20 = 1256{\cdot}64$. Also, the surface of any zone of the sphere, as *mnn'm'*, is exactly equal to the surface of the corresponding zone of the cylinder *rss'r'*.

Spherical geometry is of great importance in several of the arts and physical sciences, and more especially in astronomy and navigation.

TRIGONOMETRY—LAND-SURVEYING.

Trigonometry signifies literally the art of measuring triangles, but with the progress of science the meaning of the word has been much extended. Trigonometry is divided into plane and spherical, according as it is directed to the investigation of plane or of spherical triangles.

A fixed relation subsists beetwen certain lines drawn in and immediately round a circle; and it is upon this relation that trigonometry is founded. Most of these lines, such as tangents, secants, arcs, chords, &c., have already been mentioned; it only remains to add, that the sign of an arc is a straight line, drawn from one extremity of the arc perpendicular to the radius passing through the other extremity, or, it is in fact the half of the chord of double the arc. The sine, tangent, and secant, of the complement of an arc, are called cosine, cotangent, and cosecant of that arc. This will be better understood by carefully examining the annexed figure, which is a representation of the various trigonometrical lines.



B C is the complement of the arc A B; B M D is the supplement of A B; angle B O C is the complement of A O B, and B O D is the supplement of A O B; B E is the sine of A B; A F is the tangent of A B; O F is the secant of A B; so B G is the sine of B C, or the cosine of A B; C H is the tangent of B C, or the cotangent of A B; and O H is the secant of B C, or the cosecant of A B.

The following rules for computation are useful in right-angled trigonometry, that is, in computing the sides and angles of right-angled triangles.

I. When two sides are given, to find an angle.

¶ Make a given side radius, then the side made radius is to the other given side as radius to the trigonometrical name of the latter side.¶

II. When one of the three sides and an angle are given, to find a side.

¶ Make any side radius, then the trigonometrical name of the given side is to that of the required side as the given side to the required side.¶

Although in this case any side may be made radius, it is preferable to make one of the sides concerned radius, that is, either the given or the required side, as this introduces the radius as a term of the proportion, and its logarithm being 10, it simplifies the calculation.

III. When the two sides are given, to find the hypotenuse.

¶ The sum of the squares of the two given sides is equal to the square of the hypotenuse.¶

IV. When the hypotenuse and a side are given, to find the other side.

¶ The difference between the squares of the hypotenuse and the given side is equal to the square of the required side. Or, the product of the sum and difference of the hypotenuse and a side, is equal to the square of the other side.¶

When the square of a side is known, its square root gives the value of the side.

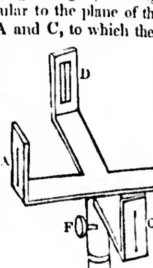
The first two rules are sufficient for the solution of all the problems in right-angled trigonometry; but the last two may sometimes be conveniently employed.

Trigonometry is one of the most useful departments in mathematical science. Its application to practical purposes are very extensive, and it is of great importance in navigation, engineering, and, as we shall immediately see, in land-surveying.

Land-surveying is the method of measuring and computing the area of any small portion of the earth's surface, as a field, a farm, an estate, or district of moderate extent. There are three distinct operations in the art of land-surveying, all of which require the surveyor to possess a competent knowledge of arithmetic, algebra, and geometry. In the first place, the several lines and angles must be measured; secondly, they must be protracted or laid down on paper, so as to form a plan or map of the district; and, thirdly, the whole area of the district must be computed by means of the foregoing operations. In performing the first operation, the most useful instrument is the chain called *Gunter's chain*, from the name of the inventor, the Rev. Edmund Gunter, who lived about two hundred years ago. It is 22 yards or 66 feet long, and is composed of 100 equal links, the length of each being 7·92 inches. At every tenth link is a mark made of brass. An acre consists of 10 square chains, or 100,000 square links. There are 80 chains in a mile, and 640 acres in a square mile.

Iron pins, about two feet long, called *arrows*, with red handles, or pieces of red cloth, attached to them, are used for sticking in the ground at the end of each chain length, when measuring in the field. Ten of them are commonly used.

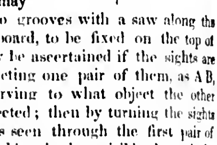
In measuring land with the chain, two persons are required, one at each end of the chain; the one who walks first is, for the sake of distinction, called the leader, and the other the follower. Lines measured perpendicularly to chain lines, to the angular points, and other points of the boundary of a field, such as to crooked hedges, brooks, &c., are called *offsets*. The cross-staff is used in measuring offsets: it consists of two bars of brass placed at right angles, with sights at their extremities, perpendicular to the plane of the bars. There are narrow slits at A and C, to which the eye is applied, and wider openings at B and D, with a fine wire fixed vertically in the middle of them. The cross is supported on a staff E, about 4½ feet high, which at the lower end is pointed and shod with brass, so that it can easily be stuck in the ground. The sights are placed on the top of the staff, and fixed to any position by a screw F.



A simple cross-staff may be made by cutting two grooves with a saw along the diagonals of a square board, to be fixed on the top of the staff. It can easily be ascertained if the sights are at right angles, by directing one pair of them, as A B, to one object, and observing to what object the other pair, C D, are then directed; then by turning the sights till the second object is seen through the first pair of sights A B, if the first object is then visible through the second pair of sights, and is exactly in apparent coincidence with the wire, the sights are at right angles; if not, they must be adjusted.

An instrument not less important in surveying is the theodolite. This useful instrument, fixed on the top of a tripod, consists of two graduated circles perpendicular to each other, one of which is fixed in a horizontal and the other in a vertical plane, and is used for measuring horizontal and vertical angles.

In the figure of the theodolite here presented, H R S represents an oblique view of the horizontal circle, and *mQn* a direct view of the vertical one, which extends to little more than a semicircle. The vertical circle is movable about an imaginary axis, coinciding with the radius O Q, which, produced passes through the centre C of the horizontal circle. On the vertical circle is fixed a telescope W, furnished with a spirit-level I, the tele-

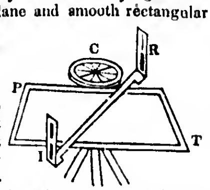


scope is connected with a movable radius O A, in contact with the opposite side of the vertical circle; and this radius is fixed to a vernier *o*, movable, by means of a screw, along the limb of the circle. When the centre *o* of the vernier coincides with the middle division Q of the circle, the axis of the telescope is then horizontal, and the instrument thus serves also as a spirit-level. A vernier to the horizontal circle is attached to the vertical circle at *e*, and is movable with it.

To measure a horizontal angle subtended at the instrument by the horizontal distance of two objects: Direct the telescope to one of the objects, and observe the number of degrees at *e* on the horizontal circle; then, while this circle remains fixed by means of a clamping screw, turn the vertical circle till the other object is visible through the telescope, and in apparent coincidence with the intersection of the cross wires, and note the number of degrees on the horizontal circle at *e*; then the difference between this and the former number is the required horizontal angle.

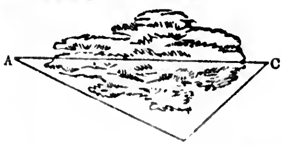
To measure a vertical angle: Direct the telescope to the object whose angle of elevation is required; then the arc, intercepted between Q and *o*, is the required angle. An *angle of depression* is similarly measured.

A plane table is frequently used in surveying. This instrument consists of a plane and smooth rectangular board fitted in a movable frame of wood, which fixes the paper on the table P T, in the adjoining figure. The centre of the table below is fixed to a tripod, having at the top a ball-and-socket joint, so that the table may be fixed in any required position. The table is fixed in a horizontal position by means of two spirit-levels lying in different directions, or by placing a ball on the table, and observing the position of it in which the ball remains at rest. The edges of one side of the frame are divided into equal parts, for the purpose of drawing on the paper lines parallel or perpendicular to the edges of the frame; and the edges of the other side are divided into degrees corresponding to a central point on the board for the purpose of measuring angles.



A magnetic compass box, C, is fixed to one side of the table for determining the bearings of stations and other objects, and for the purpose of fixing the table in the same *relative* position in different stations. There is also an index-rule of brass I R, fitted with a telescope or sights, one edge of which, called the *fiducial* edge, is in the same plane with the sights, and by which lines are drawn on the paper to represent the direction of any object observed through the sights. This rule is graduated to serve as a scale of equal parts.

A principle of measuring by triangles, which is alike common to land-surveying and the trigonometrical surveys of engineers, may be comprehended from the following figure. We wish to find the distance between two objects that are either invisible from each other, or inaccessible in a straight line from each other.



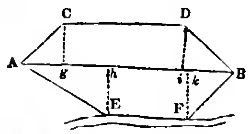
Let A and C be the two objects inaccessible in a straight line from each other, on account of a marsh. Measure two lines A B, B C, to the objects and the contained angle B. In a triangle A B C, two sides, A B, B C, and the contained angle B, are known; hence A C may be found.

Such a problem as the above is common in measuring heights and distances; and it will be understood, that the principle of throwing the area of any given field or set of fields into triangular spaces, is that pursued in all processes of land-measurement. In most instances, fields are irregular in form; their outlines being often bent, with a greater width at one place than another. In such cases, after measuring the areas of the triangles, the odd pieces at the sides require to be measured, and their aggregate area added to the whole. We may illustrate the process of surveying as follows:—

The angular points of the large triangles or polygons, into which a field is to be divided for the purpose of taking its dimensions, are called *stations*, and are denoted by the mark $\odot$; thus $\odot_1$ is the first station; $\odot_2$ the second; and so on. The lines joining the stations, and which are measured by the chain, are called *chain lines*, or *station lines*.

‖ Divide the field into triangles, or into triang'‍s and quadrilaterals, the principal triangles or quadrilaterals occupying the great body of the field, and the rest of it containing secondary triangles and trapezoids formed by offsets from the chain lines. Measure the base and height, or else the three sides of each of the principal triangles, then calculate their areas by the rules in Mensuration of Surfaces, and also the offset spaces, and the sum of all the areas will be that of the entire field.‖

Example 1.—Find the contents of the adjoining field from these measurements, A being the first and B the second station.



On chain line.	Offsets.
$Ag = 150$	$gC = 141$ to left.
$Ah = 323$	$hE = 180$ to right.
$Ai = 597$	$iD = 167$ to left.
$Ak = 624$	$kF = 172$ to right.
$AB = 769$	

The double of the areas of the component triangles and trapezoids are found, in order that there may be only one division by 2, namely, that of their sum.

$gi = Ai - Ag = 447$, $iB = AB - Ai = 172$, and $hk = Ak - Ah = 301$, $Bk = AB - Ak = 145$.

Twice the area of the

triangle $AgC = Ag \cdot gC = 150 \times 141$	$=$	21150
trapezoid $CgiD = gi\ (Cg + Di) = 447 \times (151 + 167)$	$=$	137676
triangle $DiB = Bi \cdot iD = 172 \times 167$	$=$	28724
triangle $AhE = Ah \cdot hE = 323 \times 180$	$=$	58140
trapezoid $hEFk = hk\ (hE + kF) = 301\ (180 + 172)$	$=$	105952
triangle $BkF\,F = Bk \cdot kF = 145 \times 172$	$=$	24940
Twice area	$=$	376582

And area $= 188291 = 1$ acre, 3 roods, 21·26 poles.

These admeasurements, instead of being written out as above, are generally registered in a tabular form. A field-book, which is used to enter these measurements, is divided into three columns. The different distances on the chain line are written down in the middle column, and in the right and left-hand columns the offsets are inserted, with any remarks that may be made. The measurements on the chain lines are written in order upwards in the middle column, the first being written at the foot of the column, as the surveyor can thus more conveniently compare the measurements with the imaginary lines in the field.

In surveying a whole country by trigonometrical measurement, or in engineering plans for canals, railways, and roads, it is necessary to make allowance for the earth's convexity in all the calculations of levels. The degree of convexity, or departure from a true level, is reckoned to be about 7 inches and 9-10ths in the space of a mile. (See article HYDROSTATICS.) In land-measuring, the scale of operations is ordinarily too limited to require any such allowance for difference of levels.

We have now, as far as our limits would permit, presented an outline of the methods pursued in land-surveying; and to those who design following out the study of this, as well as other branches of theoretic and practical mathematics, we recommend a regular course of instruction from Mr. Bell's excellent treatises in Chambers's Educational Course—works so cheap as to be within every one's reach.

POPULAR STATISTICS.

INTRODUCTORY.

STATISTICS is a science of comparatively late date, but it is one which promises to be of considerable service to mankind. Whatever can be ascertained by *taking down numbers and instances, and making summaries of them*, may be said to be a proper object for this science. It is generally applied to such matters as the amount of population, the rate of mortality, the progress of commerce and manufactures, and the increase or diminution of crime. The benefit of coming to correct reckonings about these matters must be obvious; but we shall cite one instance to make it quite clear. From accounts which have been kept of the burials in England for the last fifty years, it appears that the rate of mortality (or number who die yearly in comparison with the whole population) diminished regularly down to 1831, but has since then been a little on the rise, showing that the condition of the people at large (mortality depending on condition) was improving till that time, but has since been slightly declining. When such a fact as this is ascertained, statesmen are put on the alert to discover, and, if possible, remove the causes. Thus, it is seen, a nation may be much benefited by taking a census, and the keeping of a correct register of deaths. The value of statistical operations, then, is manifest. Statistics may be said to be the account-book of a nation, for ascertaining the state of its affairs. One which keeps no statistical records may be said to be like a merchant who does business without keeping a ledger or ever coming to a balance.

Statistics bears in like manner upon many of the interests of private life. Of this we trust to be able to give some notable instances in the sequel.

It is one of its least utilities that it tends to substitute real and distinct knowledge in many matters for vague and general impressions. There are many things which, to the uninstructed mind, can only be mentioned to create a feeling of doubt—for example, the comparative likelihood of life in men and women. Ask an uninstructed person whether women or men in general live longest, and, at the best, he will only be able to answer from some obscure notion in his mind, the result of a few observations which he has happened to make. Statistics has ascertained, though only within the last fourteen years, that female life is *better*, that is, of longer duration, than male. Here is a thing which no individual could ascertain for himself, and about which all was doubt for hundreds and thousands of years, settled at last by statistics. We have now the satisfaction of knowing the fact distinctly, instead of only conjecturing, and perhaps wrangling about it.

On some of these vague questions, proverbial wisdom is found to have made a conclusion for itself. For example, this oracle has long been clear, that an open winter is the most fatal to life, and that more die of surfeit than of want. Statistics finds both of these, and many like conclusions, to be exactly the reverse of the truth. It has here corrected decided error, which is better still than giving distinct knowledge where formerly there was only doubt. It is observable of almost all such proverbial notions, that they appear to have proceeded upon a principle of contradiction or paradox, the contradiction being generally to what is the most likely conclusion of the mind upon the subject. For instance, want seems at first sight a more deadly thing than over-abundance; but then it is also found, if we pause and look narrowly, that it is possible also to die of cholic and of pampering. The clownish oracle has the same wish to be novel, original, and striking, which is the bane of so much philosophy, and it decides that the most mischief is done by the less obvious evil. To put an end to such modes of judging, by adducing the undeniable testimony of figures, is, we humbly submit, a worthy service, and this service is rendered by statistics.

There is one other service which statistics has rendered, of a more remarkable though perhaps less directly useful kind than the above. Almost all the occurrences which depend on the human will happen irregularly as to time, as far as an individual is concerned. A man commits some particular crime which he is not likely ever again to commit in his life—for instance, an assault with violence. It was, to all human apprehension, the merest chance which brought him into the circumstances which provoked or prompted him to commit the offence. Yet, strange to say, there is no offence so accidental as to individuals, or so unlikely to occur above once in an ordinary man's lifetime, but what statistics finds it to occur, with the greatest regularity, in a certain range of individuals and a certain range of time. The returns of a particular crime, in such a country as England or France, are nearly the same for each successive year. In all classes of occurrences which appear occasional as to individuals, the same uniformity is observed when we go to sufficiently large numbers: even in the number of letters put into the post-office without addresses, there is a precise uniformity, if we take the office of a large city, and reckon year against year. Thus to find an order in the most casual of things, even in the wayward and fleeting movements of the mind, affords highly interesting matter for reflection.

Statistical science has its quicksands and difficulties as well as its triumphs. Often, when an extensive range of facts has been accumulated, all, as is thought, tending to confirm a certain view, there may still be room to contend that they lead to directly opposite conclusions, or that they show the presence of totally opposite causes from those presumed to exist. There is a tendency in those who pursue the science, to make inferences in accordance with their own prejudices, or to seek only for facts by which these are favoured. Such errors are particularly likely to be made in subjects where many causes are presumedly involved, and which are so extensive that it is difficult to command a general view of them. As an example, we have only to remind the reader of the various notions which are usually entertained as to the causes of any distress which may take place throughout the country. The higher class of statisticians usually, however, are cautious in drawing inferences and tracing causes, believing it to be their best course, in all doubtful cases, to restrict themselves to the collection of facts.

BIRTHS.

Proportion of the Sexes.

Many millions of observationa have been made upon births in the various countries of Europe, from which one uniform result appears, that about 21 boys are born for 20 girls. The proportion in different states is here stated:—

STATES AND PROVINCES.	Males to 100 Females.
Russia	108·91
The Province of Milan	107·61
Mecklenburg	107·07
France	106·55
Belgium and Holland	106·44
Brandenburg and Pomerania	106·27
Kingdom of the Two Sicilies	106·18
Austrian Monarchy	106·10
Silesia and Saxony	106·05
Prussian States (*en masse*)	105·94
Westphalia and Grand Dutchy of the Rhine	105·86
Kingdom of Wurtemburg	105·69
Eastern Prussia and Dutchy of Posen	105·66
Kingdom of Bohemia	105·38
Great Britain	104·75
Sweden	104·62
Average for Europe	106·

Further inquiries have shown some curious modifications of the law which seems to preside over this part of the natural economy of the world. In illegitimate births, the over proportion of boys is somewhat less, nearly approximating in some countries to a par with the number of girls. There is also a less over-proportion of boys from marriages in which the husband is the younger party, and where both are extremely young.*

The average fruitfulness of marriages is not clearly ascertained, in consequence of imperfect registrations; but it is considered by Mr. M'Culloch to be in England in the ratio of 4·2 children to each marriage.

Legitimate and Illegitimate Births.

The proportion of illegitimate to legitimate births is a point of great importance in political economy as well as morality, for illegitimate children are generally a burden to the state, and have an inferior chance of growing up useful citizens. It is also a fact ascertained by statistics, in opp[illegible] to common ideas, that such children have generally less of the elements of health and vitality than other children. The proportion of illegitimate to other births is—for France, 1 to 12·5; Prussia, 1 to 13·1; England, 1 to 14; Sweden, 1 to 14·6; the preponderance of morality thus appearing in favour of the two latter countries. In cities the proportions are strikingly different. In Paris, for 28 legitimate there are 10 illegitimate births; in other and stricter terms, the latter are in proportion to the former as to 2·84. In Stockholm, from the report of a recent traveller, the proportion is 1 to 2·3; that is, nearly a third of the children born in that northern capital are illegitimate. In Berlin, the proportion has risen since 1790, from 1 to 9 to 1 to 6.

Still Births.

The proportion of dead-born to live-born children is found in European cities to be about 1 in 20, but in the country not above half that amount; showing apparently that rural life is most favourable to the health of women during pregnancy, and to successful parturition. It is worthy of remark, that more male than female children are still-born; the proportion in Western Flanders has been found as 14 to 10, and the same result appears in some other countries. At Gottingen, in 100 births, 3 were of legitimate and 15 of illegitimate children.

Effects of Scarcity.

Times of scarcity and privation tend to reduce the number of marriages, and also of births, though generally not immediately. The great scarcity which occurred in England at the commencement of the present century, occasioned a diminution in the number of marriages to the extent of about 18 per cent., as compared with the previous years of abundance. In the Netherlands, wheat was at 9·56 florins per hectolitre, in 1816, and the births in the year 1818 had sunk, from a previous higher number (195,362 in 1815), to 183,706: in 1819, wheat had fallen to 3·72 florins per hectolitre, and the births, two years thereafter, rose to 210,359.

MARRIAGES.

The number of marriages per annum, in proportion to the population, and the ages at which marriages take place in both sexes, form interesting subjects of inquiry.

In England and Wales, the number of marriages registered was 111,481 in 1837–8; 121,083 in 1838–9; and 124,329 in 1839–40. The number is believed to have been less in the first of these years than it otherwise would have been, in consequence of a popular error which induced parties to hurry on their nuptials before the commencement of the operation of the registration act. Taking the two latter years against each other, we find an increase of 3216 marriages upon the latter; but this is liable to a reduction of 1700 on account of the increase of population; so that, on the same number of people in 1838–9 and 1839–40, there was an increase of marriages, strictly, of about 1500. While there was thus an increase upon the whole country, the greater portion of the manufacturing districts in the west of England, where at this time commercial difficulties existed, showed a *decrease*, amounting in some districts to 6 per cent.; in Manchester and Salford to no less than 12 per cent.

In England and Wales, the proportion of marriages to the whole population seems to have been diminished during the last fifty years. It is calculated that, in the period 1796–1800, there was 1 marriage annually to every 123 persons; in the period 1816–1820, 1 for every 127 persons; in the period 1826–30, 1 for every 128 persons. This seems to be nearly its present proportion.

Some years ago, Mr. Finlaison made a calculation of the ages of women at the time of their marriage from an assemblage of 878 cases, which was too small for very satisfactory results. Enlarging the number to 1000 for the sake of arithmetical distinctness, he found the following to be the various ages at marriage:—

* "In France, it was observed a few years ago, that out of 6,705,778 persons born, legitimate and illegitimate, there are 3,458,965 males and 3,246,813 females, or nearly 16 males to every 15 females. Out of 460,391 illegitimate children, there are 235,951 males, 224,440 females. From these data it follows that, in France, for every 100,000 legitimate female children, there will be 106,534 legitimate males; but for every 100,000 illegitimate females, there will be born only 105,128 illegitimate males; so that the probability of a child about to be born being a female is greater if it is illegitimate than if it is legitimate."—*Babbage*

Age.		Age.	
14 to 15	32	28 to 29	45
16 .. 17	101	30 .. 31	18
18 .. 19	219	32 .. 33	14
20 .. 21	233	34 .. 35	8
22 .. 25	101	36 .. 37	2
26 .. 27	60	38 .. 39	1

A calculation upon which more dependence may be placed was made by the registrar-general, upon the basis of 10,019 marriages which occurred in different parts of England in 1838–9, reducing the proportions to 10,000. The following table gives the results:—

Ages.	Men.			Women.			1818-9.	
	Bachelors.	Widowers.	Total.	Spinsters.	Widows.	Total.	Men.	Women.
15 and under 20	229	..	229	1315	1	1316	327	1416
20 .. 25	4999	17	5016	5043	37	5080	5220	5202
25 .. 30	2397	170	2567	1879	120	1999	2367	1772
30 .. 35	754	222	976	568	158	726	819	659
35 .. 40	262	191	453	244	132	376	451	385
40 .. 45	113	167	280	108	138	246	322	276
45 .. 50	46	134	180	53	73	126	212	157
50 .. 55	18	95	113	14	57	71	144	78
55 .. 60	8	59	67	11	24	35	81	35
60 .. 65	5	63	68	1	29	30	39	12
65 .. 70	..	26	26	2	8	10	8	8
70 .. 75	1	4	5	..	3	3	8	..
75 .. 80	..	5	5	..	1	1	2	..
80 .. 85	..	4	4	..	..	..	.	..
Totals	8832	1187	10,019	9238	781	10,019	10,000	10,000

According to this table, the average age of marriage in England is—for men, 27·4 years; for women, 25·5 years. It presents, upon the whole, a favourable view of the prudence of the English people as to marriage. Only 2·3 per cent. men, and 13 per cent. women, are wedded under the age of 20. About one-half of both sexes are married between 20 and 26. Only about three-fourths of a per cent. of first marriages are contracted by either men or women after the age of 44.

It seems to be clearly ascertained, that the tendency of the sexes to marriage is liable to be modified by a number of conditions. Above a certain point in education, comfort of circumstances, and respectability of position, the tendency diminishes, and we see men and women of the middle and upper classes living contentedly in celibacy, from a dread of the increased expenses of matrimonial life. Below that point the tendency increases, from opposite causes. It is observably more powerful amidst a dense operative population than among a scattered one, and it reaches its extreme in the half-destitute class, however otherwise circumstanced. Statistics afford us some information respecting two widely separated parts of the earth, one of which is remarkable for early and numerous, and the other for rare and long-delayed marriages—Glasgow and the parish of Montreux in Switzerland. In Glasgow, the marriages were, in 1830, in the proportion of 1 to 112 of the population; and this ratio rises much higher in unusually prosperous years, as, for instance, in 1825, when it was 1 in 84. Montreux is too small a district to afford basis for a calculation of this kind; but the people, who are all small labouring proprietors, are remarkable for postponing marriage to a late age, the average ages of men and women being 30 and 26·75 respectively. In Montreux, the births are as 1 to 46 of the population, and the deaths as 1 in 75, both uncommonly low proportions. Those of Glasgow will be found very different. It seems incontestable, indeed, that a multiplication of marriages in most situations is attended by an increase of mortality, and particularly an increase in the mortality of the young. We trust we may here venture upon a few general remarks with respect to marriage among the industrious orders.

It is a familiar saying among the industrious orders, that the mouth never comes without the meat for it; by which they encourage themselves to marry, or console themselves when, having married, they find their family increasing upon them more rapidly than they can well see how they are to provide for it. This fallacy has been in some measure brought to the test of figures. Dr. James Philips Kay, an assistant Poor-Law Commissioner, instituted in the year 1838 an inquiry into the actual income of agricultural labourers in the counties of Norfolk and Suffolk. Returns to the circulars which he issued for this purpose enabled him to make the following abstract of the annual earnings of 539 families:—

	Average annual income.		
36 single men	£25	1	4¼
64 married men, with no children at home	30	12	10¼
136 married men, with 2 7-8ths children, all under 10 years of age	32	13	2
120 married men, with 3 7-10ths children, 1 of whom above 10 years	35	9	0¼
92 married men, with 4 9-10ths children, 2 of whom above 10 years	40	10	1
44 married men, with 5¼ children, 3 of whom above 10 years	45	11	9¼
15 married men, with 7 children, 4 of whom above 10 years	50	18	6
1 married man, with 5 children above 10 years	42	13	0
1 married man, with 6 children above 10 years	52	0	0

The first question suggested by this table is—how much of the increased income of the men with families was owing to their working more steadily, from a sense of their families being dependent upon them? and how much to the earnings of their wives and children flowing into the common stock? This does not directly appear, but the returns afford means of arriving pretty near the truth by calculation. Out of the 539 male heads of families, 475 earned annually by day-work £7382, 5s. 2d., which gives the average annual earnings of each man by this means at £15, 10s. 10d., or within a fraction of 6s. a week. The earnings by task-work are specified in 350 cases, and amount in all to £5018, 17s. 7d., which gives the average earnings of each man by this means at £14, 6s. 10d. annually, or 5s. 6d. a week. There are enumerated at least 286 cases in which the labourer obtained earnings in both ways; but it would give too high an average to add the two sums together. We are enabled to approach to the truth in another direction, by deducting the amount of earnings said to be made by women and children from the average income of the families. The sum of all the annual earnings of all the families (counting each single man as a family), in the table given above, is £19,129, 16s. 5d.; and this gives an average annual income of £35, 10s. The men are stated to have earned on an average £5, 3s. by harvest-work, in addition to their regular wages; the average earnings of wives are about £2, 12s. 7d.; of children able to work, £8, 1s. 11d.; and the value of gleanings by the younger children is £1, 1s. 10d. Deducting these sums from the average family income, leaves £17, 4s. 4d. for the average annual earnings of the man by ordinary task and day *wage*; and this, when we take into consideration the number of men, and the amount earned in the year by these routine kinds of labour, seems not an improbable estimate. This £17, 4s. 4d. added to the £5, 8s. of harvest wages, gives £25, 12s. 4d. as the average annual earnings of a man (7s. 3d. per week), or only 13s. more than the average earnings of the unmarried men; from which we infer, that *the additional income of the married men is derived from the labour of their wives and children.*

Deducting the earnings of the unmarried men from the whole amount, and dividing the remainder by the number of married men, we get an average of £36, 7s. 2d. for the annual earnings of each married man and his family. But whereas the £25, 1s. 4½d. is allotted exclusively to the maintenance of one person only, the income of £36, 7s. 2d. has to provide for an average of 5·5 persons. Unless the married man can support a wife and 3·5 children upon £11, 5s. 9½d. per annum, he must dispense with luxuries, comforts, it may be conveniences, in which the unmarried man can indulge. And the average income is raised to this height by taking into account those families which, having three, four, five, and six children above ten years of age, have an average income of about £45 per annum. To reach this highest grade, even they must have passed through years of greater pinching, when their children were growing old enough to take care of themselves and earn a little. The mill through which they have been ground may be conceived by taking into account these facts. The average annual earnings of a wife with no children were £3, 8s. 9d.; of a wife with $2\frac{7}{8}$ children under 10 years of age, £2, 9s. 10½d.; of a wife with $3\frac{7}{10}$ children, one above 10, £2, 11s. 7¼d.; of a wife with $4\frac{9}{10}$ children, two above 10, £2, 5s. 7½d.; of a wife with $5\frac{3}{4}$ children, three above 10, £2, 19s. 1d.; of a wife with 7 children, four above 10, £2, 3s. 10d. From which it appears, that a woman with a family is only able to earn about two-thirds of what a woman without that incumbrance can earn. The earnings of the children, also, fall to be taken into account. In families with $2\frac{7}{8}$ children, none of whom were above 10 years of age, the average annual earnings of each child were 15s. 3¼d.; in families with $3\frac{7}{10}$ children, one of them above 10, the average earnings of each child were £1, 1s. 9½d.; in families with $4\frac{9}{10}$ children, two above 10, the average earnings of each child were £1, 13s.; in families with $5\frac{3}{4}$ children, three above 10, the average earnings of each child were £2, 2s. 5½d.; in families with 7 children, four above 10, the average earnings of each child were £2, 17s. 8d. An additional head of income must, in strict accuracy, be mentioned—the value of corn gleaned by the children. As might be expected, the amount increases with the number of children; but as the age of the latter does not much affect their ability to glean, the increase is very gradual, and of small amount.

VALUE OF CORN GLEANED.

Families.	Average annual amount to each family.
46 with no children - - - - -	£0 17 10¼
110 with 2 7-8ths, all the children under 10	0 18 7¼
97 with 3 7-10ths, one child above 10 -	1 0 6¼
85 with 4 9-10ths, two children above 10	1 5 6¼
37 with 5 3-4ths, three children above 10	1 9 6¼
13 with 7, four children above 10 - -	1 6 9¼

These figures demonstrate that the married labourers incurred in general an additional amount of expenditure, which their additional income by no means compensated. The *kind* of expense incurred by the married men, as well as the amount, is different—child-bed outlay, education of children, and the increased chances of sickness as the numbers of a family increase. It must be remarked, too, that the cases selected to illustrate this point, are, in so far as the unskilled labourers of the country are concerned, favourably circumstanced. Of the 539 families enumerated, 397 had gardens (averaging $19\frac{1}{7}$ rods); 136 had some fuel free of charge; 259 had each a pig; and 20 each a donkey. The average of their house-rent (£3, 11s. 4½d.) did not rise above the average level throughout the country; while in a rural district provisions are cheaper than in towns. Above all, the engrossment of their parents' attention by labour was not so dangerous for the children as in densely populated towns, where, when left at all to themselves, they are in constant danger of falling in with instructors in crime, and are placed in a situation where greater opportunities present greater temptation. If, then, among individuals who, for the class to which they belong, may be considered in easy circumstances, marriage be a step which must render increased exertions and self-denial necessary, what must it be for those who are in more difficult circumstances? Let the experience of a committee appointed in Glasgow, in 1837, to afford relief to the industrious poor in a season of severe pressure, answer the question. Out of 3072 adult males who applied for relief and were furnished with work, 2273 were married. The number of the children of those married applicants was 6302, or nearly 3 children to each family. No less than 532 of those married men were under 30 years of age; of the children, 3994, or nearly two-thirds, were under 10 years of age. Of the 2273 married men, 2171 were weavers; and the account given by Mr. Charles Baird, in a paper read before the Statistical Society of London, in February, 1838, of the condition of that class even in times of no extraordinary pressure, may serve to show with what prospects they had rushed upon the hazardous responsibilities of marriage:—"The great bulk of the weavers in Glasgow and its suburbs are in extreme poverty. Their wages which, even in 1819, were as low as 12s. gross, or 10s. 8d. net (the deductions being for loom-rent, winding, &c.), now average only 8s. 4d. gross, or 7s. net per week; and even for this miserable pittance they are obliged to work from 14 to 16 hours per day. Their houses, which are generally in the suburbs, are of the poorest description, barely furnished, and the food and clothing of the inmates, as might be expected, not only of the plainest description, but also quite inadequate." It is apparent, that they who, in the best of times, can barely procure a subsistence by 14 or 16 hours of daily toil, must, by the slightest and shortest stagnation of trade, be reduced to destitution, and, under such circumstances, to incur the charge of a family is madness.

This is a consideration which has of late been much urged upon the poorer classes—not always, it is to be feared, in the most judicious manner. Leaving out of view that the deductions of Malthus, whose disciples have been the most busy in giving this kind of advice, are based upon statistics remarkable both for vagueness and inaccuracy, and tainted by the polemical bias of his mind when he first published them, the form in which they have generally been submitted is of all others the least calculated to make an impression upon uneducated minds. Abstract reasoning, geometrical and arithmetical ratios, convey no tangible ideas calculated to influence their conduct; and the subordinate discussions into which some of these philosophers are fond of diverging, repel by inspiring disgust. Advice may be sound, however, although it be given in an uncouth form and by unamiable persons. In regard to improvident marriages, the industrious poor would do well to consider.

Marriage has its attractions, and, what is more, its moral advantages. It is the only institution which reconciles with the stability and good order of society one of the strongest impulses of our nature. If it add in some degree to a man's expenditure, it repays him by conferring blessings unattainable without it The un married man is isolated; the married man, if ordinarily well conducted, has a permanent hold on the affections of a portion of his fellow-creatures. A judicious selection of a helpmate ensures him comforts at home which no price could otherwise secure for him. If he act wisely, he will find his family affections the best of moral teachers. The state of marriage is honourable, and is desirable. And now let us turn to the considerations which every man, properly desirous of entering such a state, ought to weigh duly beforehand:—It is mainly by her domestic industry that he ought to expect his wife to contribute to his comfort—by her judicious aid in making what he earns go as far as possible. She may at first have some time to spare for earning, but when a family comes upon her, that, and the household together, will take up by far the greatest part of her time. Children must for a time be a mere draft upon his industry. Great and just complaints have been raised of the extreme labour exacted from infants in factories. Granting that the employers of such infants are culpable—what are their parents? The father who allows his child to be precociously employed in labour beyond its powers, calculated to destroy it physically and morally, and render all its future life one long disease, is consenting to the crime. There is no legal press-gang to sweep children into factories. A conscientious man, who contemplates marriage, will take these facts into consideration, and ask himself whether his position and prospects are such as entitle him to expect to be able to support a wife and children as they ought to be supported for a number of years. He must estimate the possible earnings of his wife at a very low figure—as something that may at times enable them to indulge in an extra luxury, but not as contributing to the necessary household expenses. He ought to assume that his children, before their eighth year, will earn nothing, and that for some years after their earnings will amount to a mere trifle. The sources of his income being thus ascertained, he must next look his expenses fairly in the face. It is a duty he owes to himself and society to aim at procuring for himself a sufficient allowance of nourishing food, comfortable clothing, the means of preserving cleanliness, so requisite to health, and weather-tight, well ventilated lodgings, with the necessary fuel. The same comforts which he aims at for himself, he becomes bound to procure for her whose time after their union ought to be mainly directed to caring for the comforts of him and his children. And for those children, he is bound, by every natural feeling, to provide while they are unable to provide for themselves, in such a manner that they shall start upon life with hale constitutions and a fair elementary education. From his knowledge of his own expenses as a bachelor, and from what he can learn of the expenses of his married neighbours, he can form a tolerably near estimate of what marriage is likely to cost him. He must take it for granted that unforeseen accidents are more likely to occur in a family consisting of two, three, or four, than in a family consisting of one; and on this account ought not to venture on the married state unless he or his intended has some little stock of sparings laid up in the event of contingencies. This being provided for, he must next take into account whether his earnings can cover the certain steady outlay of a family, and deposit a trifle at intervals in the savings' bank; and whether there is a fair prospect of their continuing to increase, and at least not to fall off. If every prospect is favourable, he may take the step; if not, he incurs the almost certain danger of reducing himself and his family to a state of destitution—of increasing by his rash act the number of sufferers in society—of adding to the number of that class which is at once miserable in itself and the cause of misery to others. When we ask all who have not a reasonable prospect of being able to rear and instruct a healthy family to abstain from marriage, we only ask of them to consult their own happiness; the benefit of their abstinence will be reaped by society at large as well as themselves, the bad effects of their rashness will be felt by society as well as themselves, but the deepest, bitterest dregs of the harsh draught will fall to be drained by them. We only ask them to submit to a necessity which it is in vain to struggle against. If they ask why they are to deny themselves a gratification which they see others indulge in, the answer is, for the same reason that they forego many other pleasures they may wish for but cannot earn by honest industry. Marriage is a fruitful source of happiness when judiciously set about; but, like all other goods of this life, it must be earned, and those who are not in a condition to earn it (whether for want of employment or want of ability), ought in conscience to forego it. To rush blindly upon the cost of marriage, without forethought, encouraging their rashness by such groundless remarks as, "When God sends mouths he sends meat," is not even to snatch a pleasure they have not had it in their power to earn, for such inconsiderate matches have more of a curse in them than of a blessing. A bachelor state may be less happy than a good marriage, but it is better than a rash one, which precipitates all parties into destitution.

It is the more necessary to impress the importance of the lesson, "Learn to abstain," because it is the more difficult to practise, on account of the strength of the impulse to be overcome, and the weakness of those subjected to it, from its reaching its intensest power at an age when the judgment is yet immatured and experience empty; and also because rash marriages are the great promoters of a destitute, and consequently a demoralized and unhealthy population; and because the man who has taught himself, by struggling against inclination, to make his instincts bend to his reason in this matter, has strengthened himself to resist almost any other temptation. It is men (and women too) who know how to earn and how to practise self-denial—who know what it is to appreciate pleasures, but are able to reconcile themselves to abstinence—in whom inclination and will are under the control of judgment and reflection—who constitute the sound and useful portion of society. In proportion as this class preponderates, will it be possible to keep the healthiness and morality of the community at a high average.

DEATHS.

A human being born with a sound constitution is calculated to live seventy years or upwards, under favourable circumstances; but, as we well know, all of us are surrounded more or less by circumstances unfavourable to life, by which, practically, our term of years is liable to be greatly shortened. Existence, as to duration, is proverbially the most uncertain of all things, and this because, from ignorance, incautiousness, and accidents, life is constantly coming into collision with the conditions calculated to destroy it. The conditions unfavourable to life come into operation, we have seen, before the human being has seen the light. They continue in operation throughout the whole of its appointed period; so that, out of any large number born, a certain proportion die in the first year, a certain proportion in the second, the third, and so on, until all are gone—only a certain comparatively small number attaining the full age which nature promises to some [illegible] maintained in favourable circumstances.

The conditions necessary for healthy and protracted existence are [illegible] of Almighty wisdom; they are briefly enumerated in the article PRESERVATION OF HEALTH, to which we refer. They vary in different countries, according to climate, civilization, and political arrangements; and, as necessarily follows, are different in the same country in different ages.

Table of Mortality for England.

During the eighteen years from 1813 to 1830 there were registered as buried in England and Wales 3,938,496 persons, of whom 1,942,301, were females. The ages of all these persons were, as far as possible, ascertained and stated; so that it was possible by these means to ascertain the rate of mortality at the different ages, for that period, and in that country. The table consequently formed is here given.

Age.	Males.	Females.	Both Sexes.	Age.	Males.	Females.	Both Sexes.	Age.	Males	Females.	Both Sexes.
Under One Year.	436,046	341,137	778,033	40	16,209	17,304	33,513	80	20,666	24,951	45,617
1	130,426	127,017	266,441	41	10,083	10,906	20,989	81	13,146	14,279	27,425
2	78,114	75,900	154,014	42	13,423	14,073	27,506	82	15,523	17,582	33,105
3	47,860	46,773	94,633	43	10,828	11,489	22,317	83	12,072	13,721	25,793
4	33,693	32,076	65,769	44	12,292	12,660	24,958	84	15,920	18,477	34,397
5	21,854	23,340	45,194	45	15,532	14,548	30,080	85	12,245	14,187	26,432
6	19,376	18,091	37,467	46	12,601	12,334	24,935	86	8,854	10,437	19,291
7	16,467	14,668	31,135	47	12,633	12,103	24,736	87	7,070	8,489	15,559
8	13,895	12,363	26,258	48	13,801	13,230	27,031	88	6,762	8,325	15,087
9	12,671	11,270	23,941	49	12,203	11,486	23,689	89	4,468	5,637	10,105
10	11,616	10,527	22,137	50	17,468	16,059	33,527	90	4,549	6,624	11,173
11	10,411	9,777	20,218	51	10,792	10,119	20,911	91	2,293	3,057	5,350
12	9,996	9,800	19,796	52	11,544	13,875	28,410	92	2,038	2,867	4,905
13	9,688	10,261	19,949	53	13,050	12,009	25,059	93	1,598	2,258	3,856
14	10,589	11,796	22,370	54	13,148	12,346	25,494	94	1,129	1,685	2,814
15	10,096	12,527	22,623	55	16,303	15,209	31,512	95	977	1,582	2,559
16	11,385	13,737	25,122	56	15,705	14,589	30,294	96	715	1,182	1,897
17	12,568	14,212	26,780	57	14,067	12,995	27,062	97	494	846	1,340
18	11,212	14,998	26,210	58	14,287	13,414	27,701	98	426	708	1,134
19	15,144	16,061	31,205	59	13,179	12,303	25,782	99	267	495	762
20	15,215	16,041	31,256	60	21,835	21,438	43,273	100	239	468	707
21	15,834	16,237	32,071	61	13,533	12,551	26,084	101	133	225	358
22	16,188	17,597	33,785	62	16,693	16,253	32,946	102	70	174	244
23	14,850	16,803	31,653	63	18,631	18,282	36,913	103	63	134	197
24	14,515	16,722	31,237	64	17,761	17,629	35,390	104	41	90	131
25	14,569	16,586	31,155	65	18,911	18,723	37,634	105	29	72	101
26	13,785	16,318	30,103	66	20,160	20,332	40,492	106	17	29	46
27	13,623	16,133	29,756	67	19,352	19,521	38,875	107	13	21	34
28	13,778	16,272	30,050	68	18,315	18,298	36,613	108	10	18	28
29	12,199	14,431	26,630	69	16,816	16,222	33,038	109	6	12	18
30	14,513	16,514	31,027	70	26,187	27,766	53,953	110	7	11	18
31	10,338	11,963	22,301	71	16,008	16,154	32,162	111	2	3	5
32	12,597	14,427	27,024	72	21,085	21,868	42,953	112	1	1	2
33	12,409	14,227	26,636	73	20,562	21,363	41,925	113	1	1	2
34	11,605	13,279	24,884	74	20,652	21,163	41,815	114	0	2	1
35	13,741	15,200	28,941	75	21,936	22,884	44,820	117	0	1	1
36	14,234	14,050	28,184	76	19,595	20,522	40,117	118	1	0	1
37	11,873	13,409	25,282	77	21,012	21,845	42,857	119	1	0	1
38	12,519	14,268	26,787	78	19,595	21,030	40,625	120	2	1	3
39	11,167	12,611	23,778	79	15,576	16,433	32,009	124	1	0	1

It appears from this table, as it has done from others constructed in other countries, that, while the births of males to females is about 21 to 20, the deaths are in an opposite relation; that is to say, female life in general is of longest duration.

Mortality at Various Ages, and Expectation of Life.

The great mortality of the early periods of life is very remarkable. One-fifth of the whole of the children born in England and Wales appear from the above table to die in their first year. (A Belgian table represents no less than a tenth of the entire mortality as taking place in the *first month of life.*) The disproportion between the deaths of males and females, appears also to be greatest under the fourth year; a fact which confirms the common remark as to its being more difficult to rear boys than girls, and which, it may further be observed, is in harmony with the disproportion of still births.

From a table of mortality, a calculation is easily made with regard to the probable duration of the life of any person. The calculation is made, with regard to any particular age, by adding up, in a table of mortality, all the deaths after that age, and dividing the sum by the numbers living at that age. The quotient is the *expectation of life* of a person of that age. A table of the expectation of life, for service in life assurance and annuity business, is formed by doing this with regard to every age, and putting the whole in proper succession. We here present such a document, formed from the above mortality table, but only showing the expectation at every fifth year; joined to which is a similar table formed from the Million Tontine of 1695, and indicating very clearly the improvement of life in England during the last hundred years.

Age.	Million Tontine. of 1695.		Parish Registers. 1813–1830.	
	Expectation. Males.	Expectation. Females.	Expectation. Males.	Expectation. Females.
Under 1 year.	37·61	..	39·96	43·20
1 year,	38·49	43·85	47·78	50·14
5	39·03	42·44	49·80	51·29
10	35·71	40·41	46·83	47·05
15	32·05	37·32	43·08	44·08
20	29·34	34·25	39·65	40·68
25	27·96	31·67	36·55	37·64
30	26.27	28·98	33·34	34·63
35	24·12	26·32	30·03	31·51
40	21·74	23·65	26·75	28·38
45	19·15	20·62	23·48	25·14
50	16·86	17·78	20·31	21·83
55	14·52	15·40	17·19	18·51
60	11·65	13·25	14·20	15·28
65	9·30	10·23	11·43	12·32
70	7·19	7·79	8·94	9·67
75	5·61	5·56	6·78	7·33
80	4·92	3·79	5·05	5·46
85	3·58	3·80	3·85	4·22
90	2·01	2·54	3·42	3·70
95	1·18	1·64	3·06	3·22
100	0·00	0·00	2·78	2·72
Sums of ages,	370·68	411·37	474.30	495·70

Diseases.

Of the specific causes of mortality, it is difficult to procure anywhere a proper estimate, on account of the imperfection of most systems of registration, and particularly the want of precision and uniformity in naming various diseases. The system of registration recently established in England, is conducted upon enlightened principles, and appears to have hitherto been managed with great regard to correctness. It has enabled its able director, Mr. Farr, to draw up very minute and comparatively satisfactory tables of the fatality of diseases in England and Wales for several recent years. The registered deaths of 1838 were 342,529, of which 175,044 were of males, and 167,485 of females. The causes of death were assigned in 330,559 instances: assuming that the other cases might be distributed proportionally among the assigned causes, a table was constructed, of which the following is a summary:—

No.	Diseases.	Males.	Females.
1	Epidemic, Endemic, and Contagious Diseases,	20·300	20·716
	Including *Small-pox*,	5·125	4·710
	Including *Typhus*,	5·500	5·861
2.	Diseases of the Nervous System,	16·034	13·999
3.	Diseases of the Respiratory Organs,	27·118	27·850
	Including *Phthisis*,	16·033	19·101
4.	Diseases of the Organs of Circulation,	1·205	·915
5.	Diseases of the Digestive Organs,	5·960	5·709
6.	Diseases of the Urinary Organs,	·793	·193
7.	Diseases of the Organs of Generation,	·006	2·008
8.	Diseases of the Organs of Locomotion,	·647	·623
9.	Diseases of the Integumentary System,	·153	·099
10.	Of Uncertain Seat,	12·974	13·805
11.	Old Age,	9·637	11·928
12	Deaths by Violence,	5·107	2·127

The healthy occupations of the country make a difference in its favour in the general mortality; but this appears larger than it really is, in consequence of the flocking of the worn-out and miserable to large towns, and the occasional resort of sick persons thither for the sake of medical attendance, in the course of which life is in many instances cut short. In 1838, out of equal numbers in town and country, the deaths in the former appeared to be 101,019, and in the latter only 70,410. The average of life in the country would thus seem to be 50, and in the city 37; but if the above modifying causes are taken into account, the disproportion must be deemed considerably less. As might be expected, diseases are of different fatality in country and in town. Taking similar amounts of population in each, Mr. Farr found that, for 1·00 in the counties, there were, in the cities, "by asthma, 3·80; erysipelas, 2·71; convulsions and teething, 2·57; cephalitis and hydrocephalus, 2·41; hydrophobia, 2·37; pneumonia, bronchitis, and pleurisy, 1·99; delirium tremens, 1·98; typhus, 1·88; small-pox, 1·73; heart-disease, 1·73; childbirth, 1·63; syphilis, 1·59; rheumatism, 1·58; gout 1·55; hernia, 1·48; purpura, 1·46; sudden deaths, 1·45; liver disease, 1·45; hepatitis, 1·35; tetanus, 1·32. The excess of mortality in cities was of less amount in the following cases:—By consumption, 1·24; croup, 1·23; violent deaths, 1·17; stone, 1·11; mortification, 1·10; malformations, 1·07; apoplexy 1·07; hæmorrhage, 1·02." Of some other diseases, the fatality was greatest in the counties. The "mortality to 1·00 in the counties was, in the cities, by paralysis, ·99; dropsy, ·99; jaundice, ·99; diabetes, ·97; cancer, ·92; hydrothorax, ·88; hæmatemesis, ·79; debility (frequently premature birth), ·75; atrophy, ·75; scrofula, ·16."

London is, upon the whole, healthy for a large city, the annual mortality being 1 in 42 of the population, a proportion very little above that of England and Wales (1 in 44·5). But the general healthiness of London is in some measure deceptive. It contains districts and kinds of population widely different; and the effects of wealth, spacious accommodations, and comparative cleanliness at the west end and in the suburbs, makes up in a summary for the opposite conditions of the eastern parts. This is rendered clear by the following statement:—

	Annual Deaths per cent.	Or
Whitechapel	3·866	1 in 26
St. George's, Southwark	3·297	1 .. 30
Bermondsey	3·121	1 .. 32
St. Pancras	2·018	1 .. 40
Camberwell	1·925	1 .. 52
Hackney	1·826	1 .. 54

It is to be observed that all these results rest, not upon the population as actually known, but as computed hypothetically from the census of 1831. Their accuracy, of course, cannot be entirely depended on, but they may be received as good approximations. The effect of crowding is shown by a table, exhibiting the mortality, and the number of square yards of space to each person in three groups of metropolitan districts.

	Square yards to each Person.	Annual Mortality.	Mortality from Typhus alone.
1st group of ten districts,	35	34·28	349
2d	119	27·6	181
3d	180	22·0	131

Hence we see that typhus is nearly three times as fatal in the first or crowded group as in the third or open one.

Glasgow is believed to stand lowest among British cities in point of health, and for some years its unhealthiness seems to have been steadily on the increase. In 1821, the rate of mortality was 1 in 39 and a fraction; in 1831, it was 1 in 30 and a fraction; in 1838, 1 in 26 and a fraction. In 1821, the deaths of children under ten years of age in this city were 1 in 75; in 1839, they were a little under 1 in 48. The extreme mortality of Glasgow is readily accounted for by the existence of a vast horde of miserable people in the meaner and closer parts of the city. Mr. Symons, an English gentleman who had taken pains to make himself personally acquainted with the subject, states as follows:—"It is my firm belief that penury, dirt, misery, drunkenness, disease and crime, culminate in Glasgow to a pitch unparalleled in Great Britain." This class becomes a focus of typhus fever and other pestilential disorders, which emanate from it to the rest of the inhabitants, and generally prove very fatal. In 1839, the deaths from typhus fever alone reached 2180. It may be remarked that statistical science, which has been cultivated to an unusual degree in Glasgow, gives an unfavourable view of the city in a number of respects. In the five years previous to 1831, the average births in Glasgow were 1 to 29·47 of the population; the burials 1 to 30·91; and the marriages 1 to 105; the respective average numbers for entire England during the same period being 1 to 37, 1 to 54, and 1 to 129. It thus appears that there are in Glasgow more marriages, more births, and *more deaths*, than in the country generally. In the parish of Montreux, where the births are 1 to 46 of the population, nineteen out of twenty complete the first year of life, and very nearly four-fifths of those baptized have been observed to live to receive the sacrament of communion.

A similar correspondence between many marriages, many births, and many deaths, is shown in the returns from Liverpool, as appears from the following passage in Dr. W. C. Taylor's work, *England in the Nineteenth Century*:—"The site of Liverpool is low, and we regret that, upon examining the returns of the population for 1841, and comparing them with those of the births, marriages, and deaths, we should have found such a startling result—a result not so surprising to us as it would be had we not seen some of the older returns. In 1662, the baptisms were 30, and burials 30: 1700, as above, the former 131, the burials 125; in 1800, the baptisms 3033, burials, 3157. The births registered in 1839, when a close approximation to correctness in the returns took place, were 7128, deaths 7437; in 1840, with a population of 223,054, the returns showed 9990 deaths to 9925 births. We then went farther, and made calculations upon a basis every way favourable, for we applied to the Population Returns of 1841 the Registrar-General's return of births and deaths for 1840 in Liverpool, consequently we applied them to nearly the tenth part of a clear increase more than we ought, and the result, compared with the totality of England exclusively of Wales, made from a table in which the decimal surplus population was deducted from England alone, gives the following figures:—

	Births to Population.	Deaths to Population.	Marriages to Population.	Births to Marr.
Population of all England reduced to June 30, 1840, 14,707,751	1 to 31·07	1 to 44·45	1 to 125·29	4·03
Liverpool, 22[illegible],	1 .. 22·47	1 .. 22·82	1 .. 60·0	2·6

Here are startling anomalies," remarks Dr. Taylor; "double the deaths and marriages, and little more than half the number of births [to a marriage], averaged in the totality of England."

Effect of Seasons.

Seasons affect mortality very considerably. We have already adverted to the popular notion that a mild winter is the most fatal to life, and mentioned that it is the reverse of the fact. Severe weather, in reality, affects life to a much greater extent, particularly in some classes of ailments, than could be supposed likely. One table, prepared from the Belgian registers, shows a surprisingly gradual decline of mortality as the spring and summer advance, and then an equally gradual increase towards the middle of winter, the influence being rather more marked in country than in town.

Months—1815 to 1816.	Deaths.	
	Town.	Country.
January	59,892	116,129
February	58,967	114,758
March	51,277	111,241
April	51,818	107,264
May	48,911	94,718
June	46,607	84,461
July	45,212	77,555
August	47,032	78,802
September	50,491	85,131
October	51,649	89,541
November	52,908	90,585
December	55,631	98,705
Average	51,700	95,822

In 1838, the weather at the commencement of the year was more than usually cold, and in certain classes of diseases the mortality of that year in the metropolis for the different seasons was as follows:—

Causes of Death.	Winter.	Spring.	Summer.	Autumn.
Paralysis	234	181	135	187
Apoplexy	299	241	201	246
Asthma	760	225	97	331
Hydrothorax	90	73	43	79
Bronchitis, pleurisy, pneumonia	1699	870	545	1154
Influenza	31	19	3	11
Diseases of the heart, &c.	273	150	177	211
Diabetes	12	4	1	6
Dropsy	501	427	375	465
Mortification	84	50	35	56
Sudden deaths	216	165	105	140
Old age	1383	969	778	941

The disproportion, it will be observed, was greatest in diseases of the respiratory system.

Effects of Wealth and Civilization.

The progress of wealth and civilization takes a prominent place among the conditi[ons] [ei]ther causing or accompanying a reduction of mo[rtality].

The number of deaths th[at] [oc]curred in the city of London in 1697, was 21,000; a [c]entury later, in 1797, the [numb]er was only 17,000, notwithstanding the increase of the population. About the middle of last century, the annual mortality in the same city was as high as 1 in 20; in 1830, it was 1 in 41. Of course, in the metropolis of a great nation, an increase in the number of inhabitants is not necessarily a proof that the indigenous population is increasing; but the average of deaths being in London 1 for every 41 inhabitants in 1830, and the average of *registered* baptisms (everywhere in this country less than that of births, and most of all in London), being in the same year 1 in every 31, we know that, independent of the increase from immigration, the population of London has been steadily augmenting. The statistics of the city of Amsterdam present a remarkable contrast to this picture. In 1727, the annual average of mortality was 1 death for every 27 inhabitants; and the average for the twelve years preceding 1832 was the same. During these twelve years, too, the average number of deaths in a year was 7336; the annual average number of births only 7282. If during that period the population of Amsterdam did not positively decrease, it must have been kept up by immigration.

There is another point of difference in the career of these two cities for a century back. Whilst the wealth of London has been increasing almost in a geometrical ratio, the commerce of Amsterdam, and with it the opulence of the city, has been diminishing. Here, then, we have two striking examples of an increase in the mean value of life attendant upon augmented wealth, and, at the least, a stationary condition of that mean value attendant upon a diminution of commercial prosperity. The analogy is marked, and not surprising, between the fortunes of communities and individuals: in both cases, opulence (that is, the comforts of which opulence gives command) has a tendency to improve the general health and prolong life. This, however, is taking but a superficial view of the question; to enable us to turn such knowledge to account, we must go more closely to work, and examine in what manner the beneficial change is produced. If we do this, there are facts established by the statistical inquiries which have of late years been made in Europe (although the science of statistics can scarcely be considered as far advanced beyond its mere infancy), which will show us that the increased wealth of a community is rather an attendant upon its increased health than a cause. They are both mutually causes and consequences—both the results of advancing civilization, and both contributing to carry on that civilization to a yet higher pitch. A recapitulation of some of the most striking circumstances either attendant upon, or productive of, the increasing health of a community, will be found fraught with useful practical lessons.

The ascertained facts regarding the rate of mortality in our own country, since the commencement of the reign of George III., invite to investigation. "The annual number of burials," says Mr. Rickman, in the preface to the Population Returns of 1830, "as collected in pursuance of the population acts, authorizes a satisfactory inference of diminished mortality in England; the average number of burials not differing materially from the year 1780 to the year 1815; the first five years of th[e] [per]iod, the last five years, and the whole period of thirty-[si]x years, giving the same average result of 193,000 registered burials, the population having increased 3,300,000 in the mean time." It appears from a subsequent part of the preface, that the annual mortality in 1780, as near as could be ascertained, was 1 in 34 or 35 of the population, that in 1820 it was 1 in 49. On the other hand, the same authority states—"The mortality of the inhabitants of England appears to have sunk to its *minimum* in the decade preceding the population abstract of 1821; and since that time it seems to have risen as fast as it descended after the year 1800. The census of 1841 gives one death annually for every 44·5 persons." The wealth of England has, however, continued to increase; and this shows the necessity of inquiring into the minute details of our social system during the period of increasing and diminishing healthiness, in order to see what has caused both.

In general terms, it may be remarked that the commencement of the diminished ratio of mortality is nearly contemporaneous with those inventions which contributed to give such an increased power to the productive industry of the nation. The Duke of Bridgewater and Brindley constructed the Worsley and Manchester Canal between 1758–60, and the Liverpool and Manchester Canal between 1762–67. In 1769, the connection between Boulton and Watt for bringing into play the patent obtained by the latter for improvements in the steam-engine, was formed. In 1775, the partners obtained from Parliament a further extension of the patent, which shows that they were then only beginning to reap the advantage of the improvements. Arkwright obtained the first patent for his spinning machinery in 1769, and his second patent in 1775. His first water-mill was erected in 1771; but five years elapsed before he began to derive any profit from it. The influence of these improvements was, from the first, of the most marked kind, and it ramified over the whole country.

By means of these inventions, conveniences and luxuries were brought within the reach of incomes which previously could not afford them; and the extraordinary cheapness and goodness of British manufactures, with such advantages, so increased the demand for them in foreign markets that the manufacturers found the supply of labour insufficient. The national wealth was not only increased, it was diffused through all classes of society. Increased incomes, the spirit of rivalry, prompted all classes, the labouring class as well as others, to live more comfortably; better clothed, housed, and fed, men became liable to fewer diseases.

From the middle of the eighteenth century, a stimulus had been given to the popular intellect, and the English were becoming a reading nation. The great inventors were themselves chiefly members of the middle and humbler classes, and the earliest of the great manufacturers were so likewise. Sunday-schools, book-clubs, and the diffusion of newspapers, were perhaps amongst the most serviceable means of enlightening the people of England during the reign of George III. At last came Joseph Lancaster with his cheap apparatus for the elementary education of the masses. When we find such circumstances accompanying the diminution of mortality in England, we cannot refrain from supposing them in some measure connected.

We deem it, then, tolerably clear that the great promoters of the health of individuals are—increased affluence, relieving the mind from despondency or harassing care, and furnishing the means of cherishing the body; and increased intelligence, teaching how to derive the most advantage from this affluence, and laying the foundation of habits of judicious self-control; and that the great promoter of the health of communities is the extension of these advantages to as many of the individuals or classes composing them as possible. The possession of affluence, and the intelligence requisite to acquire, retain, and use it aright, is the main distinction between what are called civilized and savage men. In the common practice of sinking the individual in the class—speaking of nations as resembling or contrasted with nations, we are apt to overlook the fact, that every civilized nation is not necessarily composed exclusively of civilized human beings. In every nation, even in our own, there are many who grow up, live, and die, unreflecting creatures of impulse, scrambling day after day to snatch a precarious livelihood—now gorged, more often starved—ignorant of responsibility to God or man—in short, as complete savages as are to be found among the woods of America or in the bush of New Holland. The detrimental influence of a numerous class of this kind being left in any society is not confined to itself. Its existence does not merely lower the average of virtue and comfort in a country by diminishing the ratio its sum bears to the total of the whole population; the contagion extends to the civilized or comfortable classes, who are by proximity brought into contact with it. From the squalid dens in which this class congregates, emanate contagious diseases that penetrate into the dwellings of the wealthy. Its numbers compose what an eminent statist has aptly called "the dangerous classes of large cities;" the ranks of our thieves and housebreakers are perennially recruited from among them. They constitute, in times of domestic contention, the brute instrument of the wicked of the *civilized* class. They are a chronic disease in the social body; and a nation is healthy in proportion as they are diminished in number, or become humanized by a participation in the comforts of their more favoured brethren.

The advantages which society has derived from augmented wealth and extended education, may be distributed under three classes, according as they proceed from greater facility of procuring physical comforts owing to their greater abundance, or from the greater power of contributing to their own enjoyment by regulating their moral conduct, which men derive from intellectual cultivation, or from the union of both these causes. We proceed to illustrate, by some statistical details, the mode of operation in each of these three classes.

The advantages which the whole community derive from an increase of wealth, and its source, more efficient application of industry to the natural wealth of the country, are of two kinds—those in which all participate, even those who do not exert themselves; and those of which individuals acquire a share by their personal exertions. Of the first kind are the benefits resulting from drainage in town and country. The stimulus given by the inventions adverted to at the outset has extended to agriculture; and the efforts which have been made to render land which was not productive, or productive of little, more fertile, have indirectly contributed to promote the public health. The draining of the fen counties on the east coast of England has banished a class of diseases which were most destructive in these districts. The fevers of Essex used to be inferior in virulence, but scarcely inferior in frequency, to those of the Pontine marshes. With the drainage of the marshes of that county these fevers have disappeared. "The intermittents," says Mr. Rickman, "which, heretofore, under the name of ague, infested the country very extensively (especially the fen districts), are no longer spoken of." In the time of Richardson the novelist, as we learn from his published correspondence, the scourge visited periodically even those families which were in easy circumstances. The change for the better is of course most manifest in the positively unhealthy districts, but it is experienced in the diminution of chronic rheumatisms, wherever surface drainage and underground drainage have extended. The exertions of the more wealthy classes in large towns, to promote by sewers and other aids of public cleanliness their own health and comfort, has in like manner indirectly tended to promote the health and comfort of all classes. There are nooks and corners in London, inhabited exclusively by the poor, which are still badly enough off in this respect; but we do not, even in them, find "the kennels running blood two days in every week," as Dr. Johnson has left on record was the case in Southwark in his day; nor do we find "pigs bred and fed in the houses or back-sides of paved streets," routed out in droves by the constables in the fashionable parishes of St. George's, Hanover Square, as was the case in 1761.

The advantages which each individual must acquire for himself by his own exertions, are superior household accommodation, clothing, and food.

Previous to the impetus given to national industry in the early part of the reign of George III., the following are the rates of wages which the labouring classes of England had it in their power to earn per week: *Men* —In the iron-works at Rotherham, 10s.; in the cutlery and plating trades at Sheffield, 13s. 6d.; in the cloth manufactures at Wakefield, 10s.; the colliers in that neighbourhood, 11s.; in the manufacture of cloth at Leeds, 8s. 3d.; at the alum works at Ayton, in Cheshire, 7s. 6d.; in the lead mines at Fremington, in Yorkshire, 7s. 6d., the colliers of Newcastle, 15s. 6d.; in the manufacture of cottons and checks at Carlisle, 9s.; in the manufacture of stockings, cottons, and linsey-woolseys, in the tanneries at Kendal, 9s. 5d.; in the making of pins and shoes at Warrington, 8s. 7d.; in the manufacture of fustians, checks, hats, and small-wares at Manchester, 7s. 3d.; in the potteries at Burslem, in Staffordshire, 9s. 6d.; in the manufacture of piece-goods at Witney, in Oxfordshire, 11s.; making carpets at Wilton, in Wiltshire, 11s.; pins in Gloucestershire, 11s.; says and burying-crape at Sudbury, 7s. 6d.; says and calimancoes in Suffolk, 5s. 9.; flannels and linseys at Salisbury, 8s. *Women*—In the lace manufacture at Bedford, 4s. 6d.; in the cloth manufacture at Leeds, 3s.; in the lead mines at Fremington, 6s.; in the Kendal manufactories, 3s. 3d; in making pins and shoes at Warrington, 4s. 6d.; making shoes and hats at Newcastle, 4s. 6d. *Children*—In the porcelain and glove manufactures at Worcester, 2s. 6d.; of shoes and hats at Newcastle, 1s.; boys in the potteries at Rotherham, 3s.; boys and girls in the Fremington lead mines, 3s. 3d.; children at Kendal, 2s.; children at Manchester, 3s. 5d. The medium rate of the wages of manufacturing labour was—in the east of England, 6s. 6d.; in the south, 9s. 4d.; in the west, 11s. The medium rate of agricultural wages was 8s. in the eastern counties; 6s. in the southern; and 5s. 10d. in the western districts. These rates were ascertained by Arthur Young in his tours of 1768 and 1770. Young estimates the population of England and Wales, in 1770, at 8,500,000: of these he gives 2,800,000 as the number engaged in agriculture—the landlords, with their families and dependants, amounting to 800,000; and the number engaged in manufactures, 3,000,000. This, on a rude estimate, would give the numbers of the population depending upon the wages of labour for subsistence, of that time, less than four millions. He estimates the non-industrious poor at 500,000.

The information given by Mr. Jellinger Symons in his "Arts and Artisans at Home and Abroad," published in 1839, enables us to contrast with Young's statements the capability of earning possessed by the labouring classes of England in our own day. *Men.*—In Manchester, a spinner can earn from 20s. to 25s. a week; a man in the card-room, 14s. 6d. to 17s.; a weaver by power, from 13s. to 16s.; by hand, from 7s. to 15s.; dressers earn from 28s. to 30s.; and mechanics, from 24s. to 26s. The wages at Sheffield vary from 25s. to 35s., and often amount to 40s., for workmen in the skilled departments; in the iron-works of the Birmingham district, wages average from 20s. to 30s. for the common labourers; in the Leeds flax-mills, men earn from 17s. to 19s. a week; in the Gloucestershire cloth-factories, from 12s. to 14s. In other trades, the average wages per week throughout England are—iron-founders, 28s. to 30s.; machine-makers, 26s. to 30s.; sawyers, 24s. to 28s.; carpenters, 20s. to 25s.: stone-masons, 18s. to 22s.; bricklayers, 17s. to 20s.; spadesmen, 10s. to 15s.; porters, 14s. to 16s.; colliers, 3s. 6d. a day; stocking weavers in Leicester, 8s. 3d. per week. *Women* earn per week, at Manchester, as spinners, 10s. to 15s.; in the card-room, 9s. to 9s. 6d.; weavers by power, 8s. to 12s.; by hand, 6s. to 12s.; in the Leeds flax-mills, 5s. 6d. to 6s. 6d.; in the Gloucestershire cloth-factories, 4s. to 5s. Children can earn in the Manchester factories, from 1s. 6d. (scavengers) to 7s. a week; in the Leeds flax-mills (when nine or ten years old), 3s. 6d. to 4s. "Agricultural wages," says Mr. Symons, "in England vary so little, and are so well known, that I need hardly do more than state, that in the Coteswold districts, for instance, a shepherd receives 10s. weekly; a carter, the same; day-labourers, 8s. in summer, and 6s. in winter; in addition to which, they earn 3 guineas at harvest time, which will pay their rent. Women receive 6d. a day in winter, and 8d. in summer, and 1s. in time of hay and harvest. Perhaps these are the lowest wages paid in any district in England. From 8s. 6d. to 10s. 6d. will be throughout the average wages of the great bulk of adult male agricultural labourers of England. These rates of wages are taken at a period when the remuneration of labour is retrograding in a marked manner. Even under this state of affairs, however, they show that the increase of national wealth has at least given individuals of the labouring class the command of a greater money income.

The labourer's power of commanding the comforts of life can only be partially known from a statement of his earnings: attention must be paid to what these earnings can purchase. The principal expenditure of the labourer, as already stated, is in house-rent, clothing, and articles of domestic consumption. By the improvements of machinery, all classes are enabled to procure better clothing at a lower price than they formerly paid for an inferior article. The extent to which this change has been carried, may be inferred from one or two facts regarding our manufactures. In 1787, when the mule-jenny first came into common use in Bolton, Paisley, and Glasgow, the manufacturers paid for their fine yarn at the rate of 20 guineas per lb.; the same quality of yarn has of late been sold at from 14s. to 16s. a lb. The cotton twist, which sold in 1786 for £1, 18s. per lb., is sold now for 3s. The process of reduction in the price of manufactured goods is still going on, and in the linen as well as in the cotton trade. Canvass, No. 27, an article, the quality and dimensions of which do not vary, which sold in 1814 at 30s. a piece, had fallen in 1833 to 18s. In the woollen manufactures, a great reduction of price, compared with quality, has also taken place. The consequence is apparent in the style of dress adopted by the working-classes of Great Britain, so different from what prevails on the continent, and did formerly prevail here. As to houses, every person who has attained to middle age must have remarked the improvement in many districts of the accommodation of the labouring classes in this respect; and yet the money rental seems to have remained nearly stationary. Young states the house-rent of the working man to have been in his time—at Leeds, £2; Wakefield, £2, 5s.; Newcastle, £2, 12s. 6d.; Hatfield, £2, 15s.; North Mines in Middlesex, £3, 10s.; Kensington as high as £5. In 1839, the average rental of a labourer's cottage in the country near Penzance was about £3; in the town, £5; in the county of Rutland, £1, £1, 10s., and £2. In Suffolk, in 1838, the house-rent of 539 labourers' families averaged £3, 11s. per family; in Northumberland, the average rent of a labourer's cottage was estimated at £2, 10s. Even the price of provisions, which is generally supposed to have been so much lower in former times, has not increased, if it has increased, so much as is supposed. The average prices of butcher meat, beer, cheese, milk, and butter, throughout the kingdom, do not materially differ now from what they were in 1760; bread is dearer, but improved in quality, and potatoes are much cheaper. Tea, coffee, sugar, and pepper, have been much reduced in price; and now, instead of scarcely ever appearing in the weekly bills of the labourer, are standing articles of his expenditure.

This improvement in the quality of the accommodations procurable by a moderate income must always be kept in view, when comparing what a man can earn now with what he could earn formerly.

It would, however, convey a false impression of the amount of social advantage at any time derived in Great Britain from the great increase in the productive powers of industry, were we to leave unnoticed the large and increasing class which has never yet been reached by these benefits. Even in the most busy marts of industry, numbers are to be found, and these not always entirely unable or unwilling to work, who are in a state bordering upon destitution. We have a remarkable example of this class in the city of Limerick, where a large district is in a manner given up to them. In England, it is to be observed, the mean value of life among the more comfortable portion of the working-classes is now as high as that of the middle classes in last century: this appears from comparing the experience of the Amicable Insurance Office, established in 1706 for the benefit of the middle classes, with the table of mortality collected by the Society for the Diffusion of Useful Knowledge, which embraces the history, as to mortality, of 24,323 years of life among the labouring classes from all parts of England, from 1823 to 1828. In Limerick, on the contrary, while the deaths in the three tontine societies there founded in 1807, 1811, and 1814, and with lives injudiciously selected, show respectively one death annually in 108, 81, and 182 persons, the annual mortality among the poor is 1 in 19. This is not all. "The frightful excess of epidemic and endemic diseases among the poor of Limerick may be gathered from the following fact, that while the per-centage proportion of this class to the whole number of deaths in England and Wales in 1838, was under 20 (19·8); in the metropolis and Leeds, 26·1 and 26 respectively; in Manchester, 23·2; in Birmingham, 20; and in Liverpool, 19·8; it is in Limerick not less than 40, or nearly five times as great as the proportion of deaths from diseases of the respiratory system, to which, among a healthy population, it ought to be nearly equal."* Among the families of this class who came under the notice of Dr. Griffin—"Out of 66 who had more than 10 children born alive, 13, or one-fifth, had lost 11 or more of those children; and the aggregate mortality of those families was 159, or 12 each, which, if distributed among the same number of families who had the greatest number of children born alive, amounts to 79 per cent., and was probably higher." He adds—"It has been remarked that production is often most rapid among a population in extreme wretchedness; and I strongly suspect that this is a consequence of the high mortality which occurs in such circumstances. It is the character of any influence which tends greatly to depress the powers of life, that it always bears heaviest on the tenderness of infancy and the feebleness of age. Now, as I find that the poor nurse their own children, there is generally an interval of about two years between the birth of one child and that of the next; but if a child dies early on the breast, this interval will be much shorter, and if this occurs often, there will be a certain number born, as it were, *for the purpose of dying*."

Effects of Increased Wealth and Knowledge in Combination.

Some results from the combined influence of increased wealth and knowledge may now be adverted to. It is to be observed, that the rich could at all times command many comforts favourable to life; but it is only when knowledge suggests a right employment of the means afforded by opulence, and opulence on the other hand exists to avail itself of the aid of knowledge, that the full benefit of the conditions we have been reviewing can be said to be realized. The following illustration may make our meaning more clear.—

It is commonly believed that there is more danger to life from lithotomy than from amputation; but statistical inquiry shows that death more frequently follows the latter than the former operation. The results of 640 cases of amputation of legs and arms, in hospitals and private practice, in France, Germany, United States, and Great Britain, were in 150 cases fatal—a ratio of 23½ per cent. It is to be kept in view, however, that the mortality in cases of amputation very frequently arises from the injury or disease on account of which the operation is resorted to; whereas the mortality from lithotomy is almost invariably the direct effect of the operation alone—the surgeon having it in his power, in the latter case, to choose a time when the patient is in the best condition to endure the suffering, which he can rarely do in case of amputation. When we reflect upon the intimate acquaintance with the human frame, and the confidence in his own skill, which the surgeon can only acquire by dexterity, the result of much practice and the traditional experiments of his predecessors, we are able to form some idea of the importance of knowledge in alleviating the miseries of humanity. And when we add the consideration of the cost of instruments, medicines, and the time and trouble requisite to form a good surgeon, we are able to form some idea of the extent to which stored-up capital is a necessary prerequisite to men having been able (in the first instances at least) to give and receive this alleviation.

Another example of the benefit of the co-operation of increased national wealth with increased knowledge, is the diminished risk of life in cases of child-birth. It may appear that we are wandering from the consideration of wealth, seeing that the examples we are about to subjoin are selected from the returns of lying-in hospitals—the only trustworthy statistics on this point. But it must be kept in mind, that a nation must be wealthy before it can support such institutions; that the improvement so marked in the case of the poor, must be *a fortiori* greater in those who can afford continued watching and the best assistance; and that the affluent classes must have enjoyed the benefit before it could be extended to the poor. The process by which a share in this and other privileges of the rich has been extended to the poor, is a question for after investigation. With this explanation, we submit the following quotation from M. Quetelet's Treatise on Man, to show the mortality of women in child-birth, and their children:—

"According to Willan, the mortality in the great lying-in hospital in London, into which about 5000 women were annually admitted, was,

			Of mothers.	Of children.
From 1749 to 1758,	-	-	1 in 42	1 in 15
" 1759 " 1768,	-	-	1 " 50	1 " 20
" 1769 " 1778,	-	-	1 " 53	1 " 4[illegible]
" 1779 " 1788,	-	-	1 " 60	1 " 41
" 1789 " 1798,	-	-	1 " 288	1 " 77

According to Casper, the mortality of confined women at Berlin has been—from 1758 to 1763, 1 in 95, from 1764 to 1774, 1 in 82; from 1785 to 1794, 1 in 141; and from 1819 to 1822, 1 in 152."

The same author supplies us with an estimate of the sanitary influence of vaccination:—"In most civilized countries, there are enactments on vaccination, of greater or less severity, which are enforced with proportionate rigour. According to Casper and several other savans who have written on the ravages caused by the small-pox, it would appear that formerly generations were decimated by this scourge, that is to say, one-tenth of the human race died from it. Duvillard has found—1st,

* "Wherever the absolute mortality is low, the number of deaths in the epidemic class is less than the number in the pulmonary class, and, on the contrary, wherever the deaths in the first class exceed or equal those, it may be affirmed that the absolute mortality [illegible]."—*Appendix to First Report of Registrar General*, 8th edition, p. 111

That in the natural state, of 100 individuals of 30 years of age, scarcely four individuals have escaped an attack of small-pox; 2d, That two-thirds of all infants are attacked by it sooner or later; 3d, That small-pox, in the early years after birth, destroys, on an average, one out of every three who are affected with it; 4th, And one dies out of every seven or eight affected, at whatever age it may be. Such was the state of things before the discovery of vaccination; it has since been much ameliorated. However, in 1817, 745 persons died in Paris of small-pox; in 1818, 993; and in 1822, the number was as many as 1084. Also, at St. Petersburg, in 1821, 408 deaths took place from it; and at Vienna, 238 in 1822; whilst in London, in that year, there were 712. Prussia has been much better dealt with than other countries: during the two years 1820 and 1821, taken together, only 1 in 7204 persons died; whilst France lost 1 in 4216 the last two years. The following are the data of Berlin for almost half a century:—From 1782 to 1791 inclusive, 4453 deaths; from 1702 to 1801, 4999 deaths; from 1802 to 1811, 2955; from 1812 to 1822, 555. The number of deaths for the last period, which is extremely small in comparison with the preceding years, would be still less, if the deaths for 1814 and 1815 were subtracted, during which time vaccination was neglected. Indeed, these two years had 411 deaths from it; so that during the remaining there was only 114. But we should fall into a serious error, as M. Villermé has said, if we counted as gain to the population all those individuals who had been vaccinated, and not carried off by the small-pox. 'An epidemic, or any other malady against which we endeavour to secure ourselves,' says M. Villermé, 'indeed suppresses one cause of death; but from that circumstance the probability of dying from some other disease becomes greater. In other words, by closing one of the gates of death, we open the others wider, so that more persons pass through these latter; which is not saying that mortality should be equally rapid. Consequently, vaccination, and every preservative against epidemic disease, or any disease whatever, does not increase the population of old Europe *directly*, but, what is still better, it alleviates the lot of those whom it snatches from the chance of the small-pox, it diminishes the number of the blind, it preserves the native beauty of the person, and increases the average duration of life.'"

This will scarcely be called an exaggerated estimate of the advantages resulting from the discovery of vaccination. In the three examples which have been adduced, the reader may see how far knowledge and affluence combined, have served as preservatives against tangible dangers. But in so far as the affluent classes are concerned, this is but a small portion of the benefits they have conferred. The habits generated in these classes by the advancement of knowledge, at a time of increased diffusion of knowledge, have been favourable to a general healthy condition of the individual system, alike calculated to ward off the attacks of disease and to baffle them when they are incurred. Any person whose memory can carry him back for forty years, and who has had opportunities of observing, may remember the deficient ventilation, the small rooms, and the number of inmates in each room, which characterized even the houses of the landed gentry. In towns, the evil was still greater. But it would require to carry the retrospect still farther back—to the time when Rousseau in France, and Davy and Edgeworth in England, commenced their crusades against unhealthy absurdities in the dress and manner of living of the wealthier classes—to imagine the whole amount of the improvement which has been effected in this respect. The improved taste of the wealthier classes has contributed to improve their morals; and, in return, the better regulation of their conduct has tended to improve their general health. The practice of deep drinking, which universally prevailed, has almost ceased to exist among the affluent classes. Literary and scientific pursuits, if they do not always guard against low debauchery, save many from it, and enable still more to recover, after yielding for a time to temptation. An interesting paper, published by M. Benoiston de Châteauneuf, entitled "On the Duration of Life in the Rich and in the Poor," corroborates these views. The author has made, on the one hand, an abstract of the deaths of 1600 persons of the highest rank, among whom are 157 sovereigns and princes; on the other hand, he has taken, from the civil registers of Paris, the deaths of 2000 persons in the 12th arrondissement, which contains a population of workmen of all kinds—ragmen, sweepers, delvers, day-labourers, &c., a class subjected to pain, anxiety, and hard labour, who live in want and die in hospitals. Out of these materials he has constructed a table showing the per centage of mortality among the two classes at different ages, and has added a column indicating the per centage among the middle or easy classes. He found that, between 25 and 30, the deaths per cent. were—among the rich, 0; among the common class, 1·41; among the poor, 2·22: from 50 to 55—among the rich, 1·81; among the common class, 2·68; among the poor, 2·58; from 75 to 80—among the rich, 8·09; among the common class, 10·32; among the poor, 14·59. At this last age the column showing the deaths among the poor stops for want of materials—they had all died off; the column showing the deaths of the common class extends to the age of 90; that of the rich to 95. The same conclusion is indicated by contrasting the annual mortality shown by the annual average of deaths among the English middle classes who have insured their lives with the Equitable Society, and the annual average among the negro slaves. Among the former, it was only 1 in 81·5 from 1800 to 1820; whereas it has been calculated that one negro slave dies annually out of 5 or 6.

Some facts would almost seem to show, that the education enjoyed by the more affluent classes—the cultivation their minds received, partly from direct tuition, partly from their social circumstances—gave the mind an increased power of vitality. An officer of high rank in the service of a German state made this remark to the writer, when speaking of the disastrous retreat from Moscow, in which he had taken a part. The officers, he said, uniformly stood out longer than the privates, although the previous habits of both parties had led him to expect the reverse. Literary men, and artists who have attained to any thing like a competence, are also a long-lived generation. The remark has often been made, of the greater facility with which young men, belonging to the class vaguely called "gentlemen," generally attain to superior adroitness in athletic exercises. Whenever a party of Etonians are pitted at cricket or running against a party of lads of a lower class, the difference is at once perceptible. Again, the facility with which the young men educated at Oxford and Cambridge—unapt though the system of education pursued in these two great seminaries be to prepare them for the real business of life—work their way into the routine of legal or diplomatic business, is well known. There is something in the strengthening influence of good and delicate feeding, clothing, and lodging, combined with exercise of the physical and mental faculties, sufficient to strengthen, not to exhaust, persevered in for generations, that ennobles the race of the human animal, just as careful grooming and crossing the breed judiciously ennobles the horse. What is here spoken of, is not the power of such a process to confer genius, or true nobility of disposition; but to bring out in perfection all the average commonplace qualities of the human being. In any country, a superiority of this kind is discernible in the dominant *caste;* and as mere human animals, there is no country in the world that can produce a race equal to the young gentry of England.

Limits to the Effects of Wealth.

The limits to this favourable condition of the affluent classes in England, are to be sought partly in deficient knowledge and deficient habits of self-control; partly in a redundancy of numbers compared with property, which affects them in common with all other classes, though not exactly to the same extent. The deficiency of knowledge may be detected in several noxious practices still persevered in, such as tight-lacing on the part of the fair sex. The want of proper habits of self-control is a more deeply rooted evil, inasmuch as it has its root in a physical fact too much overlooked by reasoners upon morals. When named, it will be found to be a very commonplace fact: it is, that every successive generation begins the world with as little experience as that which preceded it. Every one of us starts from as mere a state of ignorant barbarism as the child of the savage. We are forewarned of much by the instruction of those who have been taught by their own experience, or the experience of those who went before them; but there is much of which it seems impossible to forewarn us. The passions are fully developed before the reflecting powers; and every individual seems destined to experience a period of his existence in which imagination and passion are strongly and thrillingly awakened, while the guiding power of reason is yet dormant. This is the most dangerous, as it is perhaps the most pleasant, period of life; and it is one which is most dangerous with regard to that very class which is so highly favoured in other respects. Penury, or the necessity of daily labour, may restrain the less affluent classes at this period of life; but the younger branches of the affluent class have no such substitute for the control of reason; and in proportion as their general healthiness is higher, so their passions are developed, it may be, with greater intensity. It is at this period that many of the more favoured class make shipwreck of their health, incurring diseases which cling to them through life, if they do not bring it to a premature close.

The influence of economical circumstances upon the affluent classes, in regard to their moral and physical welfare, is quite as striking as their influence on the less fortunate classes, though somewhat different in kind. The anxiety occasioned to the upper classes by the prospect or actual pressure of pecuniary embarrassment, is of a much more harassing and exhausting kind than what is suffered by the poor. Pride, and all the other secondary feelings, with ranging imagination, add to their torments; and their occupations generally demanding a steady exercise of the faculties of combination and investigation, and keeping their minds continually on the stretch even in the time of prosperity—this addition renders their burden more than they can bear, and the whole man breaks down beneath the weight. Excessive mental exertion, even under the most favourable circumstances, is known to be productive of fatal effects. Ev[illegible] children of affluent and fortunate parents have been sacrificed to the vanity which was gratified by their displays of precocious talent. The cupidity which grows upon men struggling to maintain their place in society, increases this evil by forcing on the acquirements of children, in the hope of seeing them able, at a comparatively early age, to provide for themselves. Casper of Berlin published, in 1834, a tabular statement of his observations on the sanatory tendency of various occupations, which serves to throw some light on this intricate question:—

Of 100 theologians, there have attained the age of 70 and upwards	43
Agriculturists and foresters,	40
Superintendents,	35
Commercial and industrious men,	35
Military men,	32
Subalterns,	32
Advocates,	29
Artists,	28
Teachers, professors,	27
Physicians,	24

That physicians should stand lowest in this scale of vitality, is not, considering their exposure to contagion, to be wondered at; and the high grade of theologians is equally intelligible, from their certain though moderate income, and the equanimity favoured by their pursuits. It is, however, startling at first view to find the average duration of life among commercial men so little elevated above that of military men, in a table constructed in a country where war had raged at no remote period. The last fact seems to establish that the agitation of mind produced by mercantile uncertainties and difficulties is scarcely a less destructive agent than the sword.

There is perhaps a point in the development of national wealth and civilization, at which mortality shows a tendency to increase. Such an idea is naturally awakened when we learn that the mortality of England is now greater than it was some years ago. The proportion of deaths to persons in the decade 1821-31, was 1 to 49; that of the decade 1831-41, has, as already stated, been found from the population returns to be 1 to 44.5.

EDUCATION.

The statistics of education have an obvious value in their connection with many questions regarding the civilization of countries.

It is clear, however, that the state and amount of education in a country is a highly complex question; for, first, there may be much education of a poor and inadequate kind; and, second, there may be conditions favourable to education in some countries, and not in others—as, for instance, the natural character of the people, the tendency of the political and social institutions, and the direction which the energy of the people chiefly takes, as towards war, commerce, or art. The numbers at school are also liable to be affected by the ratio of the increase of population; for, where there is a rapid increase of people, there is always a greater than usual proportion of the young.

Prussia, where the most perfect of all national systems of education exists, as far as organization is concerned, contained, according to a census taken some years ago, 12,726,823 inhabitants, of whom 4,767,072 were under fifteen years of age. It is reckoned that, out of 100 children from one to fourteen years of age complete, there are 43 of full seven and upwards—the legal age for attendance at school in Prussia. This would give 2,043,030 children in Prussia liable by law to attend school. It was found, in point of fact, that 2,021,421 did attend, being only a shortcoming of 21,609, a small enough allowance for contingencies. Thus, if we were to take Prussia as a criterion for old states, where the population does not advance rapidly and consider the years between 7 and 15 as those proper for school attendance, we should conclude that about *one-sixth* of the whole population of such a country should be at school.

Most of the German states make an approach to the organization of the Prussian system; and we find that in Austria there was, a few years ago, one school for every 275 families. But the object of the governments in supporting education in Prussia and Germany generally, is said to be of a narrow kind—a species of drill, for the purpose of conferring the accomplishments of reading, writing, and arithmetic, and to train the young to a subserviency to the government itself.

Education was in a low state in France till the revo ration of the Bourbon family, since which time it has become a government object, and made a rapid advance. The elementary schools instructed 737,369 pupils in 1815; in 1828, this number was raised to 1,500,000; being *one-twentieth* of the population. It is calculated that one-third of the people of France are unable to read or write.

In England and Wales, in 1818, there was 4167 endowed schools, 14,282 unendowed schools, and 5162 Sunday-schools, educating in all 644,000 children, or *one-sixteenth* of the population. Of 11,000 parishes, 3500, or nearly a third, had no school whatever. Since then, the number of both schools and scholars has been greatly increased. In 1833, the following returns were made to parliament:—

Attending infant schools,	89,005
.. daily schools,	1,276,947
Total,	1,365,952
Attending Sunday-schools (supposed to be an exaggerated statement),	1,548,890

Probably from a tenth to an eighth of the people of England and Wales are now receiving school instruction.

The registration of marriages, by which the parties are required to sign their names on being united, has supplied within the last few years a means of testing the proportion of those ignorant of writing throughout England and Wales. Of the 121,083 couples married during the year ending June 30, 1839, there were 40,587 men, and 58,959 women, who, being unable to write their names, were obliged to sign by marks. The proportion of men unable to write was thus 33, of women 49 per cent.; medium, 41. The number unable to write was least in the metropolis, and, next to it, in the northern counties; and greatest in Lancashire, Bedfordshire, Monmouthshire, and Wales. The trustworthiness of this test was confirmed by the registration of the ensuing year, when, amongst the 124,339 married couples, 41,812 men, and 62,523 women, were found to sign with marks; and the proportion in the various districts was also nearly the same. It is to be remarked, that a large portion of the married couples recorded in these years must have consisted of persons who passed their educational years in times when the means of instruction in reading and writing were much less extended than they now are. Ten years hence, the proportion of both men and women attesting the marriage-register with "marks" will probably be much diminished.

Scotland, unlike England, possesses a national system of education, there being a legally endowed school in every parish, under the care of the clergy. Returns to parliament in 1831 gave the following view of education in Scotland:—

	Schools.	Pupils.
Parochial,	1047	68,293
Private,	3995	154,160
Total,	5042	222,453

The whole emoluments of the teachers of the parochial schools was £55,339, being at an average an income of £15, 11s. 9¼d. to each. The aggregate sum was composed of—endowments, £29,642; fees, £20,117; other emoluments, £1979. Taking 68,293 as the number of pupils in the parochial schools (it was, however, the *greatest* attendance), each costs the public 15s. 7¼d. per annum. In the same year, the Sabbath School Union for Scotland taught 63,326 children.

The proportion of children taught *out of* the parochial system was unexpectedly great. It was greatest in certain counties, as follows:

	Parochial schools.	Private Schools.
[illegible]shire,	32	190
Aberdeenshire,	91	317
Lanarkshire,	72	352

—and there was no county, except Peebles, where the parochial schools were the most numerous. Only one-fifth of the teachers and one-fourth of the scholars were under the parochial system. It is also to be remarked, that some of the schools returned as parochial, were merely under the care and patronage of parochial clergymen, by whom they had been established. The returns were considered as not quite complete, and the number attending school in Scotland in 1834 was *computed* as being more probably 323,154, the proportions in the two different classes of schools being nearly the same.

Notwithstanding the political agitations and poverty which have long depressed Ireland in many respects below the level of the sister kingdoms, it has certainly for many years been above at least England with respect to the elementary instruction of its people. The ability to read and write is observably much more diffused in Ireland than in England; and it is often remarked with surprise, of Irish peasants of the humblest appearance, that they possess an acquaintance with the classics and the elements of Geometry.* Till 1831, education in Ireland was chiefly left to private enterprise and the efforts of a few religious societies: the government in that year established a Board for National Education, which has since been a channel for the application of a considerable amount of public money to this purpose. Various enumerations give the children attending public schools in Ireland for different periods, as follows:—

	Protestants.	Catholics.	Total.
In 1808,	45,590	116,977	162,567
.. 1821,	..	..	394,813
.. 1824–6,	142,169	408,285	560,549†

In 1835, a return to the Commissioners of the Education Board gave a computed total of children attending school in Ireland at 633,946, the population being at the same time computed at 7,954,100; so that the proportion under school instruction appeared to be about 1 for every 12·5 inhabitants. Since then, the national system has made great advances. The following table, drawn up from the eight reports of the Commissioners, shows the progress down to December 31, 1841:—

Reports to the Commissioners of Education.	Number of Schools in actual operation.	Number of Children on the Roll.
No. 1. (1834),	789	107,042
.. 2. (1835),	1106	145,521
.. 3. (1836),	1181	153,707
.. 4. (1837),	1300	166,929
.. 5. (1838),	1384	169,548
.. 6. (1839),	1581	192,971
.. 7. (1840),	1978	232,560
.. 8. (1841),	2337	281,849

Number of schools in actual operation on the 31st December, 1841,	2,337
Number of school-houses in progress of erection on the 31st December, 1841,	382
Total number of national schools on the 31st December, 1841,	2,719
Number of children in attendance upon the 2337 schools in operation,	281,849
Expected attendance upon the 382 building schools	48,356
Total number of children in actual attendance, and expected attendance,	330,205

SUMMARY OF THE FOREGOING.

Schools in operation.			Schools Building		
Ulster,	1005	91,700	Ulster,	103	10,166
Munster,	482	75,772	Munster,	113	13,907
Leinster,	642	88,258	Leinster,	81	10,754
Connaught,	208	26,119	Connaught,	85	13,529
	2337	281,849		382	48,356

* Of an edition of Euclid published by the editors of the present work, by far the largest portion of copies is sold in Ireland. Mr. Bicheno, in a report on the Poor-Law, asks, "Where in England could the ordnance surveyors find persons among the *lowest class* to calculate the sides and areas of their triangles, at a halfpenny a triangle, as they do in Ireland, and plenty of them?"

† In this sum is included 10,026 whose persuasion was not ascertained.

To which are to be added eight vested schools not included in the above, making the total number of schools on the 31st December, 1841, 2727.

The Irish national system at first met with great opposition, in consequence of religious party-spirit; but this obstacle is gradually giving way. The Presbyterian Church in Ireland has 300 schools in connection with the national board, and the Irish Society is stated to be about to form a similar connection with respect to about 60 schools under its charge. About 20 Poor-Law Schools have recently come under the superintendence of the board. It may here be mentioned, that at a great proportion of the elementary schools in Ireland, one penny a week is paid by each pupil for education.

Education is actively conducted in America, and it is calculated that about a sixth of the population are at school. In most of the states schools are supported by a tax on property, and the superintendence is intrusted to committees of the rate-payers. In those of New England, the schools are as one to every two hundred of the inhabitants—a proportion, perhaps, exceeded in no part of the world.

In surveying the statistics of education, we must keep in mind a few considerations by which the character and effects of education are liable to be much affected. Education is not certain to produce *good* effects, but only those which its directors contemplate and seek to bring about. It is a means of conferring certain accomplishments upon the mind, and modifying it to certain ends, inclinations, and habits of thinking and feeling. Its efficacy, even where well directed, is liable to be greatly modified by the character of the people amongst whom it is operating: for instance, a European people of good stock, and amongst whom all refining social agencies have long been at work, will show better results with a certain apparatus of school instruction, than a people newly emerged from barbarism. Above all, our expectations of moral results must be governed by the degree in which the moral department of education is attended to. Intellectual education gives only aptitude and information; it requires a training of the moral being to produce good conduct. We shall say more on this subject under the head "Crime."

It has been seen that Prussia stands at the head of all the countries adverted to, with respect to the proportion of the population attending school. It is excelled in this respect by the United States of America, where, it is computed, there is a school for every 200 souls. England and Scotland have probably a ninth of their inhabitants at school—a considerably smaller proportion. But reckonings of schools and scholars are only a means of ascertaining a portion of educational influences. It cannot be doubted that, besides all the benefits, such as they are, of school learning, the youth of this country enjoy an immense advantage in the influence which the free institutions, the humanity, and the tone of mind resulting from an old-established civilization, must exercise upon them. In a national system of education, the central government should possess but a slight, if any influence, and the business of both arranging and supporting should be left as much as possible in the hands of the people themselves. We beg to submit the following general views on this subject:

Any thing done by government, as the organ of society, to promote universal education, must be based upon the actual state of educational efforts in the country. The people must everywhere be encouraged, invited, stimulated, to take a portion of the task of education into their own hands. With communities, as with individuals, education cannot be a one-sided matter, in which the instructor arouses the pupil; there must be exertion on the part of the latter also. The mistake of some governments, especially the Prussian, has been to hold the people as entirely passive: they have *drilled* rather than *educated*. Almost every thing that has been hitherto done in Great Britain to promote education has been the result of private enterprise: even the majority of endowed schools are the fruits of private enthusiasm in the cause of education. A paper by Mr. Long, in the second volume of the Journal of the Central Society of Education, estimates the annual income of endowments in England, for purposes of education, at £1,500,000; and shows the want of a proper power, invested in some individual or body, for the purpose of assisting, directing, and correcting all who are intrusted with the management of such charity property. Educational amateurs may be deficient in skill, but funds left to support schools require some one to administer them, and to adapt the mode of dispensing them to the perpetually altering circumstances of society. A table of the mechanics' institutions and other popular associations in England for promoting and diffusing science and literature, has been published in the Statistical Journal. It is defective, but it shows approximatively what has been done by private effort for the higher education of the people. The total number of societies is stated to be 112; of 91 of these the annual income has been ascertained, and it amounts to £36,793, 14s. This is a slender provision for the intellectual wants of the adults of England, and what is more, its influence is limited, in a great measure, to those who, strictly speaking, do not belong to the working classes. In the Glasgow Mechanics' Institution, a majority of the attendants on the lectures are shopmen, individuals employed in warehouses, and even some students—the middle classes. Of the operatives who attend, the *mechanics* form a considerable proportion. The Mechanics' Institution of Liverpool, one of the most flourishing institutions of the empire, is, both in its elementary schools and its lectures for adults, frequented and supported almost, if not quite, exclusively by the middle classes. The facts mentioned seem to justify these conclusions:—That national education requires the operation of government only as public trustee, and of the people themselves, trying to procure the kind of education their wants prompt them to seek; that the duty of government is to insist that education shall be universal, and to provide such superintendence and means of general control as are necessary for enforcing this precept; that the duty of the people, in their respective districts, is to carry into effect the general directions of government. The business of government is to see that the necessary funds are provided, the necessary establishments for training teachers and pupils kept up, and the attendance of children enforced. The business of the people is to appoint teachers, and to take precautions for their discharging their duties conscientiously. The details of tuition are best left to the teachers, care being taken that they are previously educated for their profession. Success in teaching depends, in a great measure, upon the enthusiasm and ability of the teacher; and the most successful method is that which is best adapted to the peculiar character of the teacher. Some teach more efficiently by one method, others by another. The public judge most correctly of a teacher's ability by looking at results—at the kind of scholars he turns out. Some such organization of the whole country for educational purposes, as is indicated in these general terms, would, by giving a controlling power to government, ensure equal diffusion of education; by leaving to the people the appointment of teachers, and by leaving, to a certain extent, to individuals the choice of what should be taught, would keep alive the interest which men take in their own handiwork; and by leaving the methods to the choice of well-trained teachers, would give scope for progressive improvements being effected in the art of education by those who were practically acquainted with it. The importance of leaving a certain latitude of choice to individuals (parents, or the more advanced young men and women), is apparent from the experience of the Glasgow Mechanics' Institution. The most uniformly successful classes have been those of mechanics (or natural philosophy) and chemistry; and a large proportion of the operatives who attended them have been engineers, and others engaged in processes which are best conducted by those who understand something of their principles. Human beings are most easily seduced to undergo the toil of learning (for though to pick up fragments of information be agreeable, to devote the continuous attention necessary to understand a subject thoroughly is at first a task) by the conviction that what they are learning can be turned to profitable account. Having learned one subject thoroughly, they acquire a liking for the effort, and are more easily induced to extend their researches. It is good not to attempt too much at first. Get every one to learn something that may benefit them in their occupations: none who have learned this thoroughly, be it what it may, will stop there.

CRIME.

Crime is the result of various causes—as, first, the natural or original disposition of the culprit; second, the moral atmosphere in which he has lived; and, third, the temptations placed before him. Generally, all of these causes are more or less concerned in crime, so that it becomes a very complex question. When we apply statistics to the investigation of crime, we are met by the further difficulty, that only a certain portion of the whole of the offences committed are known to us, and that the proportion known must vary in different countries according to the efficiency of the legal apparatus applied to the detection of crime. Statistics has, nevertheless, afforded some curious and valuable knowledge on the subject.

The number of persons annually committed or bailed to take their trial in England and Wales, has for a number of years past been on the increase; but chiefly, it is believed, in consequence of the increased efficiency of the laws. For the five years before 1839, it was 22,174 on an average; in 1840, it was 27,187. The last sum was an increase of 45 per cent. on the number for 1830, which was 18,657. It is important to observe, that these are not summaries of the whole offences of their respective years. There is, besides, a larger number of offences, which are tried summarily before magistrates. For example, in 1837, in addition to 17,090 persons convicted upon regular trial, there were 59,374 summary convictions.

By far the greater proportion of English crimes are against property. Taking the average of the five years before 1839 (22,174), it appears that 84·5 per cent. were thefts and frauds, the small proportion of 7 per cent. of these being accompanied by violence. Of offences against property and person, in which malice was involved, as murder, maiming, arson, and injuries to cattle, there were about 6 per cent. A class called sexual offences gave 2, and offences against the state, in which was included coining, 6½ per cent.

The counties in which committals are year after year fewest, are those of Wales, the four northern ones, Cornwall, and Derby; those in which they are most numerous, are Middlesex, Essex, and Warwick.

There are some crimes which women are not, from various causes, liable to commit; but the gentler does not appear to be the honester sex; for the proportion of female to male committals for theft without violence, is as 84 to 73 per cent., a difference of one-sixth against females.

In the inquiries which have been made with regard to the age of offenders, wonderfully uniform results have been found, as will appear from the following table, giving the centesimal proportion at each period of life:—

	1836.	1837.	1838.	Greatest Difference.
Under 12 years	1·84	1·52	1·53	0·32
From 12 to 16	9·71	0·72	0·92	0·21
„ 17 „ 21	20·03	20·23	20·13	0·20
„ 22 „ 30	31·42	31·74	31·24	0·50
„ 31 „ 40	14·43	14·56	14·75	0·32
„ 41 „ 50	6·76	6·65	7·02	0·37
„ 51 „ 60	3·33	3·24	3·00	0·33
Above 60	1·40	1·55	1·58	0·18
Not ascertained	2·08	1·79	1·78	0·30
Total	100·0	100·0	100·0	

The large proportion at the periods of adolescence and youth must be considered as strictly owing to a greater tendency to crime for the proportions of human beings at those ages to the whole population are different, the persons from 16 to 20 being as 10 per cent., and those from 20 to 30 as 15 per cent., of the entire nation. It is calculated that amongst the persons living in England and Wales, from 17 to 21 years of age, there is one committal for 232; while from 41 to 50 there is one for 941; and above 60 one for 3391 individuals. We thus see how great an influence the strong and unregulated feelings of youth exercise in inducing criminality.

The connection of education or non-education, and of poverty, with crime, has excited much attention during the last few years. It is abundantly clear that some school learning may exist where the moral department of education has been neglected, or where the temptations to error may be very great. The education of mere reading and writing may only supply the means of committing a crime—as forgery—instead of tending to restrain from it. Yet it certainly does appear that criminals are generally uneducated in all ordinary respects. Mr. Rawson, Secretary of the Statistical Society of London, has found that, of every 100 offenders in England and Wales, 35·4 per cent. could neither read nor write; 54·2 per cent. could read and write imperfectly; 10 could read and write well; and only ·4, or less than a half per cent. had received a good education. In Scotland, out of 8907 offenders, 20·2 per cent. could neither read nor write; 59·2 could read and write imperfectly; 18·2 per cent. could read and write well; and 2·4 had received a superior education.

Mr. Bentley, author of a History and Directory for Worcestershire, has shown the relation of non-education to crime in a different way. It appears from his tables, that the six English counties having the greatest proportion of schools are Cumberland, Durham, Middlesex, Northumberland, Rutland, and Westmoreland, in which the schools are one for every 727 inhabitants, and the criminal offenders one for every 1156 inhabitants. The six counties that have the smallest proportion of schools are Chester, Dorset, Hereford, Lancaster, Northampton, and Somerset, in which the schools are one for every 1540 inhabitants, and the criminal offenders one for every 528; that is, out of a people having twice the number of schools, there is not in proportion half so many criminals as where the schools are deficient. A comparison of the number of schools in the six most criminal, and the six least criminal, of the English counties, leads to the same conclusion. In Essex, Gloucester, Hertford, Chester, Somerset, and Warwick, we find one criminal offender in the lists of government for every 499 inhabitants, and only one school for every 1069 inhabitants; on the other hand, in Cornwall, Cumberland, Derby, Durham, Northumberland, and Westmoreland, we have only one criminal to every 1309 inhabitants, while we have one school for every 839 inhabitants. In other words, there are six counties in England which have nearly three times the amount of crime found in six other counties; and the counties in which the least crime is found have one-fourth more schools than the counties in which crime abounds.

The different distribution of educational acquirements among the convicts of England and Scotland is striking and requires for elucidation some inquiry into the proportional diffusion of knowledge among the whole community in each country. Among the affluent classes it is much the same, but among the working-classes it is materially different. According to the factory returns, there exists a more widely diffused instruction in Scotland than in England: in the former country, out of 29,486 operatives, 95·8 per cent. could read, and 53 per cent. could write; while in the latter, out of 50,497 operatives, only 86 per cent. could read, and 43 per cent. could write. We have seen above, that, in proportion as education was diffused through the whole community, the proportion of criminals to the total of the population was diminished; and this holds good in Scotland. But the mere extension of intellectual education to individuals of a class in which improved economical circumstances and self-education in moral respects has not induced that moral sense shown to be elicited in civilized communities, does not raise these individuals to the same elevation in the moral scale that the same education would do under more favourable circumstances. To produce the full benefit of education, it is *the class*, not merely the *individual*, that must be educated. An educated individual, belonging to an uneducated class, either continues to associate contentedly with his original companions, and retains their comparatively low standard of morality, combined with the increased power lent him by education,—he has as feeble a restraint upon his conduct as they have, with much more power to do harm—or he attempts to associate with those above him in circumstances, though only equal in acquirements, and, failing in the attempt, sinks down to his former social level, soured against society, and prepared for any act of outrage. The petty pilferers are, for the most part, supplied by the destitute and uneducated class; the more daring and dangerous offenders by those who have moved in a more affluent sphere, and fallen from it by their imprudence or vices. The lesson read by the different degrees of education possessed by Scotch and English criminals, is the necessity of educating *classes* as well as individuals.

When we come to speak of educating classes, we are brought to the consideration of their economical condition. In Bristol, an inquiry into the educational statistics of the city showed that, out of nearly 10,000 adults, taken indiscriminately among the working-classes, 22·5 per cent could neither read nor write; 25·6 could read only; 51·9 could read or write. In a wretched part of the parish of Marylebone in London, it was found that 25 per cent. could neither read nor write, and 75 per cent. could either read, or read and write; and in two other portions of the same parish, inhabited principally by Irish labourers and their families, 49 per cent. could neither read nor write, and only 41 per cent. could read, or read and write. Among 1022 able-bodied and temporarily disabled paupers above the age of 16, the inmates of several union workhouses in Norfolk, Suffolk, and Kent, whose attainments were ascertained with precision, 46·5 per cent. could neither read nor write, 18 read imperfectly, 30·2 read decently, 5·3 read in a superior manner; and of the same, 66·4 could not write, 15·4 could write imperfectly, 16·9 write decently, and 1·3 write well. It thus appears, that poverty and want of education, as well as crime and want of education, go in company.

On the last point it is necessary to guard against a misconception. There may be a district poor in resources and with respect to the style of living of the inhabitants, and yet crime may not abound in it. The department of Creuse is one of the poorest in France, yet it presents the fewest crimes. M. Quetelet draws the important distinction, that a set of people living steadily on small means, but knowing no better, and contented with what they have, are not poor, in the sense in which a people are poor who, seeing wealth and luxury around them, and exposed to the severest sufferings from the occasional failure of employment, are thereby demoralized.

SOCIAL ECONOMICS OF THE INDUSTRIOUS ORDERS.

It is surely a deplorable feature in the condition of a large portion of the working-classes in this country, that they have little or no provision made against the necessities which arise to themselves or their families in the event of sickness, a failure of employment, or death. With some this is not the case, but it is the case with many; and the result is, that these persons have never more than a thin partition dividing them from the realms of want and dependence. The effect which this is calculated to have, need not be largely insisted on, for want and dependence are universally allowed to bring many evils. What is there to be expected from the moral nature of one who is every now and then obliged, perhaps, to ask for gratuitous medicine and medical attendance—to take bread from a parish officer or the managers of a charitable subscription—to trust to the pity of neighbours whenever any thing like an exigency arises in his family—in short, is, for the supply of a great part of his needs, a stipendiary upon his fellow-creatures? These things are evidently irreconcilable with true manly dignity, with political independence, and with an upright bearing in any of the relations of life. The destitution of such individuals is commiserated when it arises—every humane person who is himself above want, feels bound to contribute to its relief: the claim from suffering man to him who suffers in the smallest degree less, is irresistible. But while it is allowed that the need, when it does exist, must and ought to be relieved, all must likewise see that, in the effort to diminish one immediate and clamant evil, another is introduced. The working man is morally deteriorated by ceasing to be independent. Better, clearly, that this portion of the community were to place themselves, by efforts of their own, above all need for such degrading aid.

"But then the working-classes realize such small gains, that they can spare nothing for this purpose." This may be said; but it is at the best partially true. A great portion of the working-classes do most unquestionably, in ordinary times, realize enough to enable them to spare a little by way of provision for the future. Since many, most creditably to themselves, make such a provision, it may fairly be presumed that others, having the same wages, could do so also, if they were willing. We may still more confidently presume, that, when some with comparatively small wages are able to save, those who are better off could save also. Now, it often happens that the labourers of least skill, and who are least liberally remunerated, contribute as largely to savings' banks as their better paid brethren. Where this is the case, and the circumstances of the men are otherwise equal, we cannot doubt that the latter class make a less economical disposal of their income. Clearly, they have only to imitate the frugal conduct of the small-wage class, in order to have ample means for making the provisions in question. On this subject, from various causes, many erroneous notions prevail. When practical men are consulted, we hear of an afflicting number of instances in which the higher-waged workmen are considered as securing little if any more comfort to their families, than the other class, and perhaps not so much. We have heard masters of works declare that their men, at 25s. a week, did not, as a class, maintain their households, or educate their children, so well as those who had little more than half the sum. In a recent return from the Savings' Bank of Dundee, it appears that, while there is £1189 deposited by 108 male weavers, a class whose wages average 8s. weekly, and £425 by 36 hecklers, a class whose average wages are 12s., there is only £637 from 56 mechanics, men whose wages range from 18s. to 30s. Such facts, and we believe many of the like nature might be adduced, seem to prove that the working-classes have much more in their power for the promotion of their physical and moral well-being than is generally thought. Admitting fully that many are ground to the dust by poverty, we cannot doubt that a far larger proportion have all but the will to take the proper means for preserving their independence.

We do not profess here to inquire into the primary causes of the unendowed condition of the working-classes; but we can readily see various immediate ones, as intemperance and bad management of resources. The tavern bill of the whole operative class in the United Kingdom must be an enormous one. Of above thirty-one millions of gallons of spirits prepared in one recent year, and for which twenty millions of pounds sterling would be received, we cannot assume less than two-thirds to have been consumed by the working-classes. These classes probably expend in this way three times the whole cost of the religious establishment of the country. In Glasgow there is a tavern or spirit-shop for every fourteen families; and the sheriff calculates that not fewer than thirty thousand of the inhabitants go to bed drunk every Saturday night. In the parish of St. David's, in Dundee, while there are but 11 bakers' shops, there are 108 for the sale of liquors. In the parish of Lochwinnoch, in Renfrewshire, three or four times more money is spent in this way than is required for the support of religion and education. The value of ardent spirits consumed in the parish of Stevenston, in Ayrshire, with a population of 3681, exceeds the landed rental by £3836. These are startling facts, telling, if they tell any thing, that a large portion of the earnings of the working-classes is worse than thrown away. Now, though it is well, certainly, to compassionate and relieve the sufferings of all who need, we cannot but be equally sensible that it is proper to tell the plain truth, and say that for much of this suffering our countrymen have themselves to blame. There has been of late years a hollow kind of cajolery practised towards them, discreditable to all parties, and of a dangerous tendency. We dismiss this entirely, and conceive it to be both paying them a greater compliment and doing them a greater service, to tell them that the conduct of a large portion of their class is in many respects wrong, and to show them how it might be shaped somewhat better.

We propose therefore, in the present sheet, to treat of various arrangements or institutions which have been devised for the benefit of the industrious orders, with a view to their maintaining their independence, or avoiding some of the greater evils which beset them.

One of the most conspicuously valuable is

THE SAVINGS' BANK.

Previous to the commencement of the present century, such of the humbler classes as were given to saving had no proper place of deposit for their spare funds, which they were obliged, therefore, to keep in an unfructifying hoard in their own possession, exposed to the risk of loss, or had to consign to some neighbour, who, though thought safe, might turn out to be much the reverse. At the same time, in the want of a proper place for the deposit of spare money, those who might save, but did not, lacked one important requisite to their doing so. About 1805, it occurred to some benevolent minds that an important benefit would be conferred on these classes, if there were institutions of the character of banks, but on a modest scale, in which the poor could deposit the smallest sums they could, from time to time, spare, certain of being able to draw them forth when they pleased, with accumulated interest. Savings' banks were accordingly established, first in England, and afterwards in Scotland and Ireland, whence they quickly spread to America and France. They were generally conducted by associations of benevolent persons, who gave the security of their own credit for the accumulated sums, and held forth every temptation in the way of liberal interest, courtesy, and promptitude in management, to induce the working-classes to resort to them.

For some years, this joint-stock but still private security was found to be sufficient for the purpose; but, when it was understood that millions had found their way into savings' banks, it became apparent that something else was necessary in order to maintain the confidence which had at first been felt. The government was therefore induced to frame a variety of statutes for the better regulation of savings' banks, and one in particular by which its own security was given for the safe-keeping of the deposits. This was done under the guidance of the best intentions towards the industrious classes, who generally are depositors in savings' banks, and with as little interference as possible with private and local management.* A substantial benefit was also conferred, in the fixing of a rate of interest rather above the medium of what could be expected in a country under the particular circumstances of the United Kingdom with regard to capital.

By the above-mentioned acts, it is directed that *all* the funds deposited in National Security Savings' Banks must be paid into the Bank of England on account of government, and that the money so invested shall bear interest at the rate of £3, 16s. 0½d. per cent. per annum, *whatever may be the fluctuations in the value of the public funds during the term of investment.* Depositors are thus afforded the best of all securities, namely, that of the *whole British nation;* while the National Savings' Banks are enabled, after paying all charges upon their establishments, to give a considerably higher rate of interest than the ordinary banks, or even the greater part of private savings' banks, allow on deposits. The highest interest which the law allows the National Security Savings' Banks to pay, is 2½d. per cent. per diem, or £3, 8s. 5½d. per cent. per annum; the difference between this and the rate allowed on the money invested by them in government securities being reserved as a fund for the payment of the officials of the banks and other necessary expenses. The rate of interest which is generally paid by these banks, is 3⅓ per cent., or £3, 6s. 8d. per cent. per annum; and whatever is left, after defraying all charges, is allowed to accumulate as a surplus fund.

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* Various rules are appointed by the legislature for the formation and management of savings' banks. An association of persons desirous of forming one in any place are enjoined first to frame a set of rules for the management, and to submit these to the approval of a barrister appointed by government, without whose certificate they cannot enjoy a legal status, or any of the advantages which the legislature has thought proper to hold out for the encouragement of such institutions. The present certifying barrister is John Tidd Pratt, Esq. A fee of one guinea is charged for the revision of the rules and certificate. The managers, trustees, and treasurer, must act gratuitously, the only paid officer being the actuary or clerk, who is obliged to give security for the money passing through his hands.

Deposits of from *one shilling* to *thirty pounds* may be received by these banks, but no individual depositor is allowed to lodge more than thirty pounds in one year, or than £150 in whole. Charitable and provident institutions may lodge funds to the amount of £100 in a single year, or £300 in all; and friendly societies are permitted to deposit the whole of their funds, whatever may be their amount. Compound interest is given on the sums lodged, the interest being added to the principal at the end of each year in some banks, and the end of each half-year in others, and interest afterwards allowed on the whole. Any depositor may receive, on demand, the money lodged by him, if it do not amount to a considerable sum; and even in that case it will be returned on a few days', or at most two or three weeks', notice. Practically, in Edinburgh at least, payment is always made on demand.

The wisest and most effectual provisions are made for insuring the proper management of the affairs of these banks. Each must have a certain number of trustees and managers, whose services are performed gratuitously, besides a treasurer, actuary, cashier, clerks, &c.; all of whom must give security, by bond, to such amount as the directors of the establishment may judge sufficient. No portion of the funds invested in government security can be withdrawn, except on the authority of an order signed by several of the trustees and managers. Detailed reports of the transactions of each bank must be periodically forwarded to the Commissioners for the Reduction of the National Debt, and also exhibited to the depositors at the bank office. It may be of use to add, that the money deposited is consigned daily to the safe custody of a bank, such as the Bank of Scotland, and is thence regularly transferred to the Bank of England. Any doubt, therefore, as to the *security* which is offered, would be quite absurd. When the perfect safety of the system is contrasted with the insecure practice of placing money at interest in the hands of private persons, as is unhappily too often done, no one in his senses would for a moment hesitate which mode of disposal he should prefer.

Under both the old and new systems, savings' banks have been highly successful in their object, and the money deposited in them reaches an amount which no one who regarded the habits of the working-classes thirty-five years ago could have anticipated. In 1840, the total sum was a trifle within *twenty-two millions.* In 1837, it was stated that the accumulations in the bank at Exeter alone, reached £800,000. At the same time Manchester and Liverpool respectively showed £280,000 and £345,000. In November, 1841, after existing five and a half years, the Edinburgh bank had accumulated £221,816: at the same period, after a somewhat briefer career, that of Glasgow showed a balance of deposits amounting to £173,204. In 1834, when the total accumulations in England (inclusive of Wales) amounted to £13,582,102, the number of depositors was 431,815, a very considerable proportion, it must be owned, of the whole population. The average deposit of each person was at that time £31, 4s. In Scotland, the average deposits are less, perhaps in consequence of the comparatively recent introduction of the national security system. At November, 1841, the depositors in Edinburgh were 18,961, giving an average of ten guineas to each; those in Glasgow were at the same time 13,239, giving to each an average of twelve pounds. We find ten guineas the average deposit at the Carluke Savings' Bank, a rural establishment.

The *kind of persons who deposit* is an important point; and here, we fear, some disappointment must be felt. We have already seen that the average amount of deposits at Dundee is little larger amongst workmen of high than amongst workmen of low wages. In that town, out of 464 male weavers in the parish of St. David's, with wages averaging 8s., 108 are depositors, or 1 in $4\frac{4}{17}$; of 181 flax-dressers, with wages averaging 12s., 36 are depositors, or 1 in 5; of 200 mechanics, with 20s. of average wages, 56 are depositors, or 1 in $3\frac{4}{7}$. The very small degree in which we thus see comparatively good wages favouring the saving principle, is surprising and lamentable. Another fact of a general character is not less striking. In many places, of the depositors in savings' banks, a majority are females. Female servants, in almost all places, form a conspicuous section. In the Dundee Savings' Bank, there were, a few years ago, 237 accounts in the names of female servants (aggregate deposits, £2235), while (and this is equally remarkable), out of the numerous class of factory female workers, only *one* had an account. It has also been stated, that, "a few years ago, in Perth, it was found, from its savings' bank, that the women of the 'Fair City' were laying up for the men, not the men for the women; that the young mechanics had forgot there were such things as want, or sickness, or age."* In the Edinburgh Savings' Bank, of the total number of accounts existing at November, 1841, the majority were by females, and generally by females isolated in society, and depending on their own exertions, as appears from the statements given below, in which the amount of balances and the average amount of each person's balance are also shown.

FEMALES.	No.	Amount of Balances. £	s.	d.	Average Amount. £	s.	d.
Domestic servants. - - -	3775	45,790	15	11	12	2	7
Single women without designation—generally persons keeping house for a father or other relative, and having no other occupation,	1804	31,540	15	11	17	9	7
Married women without designation—generally the wives of operatives,	1438	21,086	8	5	15	5	9
Minors - - - - - -	386	2515	10	0	6	10	3
Dressmakers, milliners, sewers,	352	3725	1	6	10	11	7
Widows, designated simply as such. - - - - -	141	2413	5	1	17	2	3
Shopkeepers, lodging-keepers, householders. - - -	164	2393	10	4	14	11	9
Female operatives, mill-workers, washers, - - -	95	1112	1	11	11	14	1
Governesses and female teachers.	66	1272	19	10	19	5	5
Miscellaneous designations.	28	465	5	9	16	12	1
Balances not exceeding 2s. each,	2601	123	1	8	0	0	11
Accounts in the names of females - - -	10,850	113,338	16	4			

MALES.	No.	Amount of Balances. £	s	d	Average Amount. £	s.	d.
Mechanics and operatives of all kinds. - - - - -	2138	31,889	9	7	14	18	4
Porters, chairmen, gardeners, and town and country labourers. - - - -	557	8566	0	11	15	7	7
Teachers, students, clerks, shopmen. - - - - -	530	9371	10	3	17	10	8
Domestic servants, including public coachmen, waiters, and grooms - - - - -	534	12,534	7	5	23	9	5
Shopkeepers. - - - - -	339	5587	17	8	16	9	7
Soldiers and sailors, - -	197	3855	16	11	19	11	4
Public servants—as post-office, police, excise, &c., - -	87	1261	3	10	14	9	10
Minors - - - - - -	597	3797	10	11	6	7	2
Miscellaneous designations, -	181	3722	11	1	20	6	5
No designation, - - - -	357	5721	14	2	16	0	6
Balances not exceeding 2s. each.	2586	112	0	0	0	0	10
Accounts in the names of males, - - - -	8111	86,120	5	9			
Total in the names of females, as above, -	10,850	113,338	16	4			
Societies - - - - -	169	21,800	14	7			
Total accounts in operation at 20th November, 1841,	19,130	221,559	16	8			

In Glasgow, the male depositors are a majority; but here the factory operatives are comparatively a small

* Tavern Bill of Dundee, p. 7.

section, numbering only 1282, while mechanics and artificers are 6774, notwithstanding the vast number of persons employed in factories in that city. The female domestics who deposit in the Glasgow Savings' Bank are 3862, and their aggregate accumulations are £22,378. With regard to this portion of the community, an interesting fact is mentioned in the report of the Edinburgh Savings' Bank for 1841. The five hundred accounts last opened by female servants in that bank, present the aggregate sum of £2313, 2s. 7d.; but the first five hundred opened by the same class, four or five years ago, show a total of no less than £11,921 10s. 4d. We here see, in a striking manner, how a [illegible] fund once begun by a person in humble circum[illegible], tends to mount up in the course of a few years.

It may be of service to many persons in the humbler walks of life, who are not much acquainted with business, to see an example of a savings' bank account: the following is one presumed to be formed by a man named John Smith, whose signature accordingly appears in the last column, as acknowledging the sums which he has withdrawn:—

SAVINGS' BANK in Account with ____________

No. ________

Date.	Deposited and Withdrawn	£	s.	d.	Manager's Signature.
1836.					
July 10,	Received Six Shillings,	0	6	0	George Rose.
August 12,	Received Nine Shillings,	0	9	0	J. T. Becher.
	Interest to November 20,	0	0	1½	
		0	15	1½	
November 23,	Paid Five Shillings and Three Halfpence,	0	5	1½	John Smith.
		0	10	0	
December 20,	Received Thirty-five Shillings,	1	15	0	George Rose.
1837.					
June 19,	Received Three Pounds,	3	0	0	J. T. Becher.
	Interest to November 20,	0	2	1½	
		5	7	2½	
December 1,	Paid Five Pounds, Seven Shillings, and Twopence Halfpenny,	5	7	2½	John Smith.

It is of still greater importance that a person who thinks of depositing should have a distinct idea of the benefit he is to derive in the way of interest. The interest usually given in savings' banks is at the rate of £3, 8s. 8d. per cent.; the difference between this and £3, 18s. 0½d., which the Commissioners of the National Debt allow, being, as already mentioned, reserved to pay expenses, &c. This being the interest allowed, any one may readily reckon how his money is to fructify, by supposing an addition of *one-thirtieth* being made to it at the end of every year. For instance, if he deposits fifteen shillings, and lets it lie for a year, he is then entitled to 15s. 6d. It is right that he should be fully aware that, in respect of interest, he is better off than the people of the middle and upper ranks who deposit in common banks; for not only does he get a higher per centage than is generally given by the banks, but he has the advantage of *compound interest*; that is to say, the interest due to him at the end of a year is silently, and without any trouble on his part, added to and considered as a part of the principal, on which interest is to be given in future. Thus, a common bank account and a savings' bank account, for the same sum, if left unattended to for a few years, would in the end come to a very different amount. In order that no one may be at a loss to calculate the interest he is to receive on a savings' bank deposit, we present the preceding table, which shows simple interest for a year on a variety of sums.

INTEREST TABLE, AT £3, 0s. 8d. PER CENT.

Principal. £ s. d.	Per Month. £ s. d.	Per Year. £ s. d.	Principal. £ s. d.	Per Month. £ s. d.	Per Year. £ s. d.
0 15 0	0 0 0¼	0 0 6	20 5 0	0 1 1¼	0 13 6
1 10 0	0 0 1	0 1 0	25 10 0	0 1 5	0 17 0
2 5 3	0 0 1¼	0 1 6	30 15 0	0 1 8¼	1 0 6
3 0 0	0 0 2	0 2 0	36 0 0	0 2 0	1 4 0
3 15 0	0 0 2¼	0 2 6	41 5 0	0 2 3¼	1 7 6
4 10 0	0 0 3	0 3 0	46 10 0	0 2 7	1 11 0
5 5 0	0 0 3¼	0 3 6	51 15 0	0 2 10¼	1 14 6
6 0 0	0 0 4	0 4 0	57 0 0	0 3 2	1 18 0
6 15 0	0 0 4¼	0 4 6	62 5 0	0 3 5¼	2 1 6
7 10	0 0 5	0 5 0	67 10 0	0 3 9	2 5 0
8 5 0	0 0 5¼	0 5 6	72 15 0	0 4 0¼	2 8 6
9 0 0	0 0 6	0 6 0	78 0 0	0 4 4	2 12 0
9 15 0	0 0 6¼	0 6 6	83 5 0	0 4 7¼	2 15 0
10 0 0	0 0 6¾	0 6 8	88 10 0	0 4 11	2 19 0
10 10 0	0 0 7	0 7 0	93 15 0	0 5 2¼	3 2 6
11 5 0	0 0 7¼	0 7 6	99 0 0	0 5 6	3 6 0
12 0 0	0 0 8	0 8 0	100 0 0	0 5 6½	3 6 8
12 15 0	0 0 8¼	0 8 6	104 5 0	0 5 9¼	3 9 6
13 10 0	0 0 9	0 9 0	109 10 0	0 6 1	3 13 0
14 5 0	0 0 9¼	0 9 6	114 15 0	0 6 4¼	3 16 6
15 0 0	0 0 10	0 10 0	120 0 0	0 6 8	4 0 0
15 15 0	0 0 10¼	0 10 6	125 5 0	0 6 11¼	4 3 6
16 10 0	0 0 11	0 11 0	130 10 0	0 7 3	4 7 0
17 5 0	0 0 11¼	0 11 6	135 15 0	0 7 6¼	4 10 6
18 0 0	0 1 0	0 12 0	141 0 0	0 7 10	4 14 0
18 15 0	0 1 0¼	0 12 6	146 5 0	0 8 1¼	4 17 0
19 10 0	0 1 1	0 13 0	150 0 0	0 8 4	5 0 0

A prejudice exists in the minds of many working people, and is perhaps affected by others, against savings' banks, on the ground that, when a man is known to save, he is the more liable to have his wages reduced by his master, or to want work when there is any thing like a general failure of employment. Surely, there can be little foundation in fact for this notion. It is a general wish amongst masters that their working people should save, and many endeavour to bring this about by instituting savings' banks, and acting as managers. It is felt by every master, that a workman who has saved a little, is likely to be a much more steady and respectable person than one who has not. Indeed, as it has been justly observed, a receipt from a savings' bank is one of the best certificates of character which a working man can show. Let it also be considered, that, with a little capital in his possession, a workman stands in a much more independent position with regard to his master than he otherwise could do. We cannot doubt that in these considerations there is much more than a counterpoise to the visionary fear of having wages reduced, or employment withheld, in consequence of a bank deposit.

The following table was formed to show what a certain weekly contribution paid into the Windsor and Eton Savings' Bank would amount to in a certain term of years, interest being at £3, 8s. 5d. per cent. It is a highly instructive table, well worthy of being carefully studied by every individual of the industrious orders:—

	One Shilling per week.			One Shilling and Sixpence per week.			Two Shillings per week.			Three Shillings per week.			Four Shillings per week.			Five Shillings per week.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
1 Year,	2	12	7½	3	19	0	5	5	4½	7	18	3½	10	11	1½	13	3	10
2	5	6	11	8	0	0	10	14	4	16	1	10	21	0	5	26	16	6
3	8	3	1	12	4	11	16	6	10½	24	10	11¼	32	15	0½	40	18	7
4	11	1	1½	16	12	3	22	3	3	33	5	11	44	8	6	55	10	3
5	14	1	3	21	2	5	28	3	7½	42	0	10½	56	9	0½	70	12	0½
6	17	3	4½	25	13	0	34	8	1	51	14	6	68	10	4½	86	4	1
7	20	7	7	30	12	4	40	10	7½	61	7	6	81	17	5	102	6	8
8	24	14	2½	35	12	2	47	9	10	71	7	7½	95	4	4½	119	6	5
9	27	2	10	40	15	5	54	7	5½	81	14	7½	109	0	5½	136	5	7½
10	30	13	10½	46	2	3	61	9	10½	92	8	7	121	6	1½	154	2	7½
11	34	7	4	51	12	8	68	17	1	103	8	11	138	1	0			
12	38	3	3½	57	6	10½	76	9	4½	114	18	0½						
13	42	1	10	63	5	0	84	0	10½	126	15	6						
14	46	3	1½	69	6	2	92	9	0	139	0	5½						
15	50	7	2	75	13	5½	100	18	2	151	13	9½						
16	54	11	2	82	4	1	109	12	5½									
17	59	4	0	88	19	1	118	12	8½									
18	63	16	11½	95	18	8	127	19	1									
19	68	13	1	103	3	1½	137	11	0½									
20	73	12	5½	110	12	6½	147	11	2									

It would be difficult to over-estimate the importance of a little private hoard to a working man. It not only proves a succour in the evil day, but it tends to improve his whole moral nature. Wealth has been the subject of many bitter remarks to both the poet and the philosopher; but it is after all a greater friend to virtue than to vice. Often a very small amount of it, acquired by honest industry, will supply a modest pride that supports, if it is not in itself, moral efficacy. Doing well in this small way suggests and leads to doing well in other ways. The saver may prove the stay of a declining parent or other friend: he can do a better duty to his children; he can contribute to philanthropic objects which interest and bring out his finest feelings. It may even happen that, from less to more, and with no sacrifice of peace of mind, he is enabled by saving to rise into a higher grade in society. One of the best of the immediate effects of saving is, that, once fairly begun, it proves a preservative from many extravagances and vices. Temptations may present themselves; but the mind reverts to the fondly regarded little hoard in the savings' bank, and they are easily resisted. Hence, it is generally observed that, once a practice of saving has commenced, a great revolution takes place in the character. Irregularities and self-indulgences disappear, and steadiness, sobriety, and reflection take their place.

These views are, we feel assured, accordant with general experience; but it may nevertheless be well to quote one testimony from a practical quarter in support of them. The following passages are from a tract, published early in 1842, respecting an auxiliary to the Govan Savings' Bank, in Kerr and Company's Nailery:—

"Three years ago, nearly all the men in this work were seemingly constitutionally and hopelessly afflicted with *a spark in the throat*, and spent a very large portion of their wages on ardent spirits to quench it. As might have been expected under the circumstances, both their persons and dwellings presented standing proofs of their ruinous habits; and their employer was frequently annoyed by their suspension of labour to gratify their vitiated taste, at times when the hurried execution of orders rendered him most dependent upon them. However, by the exercise of a little kindly feeling towards them, matters began to assume a more pleasing aspect. By being regarded and spoken to in their sober intervals as rational and accountable beings, and having exhibited to them the advantages they were likely to derive from connecting themselves with the Total Abstinence Society and the Savings' Bank, one after another was cured of the long-existing malady, and not only took up a new position among his fellow-workers, as at once an advocate and an evidence of temperance and economy, but was enabled to provide himself and family with household comforts to which they had previously been strangers. With the view of cherishing such newly-formed habits, their employer afforded them the weekly opportunity of husbanding their spare earnings, by forming among them and conducting a little agency of the National Security Savings' Bank. The following summary of its transactions will show both the success of his labours, and the encouragement which the proprietors and managers of other public works are likely to enjoy in making similar efforts:—The nailery consists of three shops or hearths, each accommodating four workmen. Among the twelve persons employed in these shops, and two junior members of one of their families, there are nine open accounts; the number of deposits has been 351, and the amount deposited, including interest, £61, 15s. 10d. The number of repayments has been 31, and the amount repaid £36, 11s. 9d., so that the balance due at the 20th November, 1841, upon the nine open accounts, is £25, 4s. 1d., or about £2, 16s. each—a small average, certainly, in comparison with that of some other trades, but presenting a pleasing contrast to the situation in which matters stood at the commencement of the agency, when scarcely one of the workmen could, on a Wednesday or Thursday, muster a sixpence of his previous week's earnings. One observation must yet be made; they are now *not only more independent and comfortable, but stand much higher in the estimation of their employers.*"

THE FRIENDLY SOCIETY.

Savings, instead of being stored up in a bank, to be there constantly at command, may be disposed by a working man in a well-constituted friendly society, as a means of ensuring for himself certain contingent and fixed benefits. Friendly societies generally embrace several objects, as the securing of a weekly sum during sickness, and a pension after a certain age. They are based on the principle of mutual insurance; that is to say, members make payments, either at once or in small periodical sums, and thus constitute a fund, out of which such as happen to fall sick or to survive a certain age are supplied, the uncertainty attached to all individual concerns being lost in the certainty which attends calculations involving great numbers. In some respects, and for some cases, joining a friendly society may be better than becoming a depositor in a savings' bank. Sickness may come before the savings are considerable; or, if considerable, they may be melted away by a long-continued sickness; but, after the first weekly payment is made to a friendly society, the member is secure of succour, however long his illness may continue, besides, perhaps, other advantages. It is possible, on the other hand, that a difficulty may be experienced, in certain circumstances, in keeping up the weekly or other payments required to secure the benefits of friendly societies. Here, however, it may be said, there is no more than the usual uncertainty attached to all things. Assuredly, the arrangement of a rightly constituted friendly society furnishes a very considerable degree of security against some of the uncertainties of life.

It is to be regretted, of this excellent class of institutions, that many of them are founded upon erroneous principles, or rather upon no principles at all; and it often happens, therefore, that those who trust to them are disappointed, the funds falling short before all claims are satisfied. This was at one time not to be wondered at, as no proper calculations for friendly societies existed; but such is no longer the case, for sound calculations are now attainable. Nevertheless, there is still a vast number of obscure friendly societies, proceeding altogether at random, and by which the industrious classes are induced to misspend large sums. We trust that what we have now to state will be of some service in promoting the establishment of sound societies, and putting an end to such as are of a different kind.

One great mistake in the formation of friendly societies, is to assume that each member should pay an equal sum, whatever his age may be. This is unjust; for the younger members have a less chance of becoming burdensome to the funds than the middle-aged; and, indeed, there is a rising scale of probability of sickness throughout all the years of a man's life. The Highland Society found that, between twenty and thirty, men are liable at an average to be half a week indisposed per annum. Between thirty and forty, the average was about two-thirds of a week. At forty-six, it became a full week; at fifty-seven, two weeks; at seventy, eleven weeks. The Society, from taking unsuitable grounds for their calculations, made out the probabilities of sickness too low. In the following table, three sets of calculations are given, as to the proportion of sick out of one hundred at particular intervals of age:—

Ages.	Highland Society.	English Benefit Societies.	Mr. Edwards' Theoretical Table.
20 to 30,	1·11	1·54	1·72
30 .. 40,	1·42	1·83	2·30
40 .. 50,	1·97	2·58	3·10
50 .. 60,	3·60	4·42	4·54

The difference in the three columns is here of little consequence. They at least agree in representing *increase of years as attended by increased liability to sickness.* Now, a right friendly society is bound to advert to this circumstance. To admit all ages at an equal payment, is clearly making the younger members pay for the elder, who should have entered at an earlier age, and been paying all along.

Another great error in the constitution of benefit societies, is in making them for a year only. Many of the old friendly societies having ended in disappointment, in consequence of want of right calculations, or bad management, or peculation of the funds, the working-classes have contracted the notion that there is more safety in a yearly term. The immediate payments are also less than in a well-constituted friendly society. Yearly societies, as they are called, usually originate with some individual, often the keeper of a tavern, who advertises that a society will be formed in his house on a particular day. Applicants for admission pay one shilling as entry-money, which goes into the pocket of the originator of the scheme, by way of rent. The objects are generally threefold, namely, a fund for sickness and funeral expenses, a deposit fund, and a loan bank. Towards the first, there is perhaps a weekly payment of two-pence, or more if necessary, together with the interest arising from the loan of money to the members. Towards the deposit fund, there is a payment ranging generally from sixpence to two shillings, the accumulations being received back when the society closes. The money deposited is employed in making loans to such of the members as desire such accommodation, within the amount of their several entire deposits for the year, one penny per pound per month being charged by way of interest. The surplus, if any, of the twopences and interest, after sick and funeral money books, and other necessaries are paid, is divided among those members who may be clear of the books at the close of the society. Some such societies are formed by a spontaneous association of persons, who prefer renting a room for their meetings, and thus escape the temptations of a tavern; but none of them avoid the errors of an equality of payments for all ages, and the yearly dissolution. The youth of fifteen, who is not liable to half a week's sickness per annum, pays as much as the man of fifty-seven, who is liable to two weeks. Should sickness befall any one towards the close of the year, he is left, when the society dissolves, quite unprovided for, because he cannot enter another society in a state of sickness. Considered as a deposit for savings, the yearly society is strikingly inferior to the savings' bank, in as far as the depositor cannot take out money without paying an exorbitant rate of interest. Finally these societies are generally under the care of obscure persons, who can give no security for the funds placed in their hands, and who in many instances become bankrupt or abscond before the final reckoning. Yearly societies are, indeed, in all points of view, a most objectionable class of institutions, to which working people would never resort but for their ignorance and unwariness, and the temptations held out to allure them.

A well-constituted friendly society involves the principle of payments appropriate to particular ages, as no other plan can be considered equitable. It stands forth before the working-classes as a permanent institution, like the life-insurance societies of the middle and upper classes, and necessarily requires its members to consider the connection they form with it as an enduring one, because its grand aim is expressly to make provision at one period of life for contingencies which are to arise at another—youth, in short, to endow old age. By a yearly society, a man is left at last no better than he was at first, as far as that society is concerned; but the proper friendly society contemplates his enjoying a comfortable and independent old age from the results of his own well-bestowed earnings.

It is also essential to the character of a proper benefit society, that individuals be not admitted indiscriminately. To take in a person in bad health or of broken constitution, is unjust to the rest who are healthy, because he is obviously more likely to be a speedy burden to the funds. Here, as in life-assurance societies, it is necessary to admit members only upon a showing that they are of sound constitution and in the enjoyment of good health. And it may be well to grant no benefits until after the member has been a year in the society. By these means, men are induced to enter when they are hale and well, instead of postponing the step until they have a pressing need for assistance, when their endeavour to get into a benefit society is little else than a fraud.

Government has thought proper to interfere with its aid in the formation of friendly societies, though not compulsory. An association of persons forming one, has the means of ascertaining the soundness of its principles, and also entitles itself to deposit funds in savings' banks, with the government security and liberal interest, by submitting the proposed rules to the barrister appointed to certify them (at present John Tidd Pratt, Esq.), to whom a fee of a guinea is payable. Under the sanction of government, tables have been formed by a highly competent person, John Finlaison, Esq., Actuary of the National Debt, for the guidance of friendly societies; and these are easily to be had,* so that it is quite inexcusable to proceed upon random and unauthenticated data. Before quoting any of these tables, we shall endeavour to explain how they are formed.

We have an idea of a benefit society in its simplest form, if we suppose a hundred men, of exactly 33 years of age, to associate, and make such a payment at first as may be sure to afford each man that shall fall sick during the ensuing year one shilling a day during the term of his sickness. Taking (for the sake of illustration) the Scottish tables, we find that, among such a body of men, there will be about 66 weeks of illness in the course of the year. This, multiplied by 7, gives the whole sum required, £23, 2s., or a little more than 4s. 6d. each, which, less by a small sum for interest, will accordingly be the entry-money of each man. A society of individuals of different ages, each paying the sum which would in like manner be found proper to his age, would be quite as sound in principle as one on the above simple scheme. It is only a step further to equalize each man's annual payments over the whole period during which he undertakes to be a paying member.

We shall suppose that the superannuation allowance or pension is contemplated as commencing at 60 years of age. It is necessary to consult tables of mortality, in order to ascertain how many may be expected to reach that age, and how long each of these has a chance of surviving it. Having already treated of tables of mortality (see the article on LIFE-ASSURANCE, No. 46), we shall not say much on this subject. The table presented by the Highland Society, as proper for friendly societies, is a mean of the Northampton, Carlisle, and Swedish tables, and may be regarded as tolerably safe for both life-assurance and annuity schemes. It shows that, of 1005 persons of 21 years of age, no fewer than 528 reach the age of 60, 336 that of 70, and 127 that of 80; thus making it evident *how absurd it is for a working man to think that he has an extremely small chance of growing old, so as to need a provision.*

Another point for consideration is the rate at which the funds of the society may be improved. In most cases, we believe, it is best for such societies to rest content with taking advantage of the privilege which they enjoy by act of parliament, of depositing their money in the funds or the savings' banks, in which case they obtain for it (considering the half-yearly payment of interest) about £3, 17s. 6d. yearly.

Age of the Purchaser.	Total value in ready money of the three Benefits.	Equivalent Monthly Contribution ceasing at the Age of 65.	Age of the Purchaser.	Total value in ready money of the three Benefits.	Equivalent Monthly Contribution ceasing at the Age of 65.	Age of the Purchaser.	Total value in ready money of the three Benefits.	Equivalent Monthly Contribution ceasing at the Age of 65.
	£ s. d.	£ s. d.		£ s. d.	£ s. d.		£ s. d.	£ s. d.
15	8 0 1¼	0 0 8¼	35	13 7 2¼	0 1 5¼	55	25 10 9¼	0 5 8¼
16	8 11 8¼	0 0 9	36	13 14 0¼	0 1 6	56	26 10 7¾	
17	8 14 6	0 0 9¼	37	14 1 3¼	0 1 7	57	28 4 9¼	
18	8 17 0½	0 0 9½	38	14 8 11¼	0 1 7¾	58	29 12 6	
19	9 0 10¼	0 0 9¾	39	14 17 1¼	0 1 8¾	59	31 3 0¾	
20	9 4 0	0 0 10	40	15 5 8¾	0 1 10	60	32 16 10	
21	9 6 5	0 0 10¼	41	15 14 4	0 1 11	61	34 10 0¼	
22	9 12 7½	0 0 10¾	42	16 3 4¾	0 2 0¼	62	36 7 1¼	
23	9 17 1	0 0 11	43	16 8 11¼	0 2 1¼	63	38 8 8¼	
24	10 1 9¼	0 0 11½	44	17 3 0¼	0 2 3¼	64	40 15 6¾	
						65	43 8 9¾	
25	10 6 8	0 0 11¾	45	17 13 8¼	0 2 5¼	66	41 17 9¾	
26	10 12 1¼	0 1 0	46	18 5 0½	0 2 7	67	40 7 9	
27	10 16 11¾	0 1 0¼	47	18 17 2	0 2 9¼	68	38 18 7½	
28	11 2 4¾	0 1 1	48	19 10 2¾	0 2 11¾	69	37 10 0	
29	11 7 11¾	0 1 1½	49	20 4 3¾	0 3 2¼			
						70	36 3 5¼	
30	11 13 9¾	0 1 2	50	20 19 6½	0 3 5¾	71	34 17 0¾	
31	11 19 [illegible]	0 1 2¼	51	21 15 11¼	0 3 9¼	72	33 10 11¼	
32	12 0 [illegible]	0 1 3¼	52	22 13 8¼	0 4 2	73	32 5 1¼	
33	12 12 11	0 1 3¾	53	23 13 0¼	0 4 7	74	30 19 5¾	
34	12 19 10¾	0 1 4¼	54	24 13 11¾	0 5 1	75	29 13 8	

Proceeding upon these or nearly similar grounds of calculation, Mr. Finlaison formed the table which is given above, to show in one sum (and also in an equivalent monthly contribution, to cease at the age of 65), the value of an allowance of four shillings per week during sickness, from and after each age until 65, combined with an allowance or pension of 2s. per week, commencing payment at the age of 65; and further combined with a payment of four pounds whenever the death of the purchaser shall happen.

We would here call particular attention to a point of view in which savings' banks and friendly societies might be regarded as favourable to each other. It will be observed that, for the sum of about thirteen pounds at the age of thirty-four, a man can insure himself against absolute want under all future contingencies except deficient employment. Now, at that age, a prudent and careful man, who has begun early to frequent the savings' bank, may without difficulty have saved thirteen pounds. Let him draw his thirteen pounds from the savings' bank, and place it with the friendly society, and he is all but an independent man for life. This is a course highly worthy of the attention of domestic servants, who in the latter years of life are so often exposed to want.*

* See "Instructions for the Establishment of Friendly Societies." Printed by W. Clowes, London, for his Majesty's Stationery Office: 1835.

* Friendly societies and savings' banks sometimes appear as rival institutions, and their respective merits are keenly canvassed. Both have certainly their peculiar advantages. There is much in the consciousness of having a small fund stored up, and in the power of employing it for any particular purpose at pleasure; but it cannot be doubted that a reserve fund is a less efficient protection against contingencies, such as sickness and death itself, than connection with a sound friendly society. The difference is like that between taking one's risk of loss from fire, and paying in to an insurance office. "Whenever there is a contingency, the cheapest way of providing against it is by uniting with others, so that each man may subject himself to a small deprivation, in order that no man may be subjected to a great loss. He upon whom the contingency does not fall, does not get his money back again, nor does he get for it any visible or tangible benefit, but he obtains security against ruin, and consequent peace of mind. He upon whom the contingency does fall, gets all that those whom fortune has exempted from it have lost in hard money, and is thus enabled to sustain an event which would otherwise overwhelm him.

The individual depositor, not the contributor to a common fund, is really the speculator. If no sickness attacks him during his years of strength and activity, and he *dies* before he is past labour, he has been successful in his speculation; but if he fall sick at an early period, or if he live to old age, he is a great

The scheme of a right friendly society may be further illustrated by the actual arrangements of one of approved character, which happens to be well known to us. We allude to the Edinburgh School of Arts' Friendly Society, established about thirteen years ago. This society, although originating with certain of the members of and friends to the School of Arts (a species of mechanics' institution), and taking its name, is not otherwise connected with that institution, but is open to all persons, male and female, residing in Edinburgh. It has three separate funds or schemes—namely, a *Sickness Fund*, *Deferred Annuity Fund*, and a *Life Assurance Fund*. *One share* of the sickness fund entitles the member during sickness to 10s. a week for 52 weeks, 7s. 6d. a week for other 52 weeks, and 5s. a week for all future period of sickness until the age of 60 or 65, according to the age of superannuation fixed at entry; and thereafter his contributions cease, and he enters to the enjoyment of the *Deferred Annuity Fund*, one share of which entitles the member to an annuity of £8 a year, commencing at the age of 60 or 65, as fixed at his entry. One share of the *Life Assurance Fund* is a sum of £10 payable at the member's death. In this case, as in the others, the contributions cease at the age of 60 or 65.

The rates are calculated from the Highland Society's sickness table, increased by 50 per cent., which in this case may be considered as sufficient (seeing that only sound healthy men are admitted), and a mortality table compounded of the Northampton, Carlisle, and Swedish, assuming the rate of interest at 4 per cent. accumulated yearly; and the only charges for management are 2s. 6d. entry-money to each fund, and 1s. a year payable by each member of each fund.

The life assurance fund of this society stands apart from the other two, and may be entered independently. Its table being the only one we are acquainted with, which presents the advantages of life assurance to the humbler classes, we extract it. It is to be observed that females are admissible at one-sixth less charges. Half a crown of entry-money is charged.

Life Assurance Fund.

Contributions cease at 60

Age.	Single Payment.	Annual Payment.	First Month.	Other Months.
	£ s. d.	s. d.	s. d.	s. d.
19	2 18 10	3 ½	0 7	0 3
25	3 4 7½	3 11	1 2	0 3
30	3 10 0½	4 0½	0 10½	0 4
35	3 17 3	5 5½	0 10½	0 5
40	4 4 7½	6 9	1 3	0 6
45	4 13 0½	8 9	1 5	0 8
50	5 2 5	12 5½	1 5½	1 0

Contributions cease at 65.

Age.	Single Payment.	Annual Payment.	First Month.	Other Months.
	£ s. d.	s. d.	s. d.	s. d.
19	2 18 10	3 3	0 0	0 3
25	3 4 7½	3 9½	1 0½	0 3
30	3 10 6½	4 4½	0 8½	0 4
35	3 17 3	5 1½	0 6½	0 5
40	4 1 7½	6 1½	0 7½	0 6
45	4 13 0½	7 7½	1 2½	0 7
50	5 2 5	9 11	1 8	0 9

The sickness and annuity funds are essentially connected, and the tables for them are subjoined. It is to be remarked, that two, three, or four shares may be taken in all of these funds. Towards the annuity fund females pay one-fourth additional, in consideration of their lives being so much better than those of men.

Sickness Fund.

Contributions and Benefits cease at 60.

Age.	Single Payment.	Annual Payment.	First Month.	Other Months.
	£ s. d.	£ s. d.	s. d.	s. d.
10	10 3 10	0 11 0	1 5	0 11
25	10 12 5	0 12 9½	1 0½	1 0
30	11 0 6½	0 14 3	1 5	1 2
35	11 8 8	0 16 2	1 6	1 4
40	11 16 0½	0 18 9	2 3	1 6
45	11 17 10½	1 2 4½	2 2½	1 10
50	10 18 0½	1 6 7	2 9	2 2

Contributions and Benefits cease at 65.

Age.	Single Payment.	Annual Payment.	First Month.	Other Months.
	£ s. d.	£ s. d.	s. d.	s. d.
10	11 3 [illegible]	0 12 4	1 4	1 0
25	11 19 [illegible]	[illegible] 13 11½	2 0½	1 1
30	12 15 [illegible]	[illegible] 5 9	2 0	1 3
35	13 13 9	[illegible] 1½	1 7½	1 6
40	14 14 9½	[illegible] 4½	2 1½	1 9
45	15 [illegible]	1 5 9	2 10	2 1
50	16 [illegible]	[illegible] 11 1	2 8	2 7

Fund.

Contributions cease at 60.

Age.	Single Payment.	Annual Payment.	First Month.	Other Months.
	£ s. d.	£ s. d.	s. d.	s. d.
19	7 15 0	0 8 4	1 0	0 8
25	10 10 1½	0 12 8	1 8	1 0
30	13 9 8½	0 17 5	1 10	1 5
35	17 8 5	1 4 7½	2 7½	2 0
40	22 14 1	1 16 1	3 1	3 0
45	29 17 3	2 16 2	4 10	4 8
50	39 16 7½	4 16 11	8 11	8 0

Contributions cease at 65.

Age.	Single Payment.	Annual Payment.	First Month.	Other Months.
	£ s. d.	£ s. d.	s. d.	s. d.
19	4 8 6	0 4 10½	1 2½	0 4
25	5 19 11½	0 7 0	0 7	0 7
30	7 13 11½	0 9 6	1 3	0 9
35	9 18 11	0 13 2	1 3	1 1
40	12 10 3	0 18 9½	2 3½	1 6
45	17 0 11½	1 7 10½	3 1½	2 3
50	22 14 9	2 3 11	4 6	3 7

The following is an example of the payments required for *one share* in all the three funds; namely—

Payments to cease at 60.

Age.	Annual Payment.	Monthly Payment.
	£ s. d.	£ s. d.
25	1 10 5	0 2 6½
30	1 17 3	0 3 1½
35	2 6 3	0 3 11½

Payments to cease at 65.

Age.	Annual Payment.	Monthly Payment.
	£ s. d.	£ s. d.
25	1 5 9	0 2 2
30	1 10 7½	0 2 6½
35	1 17 5	0 3 1½

So that a person of the age of 25, for an entry-money of 7s. 6d., and the payment of 2s. 2d. a month until the age of 65—or £1, 5s. 9d. a year—may secure an allow-

loser: for his savings, with their accumulations, will support him but a short time in sickness; or even if he retain something in old age, after having provided for his occasional illness, the annuity which he can then purchase will be very inferior indeed to that which he would have obtained, if he had entitled himself to the benefit of the accumulated savings of all those who, having contributed for many years to a superannuation fund, had never reached an age to require it."—*Report of Committee on Friendly Societies*, 1825.

ance of 10s. a week during sickness for 52 weeks; 7s. 6d. a week for other 52 weeks; and 5s. a week during the whole remaining period of sickness, until the age of 65, an annuity of £8 a year during life after 65, and a sum of £10 at death.

Or, for 4s. 4d. a month, or £2, 11s. 6d. a year, double of those allowances.

At an examination of the society's transactions and funds in December, 1840, it was found that, after twelve years of business, when the deaths of unfree members, or persons who died in the first year of membership, were deducted, the mortality was within that allowed for the tables; and that all the three funds were in a good condition, each showing a surplus over what is necessary to make good the claims to which it was liable, when the value of the future contributions was taken into account against the value of the promised benefits.

For those who find occasion to go deeper into the subject of friendly societies, with a view to founding such institutions, we would recommend a careful perusal of the work which Mr. Charles Ansell prepared for the Society for the Diffusion of Useful Knowledge, and which was published by that society in 1835. Much benefit might also be derived from Mr. William Fraser's papers on Friendly Societies, published in Professor Jameson's Philosophical Journal in 1827.

THE LOAN SOCIETY.

The modern history of Scotland has proved that advances of money to persons of the trading class, made by the banks under prudent cautions with respect to security and the personal character of the borrowers, have a beneficial effect, supplying materials on which industry may work, and at once enabling many individuals to thrive, and giving a powerful impulse to the country at large. The well-cultivated face of our northern region bears powerful testimony to this fact. The institution called a Loan Society contemplates the same benefits to be conferred on an humbler portion of the trading class than those who resort to banks. By making small advances to such persons, it enables them to make little ventures in business which they could not otherwise have attempted, and often sends them forward upon a career which leads to their permanent advancement in life. The purchase of a cow or horse, of farm or mechanical implements, the discharge of rent, and the fitting out of a child for service or apprenticeship, are among the chief objects for which such loans are desired in the humbler walks of life. One might at first sight dread the effects of such anticipations of income; but, practically, the loan system, when rightly conducted, works well, and is productive of much good. "A loan fund," says a late writer, "is a savings' bank reversed, and even leads to the savings' bank, if well managed. For instance, I have before me now the case of a man who, though he has a family, is able to put by at least one shilling weekly. I might have urged him for ever to do so, but it would have been to no purpose. He came to me to borrow 30s. from the loan fund to buy corn to fatten his pig; he paid back this regularly at the rate of one shilling a week; and at the end of thirty weeks I said to him, 'Now, you have been owing me money, and have felt no inconvenience in paying it back; why should you not begin to make *me owe you?*' He had nothing to say to this, and is now a regular depositor in the ——— Savings' Bank through my hands."*

Loan societies are not institutions of yesterday; but, until a recent period, there were none upon an equitable or philanthropic footing. Government, sensible of the erroneous principles on which they were generally conducted, obtained an act in 1835 for their better regulation. By this statute certain benefits were held out to such loan societies as should be formed upon principles approved of by a revising barrister, and enrolled in conformity with the provisions of the act for benefit societies. The principal benefits offered were exemption from stamp-duty, and certain powers for recovery of loans. Enrolled loan societies were forbidden by this act to make loans of above fifteen pounds, or to make in any instance a second loan until the first should be paid off. A scheme of rules for a loan society conformable to law, is presented in the pamphlet quoted below.*

It seems here necessary to state, in the most explicit terms, that loan societies formed by interested individuals are entitled to no confidence, being almost universally usurious and oppressive in their modes of dealing and a source of great misery to the poor. There are about two hundred loan societies in London, and almost without exception they are of the same character as pawnbroking establishments.† On this subject we quote the following passages from a valuable communication which appeared in the *Times* newspaper:—"They generally originate with a knot of small tradesmen, who, having a surplus over the demands of their immediate business, find in them a profitable employment of their money. A capital of £500 has been known to start such a society—the paid-up capital eventually to be £2000 in shares of £5 each. It is very rare that the whole of the capital is at once paid down. Their rules in the outset describe the name and the constitution of the society; then follow the terms on which the shareholders have taken their shares, and the manner in which they are to receive a return for embarking money, which is the allowance of 4 per cent. interest per annum on the amount of subscription, while the balance of profit afterwards accruing is to be declared as a dividend. There are separate rules which apply to the borrowers from the society, which are called the 'borrowers' rules.' The general place of business is a public house; some few, but very few, are carried on in offices hired for the purpose. The borrower has, in the first instance, to call on the secretary, director, or treasurer, all of whom are allowed to sell (at a profit) what are termed 'application papers,' and purchase one (they are either 2d. or 3d. each), fill in the amount of the loan he requires, and leave it with the name of one or two sureties, according to the amount, for the inspection of the directors. He calls again, and has to pay 1s. for his security being inquired into, which goes into the pocket of the director whose turn it happens to be to look after the securities, the emolument of this office always going in rotation. He calls again, and is told whether or not his security is sufficient; if not, he gives another security and another shilling; if it is, he is told to call on a certain evening when the loans are made, and he will be attended to. Should he give half a dozen securities, and none prove acceptable, he pays his six shillings—for nothing is returned. When the evening arrives, he is called in his turn before the secretary, treasurer, and two directors, who form the authorized court for the conduct of the business. He is asked what amount he wishes to borrow. Perhaps it is £5 for six months; the first thing is to deduct 5 per cent. from the amount of the loan, 1s. for the book with the 'borrowers' rules,' in which will be made the entries of his weekly payments (for the loan is repaid in this manner), and the first week's instalment, and then in addition 1d. in part payment of the

* "Prospects and Present Condition of the Labouring Classes." By a Beneficed Clergyman. T. and W. Boone, London.

* "Instructions for the Establishment of Loan Societies." London; Printed by W. Clowes and Sons, for his Majesty's Stationery Office: 1837.

† See "A Guide to nearly One Hundred Loan Societies." London: W. Strange.

rent of the office and 1d. towards the secretary's salary, both of which expenses he is obliged by the 'rules' to bear in common with the rest of the borrowers, weekly. Should he fail to keep up his weekly instalments, he is written to by the secretary calling upon him to pay, and for this letter he is charged 3d., a fee for the benefit of the secretary. If he does not pay due regard to this, he is, at the expiration of three weeks, summoned before the magistrates of the district, who, however, have shown a disinclination to enforce the payment of the extras, and have confined their decisions merely to the sum due to the society after the deduction of the legal interest. That these societies occasionally sustain losses there is no doubt, but they are trivial in comparison to the immense profits they make, as will be seen from the fact that one of them, upon a capital of £2000, was known to declare on the first half-year's business a dividend of 15 per cent., and on the second half-year a dividend of 18 per cent."

A proper loan society is a modest association of philanthropic persons, connected with some limited district, who wish to aid the meritorious poor of their neighbourhood with small advances of money, with or without the prospect of a small interest for their outlay. Anxious only for the good of their humble neighbours, they extend their aid on terms strictly equitable; while they guard against abuses of another kind, by making loans only where, from personal knowledge, they are assured that a good use will be made of the money. It is only in such circumstances that a loan society will do any good, as it is only under certain circumstances as to prudence and careful management that the Scotch system of banking, which loan societies resemble, is attended with the contemplated results.

As far as our information enables us to judge, the loan fund system is nowhere on a better footing than in Ireland. Private, irresponsible, and usurious, loan societies exist there, as elsewhere, but apparently in less proportion to those of a beneficial character. The extensive utility of loan funds in Ireland is owing to the establishment, by an act in 1836, of a central board of commissioners, with power to inspect the books of all societies formed under the act. In consequence of this statute, there are now from two to three hundred loan fund societies throughout Ireland, conducted on philanthropic principles, and said to be producing a great amount of good. In these societies, all profits, after paying clerk's salary and other unavoidable expenses, are applied to charitable purposes. It appears that in 1840, 215 such societies were circulating £1,164,046 among 463,750 borrowers, and that £15,477 of profit had been realized in three years.

Mr. S. C. Hall, in the agreeable work on Ireland published by him and his lady, gives the following account of the way in which one of these societies is usually constituted, and the manner in which the business is subsequently conducted:—"The resident gentry of some locality in which no loan society exists, perceive that such an institution is required, or would benefit the people in the district. A meeting is called, and as many as are inclined to become depositors state their intention of taking debentures from the new society, for which they receive interest, in some places five, and in others six per cent. One party is voted treasurer, another honorary secretary, and three or four others trustees. Rules for the government of the society are then drawn up, and it is imperative that each set of rules shall contain a provision that no manager or trustee shall directly or indirectly derive any profit from it. Another rule must ascertain the limit to which the managers shall be at liberty to go in expenses of management; and a third, that the treasurer shall become bound with solvent sureties in a reasonable amount for the faithful performance of his duties. These rules are then transmitted to the secretary in Dublin Castle, for the approval of the board, who make any alteration in them they may deem expedient; and the copy is then returned to the society, that three fair transcripts may be made and sent up for certification. On their reaching the secretary, he submits them to the certifying barrister, who, if they are in accordance with the acts, attaches his certification and signature that such is the case. One of these transcripts is then lodged in the office of the secretary to the board, another with the clerk of the peace of the county in which the society is situated, and the third is transmitted to the treasurer of the society, as a voucher that his society is entitled to the privileges conferred by the act.

The society is then in legal existence, and commences operations. A person is appointed clerk, and to him the intending borrowers apply for application papers, which are according to the form printed in the note,* and for each of which a penny or a halfpenny is generally charged.

This being filled up, and returned by the applicant, his solvency and general character, with those of his sureties, are considered, by one or two of the trustees in council met for the purpose, and if approved, the full loan applied for, or such portion of it as they may think proper to grant, is paid to the borrower, stopping, at the time the loan is issued, sixpence in the pound by way of interest. The borrower then receives a card, on which the amount lent to him is entered, and the instalments he pays are marked off. A duplicate of this, or a proper account of the transaction, is, of course, booked by the society. The borrower, and his sureties for him, bind themselves to repay the amount of the loan in twenty weeks, by instalments of one shilling in the pound per week. Thus, if a borrower applies for a loan of £5, which is approved, the society hands him £4, 17s. 6d., retaining two shillings and sixpence as interest. He then pays five shillings for twenty weeks, and the £5 is paid off. Should the borrower run into default, he subjects himself, in most societies, to a fine of one penny for the first week, and threepence for the second and every succeeding week, on each pound lent him; and should he remain two weeks in default, his sureties receive notice that they will be sued for the amount, together with the fines incurred; and unless the borrower comes in, this is immediately done. But in the very great majority of cases no such steps are necessary, the poor borrowers being generally very punctual in the repayments.

It has been objected by some, that the borrowers lose their time in repaying these instalments, but in practice

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* APPLICATION FOR A LOAN FROM THE ——— LOAN SOCIETY.
Former Loan (if any) No.
Amount. £ Fines, *s.* *d.*

I, ——— ———, of ———, parish of ———, county of ———, of which the Petty Sessions are held at ———, and holding acres of land, request that I may be accommodated with pound shillings, according to the rules of the ——— Loan Fund, which I intend to employ in , and of which I solemnly declare that the whole is to be applied to my own use, and not divided with any other person.

——— ———

I certify that the above-named ——— ——— is personally known to me, and that I consider to be a solvent, honest, industrious person, and that I believe the above statement to be perfectly correct.

Given under my hand, this day of 184 .
Signed, ——— of ———.

[It is requested that no person will certify for an IMMORAL PERSON, or for one who does not live industriously in some calling.]

We whose names are hereunto subscribed, will guarantee the payment by a promissory note of £ , s., to the treasurer for the time being of the ——— Charitable Loan Society, applied for by ——— ———.

Given under our hand this day of

——— ——— of ———, of which the Petty Sessions are held at ———, possessed of property in ——— to the value of at least £

——— ——— of ———, of which the Petty Sessions are held at ———, possessed of property in ——— to the value of at least £

the personal attendance of the borrower or his sureties is seldom given. The instalments of a whole neighbourhood are frequently brought in by a child, or some old person, fit for no other employment, who goes, *per vicem*, for two or three town lands. 'Indeed,' remarks the Rev. Mr. Nixon, of Castle Town, 'it is quite delightful to see the confidence reposed by the borrowers in the persons who carry their instalments, and also the fidelity, and accuracy, nay, even the tact, that these latter evince in the discharge of the duty they have undertaken.' In some places the amount of interest charged is less than that above stated, and in others the fines are higher. There is no uniformity in these matters, nor have the central board any power of enforcing it, though it is evidently desirable."

Mr. Hall, adverting to the Third Report of the Loan Fund Board to Parliament, says—"It appears by this return—and the circumstance is so remarkable as to appear at first incredible—that out of an amount of £1,164,046 circulated in small loans among 463,750 individuals, so small an amount as £360, 18s. 8d. only should have been lost, or about ¼q. in the pound. We were very skeptical on this point, and consequently directed vigilant attention to the subject; when, what was our surprise to find that even this £360—this ¼q. in the pound—is considerably more than has been really lost, or left deficient by the poor borrowers! From the 'list of societies whose accounts show a loss on the transactions of the year 1840, after paying interest to depositors and expenses of management,' we took the first, namely, Mitchelstown, where the reported loss was £43, 2s. 6d., when we ascertained that this society lent during 1840, £5420 among 3070 borrowers, who paid £135, or sixpence in the pound, for its use, besides £11, 10s. 10d. for the price of their application papers and cards. The society paid in interest for money lent to it, and expenses of management, £190, 3s. 4d., and the difference between its receipts and disbursements constitutes this £43, 2s. 6d., not one penny of which was lost from defaulters. We are informed by a person in every way competent to judge, it is his firm belief that out of this £1,164,046 lent, not the odd £46, or not *one-tenth* of a farthing in the pound, was unpaid. This fact alone speaks volumes for the honesty of the people, and their appreciation of the benefit which the loan funds confer on them.

"It has been argued that this security from loss has arisen in consequence of the power which the law gives for the recovery of the loans; but the observation is equally applicable to societies more strictly private. For example, in New Ross a society has been established upwards of forty years, for the lending small sums to the poor; and the sum lost during the whole of that period is within five pounds. This fact we give upon the authority of the Rev. George Carr; we could adduce others equally strong, and we have no doubt might receive similar statements from nearly every institution of the kind in Ireland. We rejoice greatly at the opportunity thus supplied us of bearing out by unquestionable proofs our own opinions in favour of the honesty of the Irish peasant. It is indeed a subject upon which satisfactory evidence is especially necessary; for it has been too frequently and too generally questioned in England, where, upon this topic particularly, much prejudice prevails, and where it has been far too long the custom to

'Judge the many by the rascal few.'

"We therefore, from the very minute inquiries we have instituted, have no hesitation in arriving at the conclusion, that the loan funds in Ireland will speedily become, nay, are already, mighty engines either for good or evil, according as they may be worked and superintended Where properly managed, they cannot fail to exercise a vast influence on the moral and social condition of the people; where conducted carelessly, or by parties endeavouring to force business for their own gain, they may be indeed considered a moral pestilence, blighting the energies of the surrounding population, and fostering habits of improvidence or dishonesty."

THE ANNUITY.

The purchase of an annuity is a mode of providing for the latter part of life, which may be the most appropriate in some instances, especially where a person is unconnected with wife, children, or other near relatives, or where these have been otherwise provided for. When the case is different, such a mode of provision is liable to the charge of selfishness, in as far as it concentrates the benefit upon the purchaser alone; it has also been thought to tend to encourage improvident and careless habits, seeing that, once assured of a full provision for life, the need for further saving is in a great measure precluded.

There are numerous companies which grant annuities on the principle of making a profit by them; and sometimes this branch of business is carried on in connection with that of life-assurance. There are also associations of individuals for obtaining annuities and endowments to widows and other nominees on the mutual assurance principle, and one large class of these, at present flourishing in various parts of the United Kingdom, are said to be based on unsound calculations, and fraught with disappointment to those relying upon them. There is indeed one circumstance generally unfavourable to annuity business, namely, that the ordinary tables of mortality present views of the expectation of life somewhat below what is at present the truth in England. Hence, what makes life-assurance business everywhere so prosperous, is precisely that which tends to make annuity business a source of loss. It is obvious that, where individuals unite for annuities, and too low charges are made, those dying first will secure an over-proportion of the benefits, and leave those who come behind nothing but an empty purse.

With a view to encourage persons of the humbler classes to provide of themselves for their latter years, the government obtained an act (3 and 4 Will. IV. c. 14) to enable trustees of the legally established savings' banks to sell annuities of not less than four or more than twenty pounds, upon the security of the national credit. The same act provided that, in parishes where there was no savings' bar[illegible] society for granting such annuities might be form[illegible]vided that the rector or minister of the parish, [illegible]resident justice of peace, should be one of the trustees. Any person above fifteen years of age was entitled to purchase such an annuity, which might be to commence immediately, or at a future period of life, or for a limited term of years, at the pleasure of the party, and might be paid either in one sum or in half-yearly sums, convertible into quarterly by dividing the annuity, and commencing the two parts at different periods of the year. The whole arrangements of this act were dictated by the most considerate benevolence towards the classes designed to be benefited. To quote an authoritative document:—"Provisions are made for enabling the party to make his annual payments, or receiving the annuity, at any other society than the one at which the contract was originally entered into. Upon the death of the person on whose life the annuity depended, a sum equal to one-fourth part of the said annuity (over and above all half-yearly arrears thereof respectively) will be payable to the person or persons entitled to such annuity, or his, her, or their executors or administrators (as the case may be), provided such last-mentioned payment shall be claimed within *two years* after such decease, but not otherwise; provided also, that the fourth part of any expired life-annuity, payable under the provisions of the said act, will not be payable, nor be paid upon, or in respect of any *deferred life-annuity*, unless one half-yearly payment of such deferred life-annuity shall have been actually paid or become due at the time of the decease of the nominee. Independently of the advantages which are thus afforded to the industrious classes to obtain by small payments a certain provision in old age, or at any other stated period, *secured by government*, and of which they cannot be deprived on account of miscalculation, the tables of contributions have been so calculated, that *if the purchaser of a deferred life-annuity die before the time arrives at which the annuity is to commence, the whole of the money he has actually contributed will be returned, without any deduction, to his family.* And if it does not exceed £50, it is not necessary that probate or letters of administration should be taken out. But if he has left a will, or administration is taken out, no stamp or legacy duty is payable in respect of the sum so returnable, if the whole estate, &c., of the member is under £50; and again, *if a purchaser is incapable of continuing the payment of his yearly instalments, he may, at any time, upon giving three months' notice, receive back the value of the money he has paid.* No annuity granted will be subject or liable to any taxes, &c.; nor can the same be transferred or assigned, but must continue to be the property, or be received for the benefit, of the party by or for whom it was purchased; but in case of the bankruptcy or insolvency of the purchaser of an annuity, the same is to be repurchased by the commissioners at a valuation according to the tables upon which the annuity was originally granted, and the money will be paid to the assignee for the benefit of the creditors.

"From the above statement it will appear that any *deferred annuity*, purchased by annual or other payments, from a society established under the stat. 3d Will. IV. c. 14, will entitle the purchaser (if he live to the age at which the annuity is to commence) to receive an annuity equivalent to the value of all his payments, with the accumulation of compound interest; if he be unable to continue his yearly instalments, he may have back all the money he has paid, exclusive of interest; and if he die before the commencement of the annuity, his family will, in like manner, receive the whole of the contributions he may have actually made previous to his decease, exclusive of interest."

Age of the person at the time of Purchase upon whose Life the Annuity is to depend.	Yearly Sum required.			Money to be paid down in One sum at the time of Purchase.		
	£	s.	d.	£	s.	d.
15 and under 16,	10	11	6	157	11	0
16 17,	10	9	6	155	17	6
17 18,	10	7	6	154	3	0
18 19,	10	4	0	152	7	0
19 20,	10	2	0	150	10	6
20 21,	9	19	6	148	13	0
21 22,	9	17	0	140	13	0
22 23,	9	14	0	144	11	6
23 24,	9	11	0	142	8	6
24 25,	9	8	6	140	2	6
25 26,	9	5	0	137	15	0
26 27,	9	1	6	135	4	6
27 28,	8	18	0	132	11	0
28 29,	8	14	6	129	15	6
29 30,	8	16	6	126	18	6
30 31,	8	6	0	124	1	0
31 32,	8	2	6	121	2	0
32 33,	7	19	6	118	6	6
33 34,	7	15	6	115	11	0
34 35,	7	11	6	112	17	0
35 36,	7	8	0	110	3	6
36 37,	7	4	6	107	11	6
37 38,	7	1	6	104	19	6
38 39,	6	17	6	102	7	6
39 40,	6	14	0	99	15	0
40 41,	6	16	6	97	1	6
41 42,	6	6	6	94	5	6
42 43,	6	2	6	91	7	0
43 44,	6	18	6	88	6	0
44 45,	5	14	6	85	5	6

The tables on which the government annuities are granted have been formed, as might be expected, on the soundest principles, and are entitled to the greatest respect. They relate to four kinds of benefit—deferred annuities upon the continuance of single lives, immediate annuities upon the continuance of single lives, deferred annuities to continue for a certain term of years, and immediate annuities to continue for a certain term of years. The whole are presented in a brochure quoted below.* We have extracted only one specimen, namely, the terms of an annuity of £20, payable after twenty years from the time of its purchase—(See preceding table.)

BENEVOLENT PAWNBROKING.

The necessities of the humbler classes have given rise to the trade of pawnbroking, which, even when conducted, as it often is, by respectable persons, certainly forms a severe punishment upon the poor for their poverty. On this subject some exaggerated views have of late years gone abroad; but there can be no doubt that the poorest class, in pledging small articles for short periods—and the greater part of pawnbroking business appears to be of this kind—are subject to enormous extortions, calculated, most materially, to keep them in a depressed condition. It has been said that £3000 is annually lent by pawnbrokers in Ireland in one shilling loans, and that this sum actually produces to the lenders in a year not less than £19,500. To a poor person in want of a shilling for a week, it appears no great hardship to pay a penny for the loan of it; but when we consider that this is, in reality, borrowing money at 433⅓ per cent. per annum, the hardship of the case is presented in its true light. Nor is the licensed and ostensible trade of the pawnbroker the worst of the case. Wherever a large horde of very poor people is collected in our large towns, there rises an unlicensed and clandestine species of the trade, conducted upon principles still more ruinous to the needy. It has been shown that there are in Glasgow no fewer than seven hundred small unlicensed pawnbroking establishments, whose extortions from the poor infinitely exceed the legal rates to which the licensed traders are restricted. The saying of Solomon, that the destruction of the poor is their poverty, was never perhaps shown in a more striking light than in the losses which they endure in consequence of the necessity they are occasionally under of raising money by pledges.

On the continent, the system of lending upon pledges has been practised for several centuries upon a benevolent principle. The establishments where the business is carried on are called *Monts de Piété* (*mounts* being a term applied to heaps of money, while the word *piété* expresses the religious views in which the plan originated). In this case, an association of benevolent persons, possessing a little capital in common stock, are the pawnbrokers, and the objects they keep in view are to make the evil of pledging as light to the poor as possible, and to apply the profits to charitable purposes by which the poor will be benefited. Here there is no extortion, no punishment for poverty, and the poor, as a body, may be said to lose nothing. In France, some abuses have crept into the system; but these are not essential to it, and we have lately had experience nearer home how much good may be done by a well-conducted mont de piété.

The first establishment of the kind in the United Kingdom was set up at Limerick in 1837, through the exertions of a gentleman named Barrington, for the purpose of supplying funds to an hospital which he had founded out of his own fortune. The required capital was raised by debentures (or joint-stock shares) varying in amount from one to five hundred pounds each, upon

* "Instructions for the Formation of Parochial Societies for granting Government Annuities." London: Printed by W. Clowes and Son, for his Majesty's Stationery Office.

which interest was to be allowed at the rate of six per cent. These might be withdrawn at three months' notice, or money would be advanced upon them as pledges. Mr. Barrington described the following as the advantages proposed by his scheme:—

"1st, The raising a capital by small debentures at a certain interest, and lending it on a greater interest, and applying the profits to the purposes of charity.

"2dly, Receiving the debentures in pawn, thus giving to the depositors an advantage which they do not possess in the savings' bank.

"3dly, Lending money at interest to poor persons of unimpeachable character and industrious habits, on personal security, as is done by the loan-banks.

"4thly, Lending money on goods, as is now done by the ordinary pawnbrokers.

"5thly, In case of deserving objects, to restore the article, such as implements of trade pawned in the hour of *real* want, without interest or charge.

"6thly, Using every precaution against receiving stolen goods in pawn."

The plan meeting with a hearty approval, a capital of above fifteen thousand pounds was quickly subscribed, partly by the gentry, and partly by persons in the humbler walks of life. An active and intelligent person, who had himself been a pawnbroker, was placed at the head of the establishment, which had no sooner commenced business than it became largely supported. The following view of the transactions, from March, 1837, when it commenced, up to December, 1840, is given by Mr. and Mrs. Hall in their work on Ireland:—

Years.	Amount lent on Pledges.	Amount received for Released Articles.	Gross Profit.*
	£ s. d.	£ s. d.	£ s. d.
1837,	14,130 1 6¼	9,668 11 10¾	335 2 7¼
1838,	17,885 13 3¾	16,923 15 8¼	1074 18 4¼
1839,	21,091 7 8¼	20,727 19 6¼	1172 15 3¼
1840,	25,488 6 5¼	23,675 1 5¼	1357 13 11
Total,	78,595 0 0¼	71,005 8 7	3940 10 2¼

There is no charge for tickets at this establishment; consequently, if those pawns were pledged at a pawnbroker's, the poor would have to pay for each pawn a sum of one penny; if the amount borrowed amounted to 10s., twopence, if it amounted to 40s., fourpence: therefore (not at all taking into account the low rate of interest) the saving effected by the very poorest persons is most remarkable. For instance, say that

360,000	of those pledges were	*under* 10s., at 1d. each,	£1500 0 0
90,000	do.	*under* 40s., at 2d each,	750 0 0
10,895	do.	*over* 40s., at 4d. each,	181 11 8
Or a sum saved in four years on the bare item of tickets, to the very poorest people, of . .			£2431 11 8

If to this be added the saving in interest, we may safely calculate that nearly as much in addition is saved as the establishment is realizing, as the following table will show the difference in the rate of interest, for different sums, to 10s. and £1.

Sum Lent.	Mont de Piété Interest.	Pawnbroker's Interest.	Pawnbroker's *Total Charge* of Interest and Ticket.
£ s. d.	d.	d.	d.
0 1 0	0¼	0¼	1¼
0 2 0	0¼	1	2
0 3 0	0¼	1	2
0 4 0	1	1½	2½
0 5 0	1	1½	2½
0 6 0	1½	2	3
0 7 0	1½	2	3
0 8 0	1½	2½	3½
0 9 0	2	2½	3½
0 10 0	2	3	5
1 0 0	4	5	7

* Total number of pawns received since the establishment opened, to March 19, 1841, 460,895.

The Mont de Piété of Limerick having been attended with success, insomuch that it supports the hospital for the sick poor of the city, similar establishments have been opened at Belfast and Tandragee, and the example will doubtless be followed in time on this side of the Irish Channel. In September, 1840, at the meeting of the British Association at Glasgow, an interesting paper on the subject of the Irish establishments was read by Mr. H. J. Porter, from which we make the following extract:—

"At the close of the first nine months of the operations of the Tandragee Mont de Piété, I was able to show that the borrowers from the loan fund department, on personal security, had in their possession 1189 looms, of which 612 (more than half the number) were hired at 10s. per annum. One man had at that period one loom, for which he had paid £12 within the previous twenty-four years, without any other alteration than that which was necessary on the invention of the fly-shuttle; and, after having paid the price of four new looms in interest, he was not at that time the owner of one. Here, and in many similar cases, the mont de piété was the means of relieving the poor, and the owners of looms for hire began to find it difficult to let them out. One farmer proposed to sell his stock of looms to the institution, finding the hope of his gain drawing to a close but of course the proposal was rejected, as these old looms were incapable of producing as good a fabric as the new looms issued by the mont de piété.

"At the period of which I speak (first nine months of operation), above 2600 loans had been granted for the following purposes:—

For provisions . .	Loans, 550	amounting to	£1649
Materials for trade .	.. 138	..	402
Dealing	.. 194	..	661
Clothing	.. 41	..	81
Repairs of houses . .	.. 51	..	143
Yarn for weaving . .	.. 187	..	612
Looms	.. 131	..	449
To pay small debts .	.. 70	..	193
To buy cows . .	.. 504	..	2569
.. pigs . . .	.. 375	..	1223
Farming purposes, seed, &c.	.. 260	..	839
Rent	.. 77	..	252
Total	2608		£9070

"In order to form some idea of the benefit derived by these borrowers, I examined great numbers of them as they appeared, on the payment of the last weekly instalment. I ascertained pretty nearly the amount of money saved or realized by their having the advantage of ready money, and from these I formed an average estimate of the whole.

Oatmeal . .	£1100	Saving . . .	£309
Potatoes . .	550	.. . . .	338
Cows . .	2569	Profit . . .	124
Pigs . .	1223	.. . . .	160
Dealing . .	664	.. . . .	166
Total .	£6096	Total .	£336

"Had the mont de piété conferred no other benefit on the country than that derived by the peasantry, in procuring their summer provisions for ready money, that alone would amply repay the directors for all the labour bestowed on the working of the institution. What were the circumstances of these 550 families in bygone summers? Many of them found it difficult to procure credit, or obtain a sufficient supply of wholesome food for the maintenance of their families; idleness prevailed, sickness increased, and not unfrequently fields were mortgaged to more wealthy neighbours, who supplied the wretched holders of two or three acres of land with the required food at an exorbitant price. Others, whose credit was good, passed promissory notes, payable at harvest, and not unfrequently they were charged for meal 6s. or 8s. per cwt. more than the market price, independent of the expense of stamps; and it was no uncommon practice for a poor man, wanting the immediate use of a few pounds in money, to purchase oatmeal from a forestaller of provisions, while a third person would buy back the oatmeal from the poor man at a much less price than he was charged, hand him the money, and the oatmeal would never be delivered, but sold again by the forestaller to the next customer. The object of this transaction is evident. The value of a promissory note for provisions would be easily recoverable at the quarter-sessions, while one for cash, bearing usurious interest, would be likely to involve the forestaller in an open violation of the law. Thus were the poor on every side oppressed; the harvest time arrived, and the debts for summer provisions were generally first paid from the produce of the farm; too often were they unable to pay just demands of rent and other charges, while in few cases were they able to hold over their corn till the most favourable time arrived for bringing the produce of their farm to market.

"What, on the other hand, has been the experience of the last summer? Those 550 families borrowed, on moderate interest, from the mont de piété, £1640, and by habits of industry and increased diligence, their weekly instalments are paid; at harvest, instead of being deeply involved in debt, they owed nothing for their summer's food, and the produce of their land has in many cases been reserved for weeks, till the best price could be obtained; they are able not only to pay their rents, but to supply themselves and their children with better clothing. But other moral effects have followed. Halfpence and pence, which formerly were squandered in tobacco, snuff, and ardent spirits, are treasured up for the Monday morning's instalments, and the people are beginning to feel the value of small sums, and the truth of the old proverb, that, 'if you take care of the pennies, the shillings will take care of themselves.'

"Again, we find that £2569 has been borrowed for the purchase of cows. The benefit to the poorer classes in this particular is incalculable—the health arising from the possession of an abundant supply of milk; the improvement on their farms, by sowing green crops for the maintenance of their cows; the increased quantity of manure which is provided for the land—while it has been ascertained that in twenty weeks the generality of cows purchased have paid, by the produce of milk and butter sold, one-half of their own cost. Hundreds of families are now possessed of a cow each, and great numbers have already procured a second. As a proof of the saving habits which are promoted by this system, I may mention, that a respectable person has settled in this town, whose sole business is the purchase of butter and eggs for exportation; and he finds it frequently difficult to attend to the immense influx of persons who come to sell their produce to meet their weekly instalments. One poor woman borrowed a pound; she bought five hens for 4s. 2d.; she expended 15s. 10d. in clothing; and at the end of the twenty weeks her five hens had been the sole means of paying off her debt to the loan fund.

"But what is the testimony of the manufacturers in the neighbourhood? That the industry which is promoted by the necessity of those weekly instalments, and the punctuality of the weavers in returning their cloth, has already had the most beneficial effects.

"And how are persons in trade affected by the operations of the mont de piété? I have it from the best authority, that a great increase of business has been the result, and a greater degree of punctuality in meeting all engagements on the part of the poorer classes.

"One class alone are suffering from the effects of the mont de piété, and they are little deserving of compassion. Those who live by the destruction of others, both soul and body, are not to be commiserated—those who keep open houses for the drunkard—and when they have given a poor person as much whisky as they think he can pay for, or is able to consume, turn him out incapable of taking care of himself, and exposed to the risk of a watery grave in the next river or canal he meets—those are surely persons whose lack of business and prosperity is a blessing, and whose failure in trade must be held as a common good. I have undoubted authority for saying, that the temperance cause and the mont de piété are going hand-in-hand; and the twopence for the morning glass, or the shilling for the night's carousal, are now carefully saved to meet the weekly instalment.

"I might enlarge on the important benefits which this institution confers upon the working-class—above £1200 expended in the purchase of pigs, which are such a source of wealth to the Irish poor, being nearly fattened on the refuse from the tables of the owners."

We must be excused for adding one more anecdote from a report by Mr. Haynes of the Limerick establishment:—"A poor woman, when the institution first opened, was in the habit of pledging *every* morning her bed-tick for two shillings and sixpence, and releasing it every evening; this she did for the purpose of purchasing potatoes from the country people, and retailing them afterwards in small quantities, at a higher price, thereby endeavouring to support her family: for this loan she *daily paid the pawnbroker the sum of twopence.* When the mont de piété opened, she being only charged a halfpenny, saved three-halfpence daily, which eventually enabled her to raise a small stock-purse of ten shillings; and she now seldom, if ever, visits even that office."

THE PROVIDENT DISPENSARY.

On the subject of medical attendance, the working man, in ordinary circumstances, may well be at a loss how to act; for, on the one hand when he calls in a doctor on account of himself or his family, he is oppressed by the high charges for attendance and medicine; and on the other, if he resorts to a dispensary or hospital, he loses his independence. That these are evils of large amount, and widely prevalent, might easily be shown. In England, the ordinary medical practitioner charges for medicine only, but he gives much of that, and places a high price upon it. A working man, ill for three weeks, will find, on his recovery, a bill of thirty or forty shillings run up against him, either causing him to break up his little hoard in the savings' bank, or keeping him in embarrassment for the ensuing twelvemonth. Conducted as the medical profession is in that country, it is impossible, in short, for a poor man to have independent medical attendance which he means to pay, without the most serious pecuniary distress being entailed upon him. So severely is this felt, that the resort to medical charities has of late years been rapidly on the advance in England, both involving more individuals, and individuals of a better class than formerly. In 1821, when the population of Manchester was 158,000, the dispensary patients were 12,000. In 1831, when the population was 230,000, this class of patients had advanced to 41,000; an increase of fully two to one. It was calculated in the latter year that, of all the persons ill and requiring medical advice, the dispensary patients were a majority. Similar facts are stated with respect to Leeds and Birmingham. It would appear as if a wide-spread demoralization were going on throughout England from this cause. Dr. Holland, of Sheffield, has recently published a volume calling attention to the subject. He sets out by stating very broadly, as his opinion, that the character of the working-classes in Sheffield is at present undergoing a certain degree of deterioration, in consequence of so many charities, and particularly medical charities, being thrown open to them, the self-respect connected with independence being thus gradually worn away, and with it the virtues which have never yet been found to exist without it. The Infirmary, we are told, was established for the benefit of the poor and needful of all nations; but it never, our author argues, could have been designed for those who are able otherwise to obtain the desired aid. Now, however, the fact of being an operative is held as a sufficient claim

"The artisan never dreams of the possibility of rejection on the ground of being in full and regular employment, and being amply remunerated for his labour. He applies u[illegible] as naturally to the charity when he is sick, as to the tailor for the repair of his clothes, with this difference, that he would be perfectly astonished were any one to hint at the propriety of paying for the favours conferred by the former." Our author argues against the following classes, at least, having any right to the benefits of the institution: Single men in employment—married men with only young and small families—men with several children but high wages—men who have several sons and apprentices working along with them—servants in situations. All of these persons, excepting the last, must be able to provide medical attendance for themselves, if they economize their resources. He presents a hundred cases of applications, being those within the few weeks before the time when he was writing, and out of these he showe that there were fifteen young single men, all of whom but two had been in employment till the time of their illness, twelve at well-paid crafts, and one as a labourer. Eleven cases were of married persons without children; and thirty-two applicants were married, with only one or two children. In some of the latter instances, "the only child is a daughter eighteen or twenty years of age, who had never been allowed to go out to place, or to learn any business; in others, a son apprenticed to his father, and both in regular employment. In one instance, where the wife was the patient, the daughter was in a warehouse, and the son, a youth of fourteen years of age, was a day scholar in a respectable private academy in the town. The husband had received regularly twenty-four shillings a week for the last twenty years. Many of the thirty-two cases are even more flagrant instances of imposition on the charity."

Certainly in the whole number of applicants for relief, as far as our author has described them, we do not find that proportion of persons likely to be in necessitous circumstances, which might be expected. To support his views, he brings the testimony of the house-surgeon, who, in answer to queries put to him, says—"The character and appearance of the patients generally are very different from what they were fifteen or twenty years ago. The patients are much more respectably dressed, and in better circumstances. Many now, not from inability to walk, are conveyed to the house in hackney coaches. * * They apply for much more trivial ailments than formerly." The author speaks of females who come to the institution in elegant cloaks, shawls, and clogs. Not one half of the applicants have the appearance of indigence. "The frequency with which they apply for very trifling ailments, such as slight symptoms of indigestion, coughs, or occasional pain, or, indeed, for the removal of a disease which just perceptibly mars the beauty of the face or neck, is evidence that their situation in life is very remote from those circumstances which entitle them to the sympathy of the benevolent. *The really poor never apply for the relief of slight and unimportant complaints.*" Afterwards he adds—"In evidence of the trifling nature of many of the medical cases, we may state that one-half are often cured in ten days, and two-thirds in three weeks."

The results of his inquiries at the Dispensary are nearly the same. The great bulk of the applicants are either themselves artisans in the receipt of good wages, or the connections of such persons. They come in respectable apparel, and, when visited at their homes by the medical men, are found to possess every appearance of domestic comfort. Recommendations from subscribers to the institution are necessary to procure admission; but these are given, in seven cases out of ten, by persons who have no knowledge of the circumstances of the applicants. "A gentleman who, from his position in society, is often applied to, informs us that he always refuses, unless the individual bring a letter from his employer, stating that he is a necessitous object; and though promising to give a recommendation on this condition, *not one in twenty returns to receive it.*"

Facts still more remarkable are brought out by Dr. Holland. "The distresses of a community," he says (meaning such a community as that of Sheffield), "will be admitted to bear a strict relation to the state of trade. When this is extremly depressed, many hands are thrown out of employment. When the trade is good, the demand for labour is great; wages advance, and the blessings of plenty are universally experienced. The amount of misery or destitution cannot be the same in these very different circumstances. It cannot be a fixed quantity floating in society. The idea is preposterous; and yet, if the registered demand for charity be any criterion of the misery existing, there is indeed a quantity subject to scarcely any variation whatever.

"From midsummer 1835 to midsummer 1836, between which periods trade was better in this town than it had been known for years, the number of patients admitted on the books of the Infirmary was 3126.

"From midsummer 1836 to midsummer 1837, between which periods the trade was exceedingly depressed, the number was 3431, being an increase only of 305 patients.

"Between the former periods the number of patients on the books of the Dispensary was 2888.

"Between the latter periods, that is, from July 1836 to July 1837, the number was 2575, being less by 313 patients.

"According to these returns, there were *eight patients more during a prosperous state of trade, recipients of medical charity, than during the severe depression of it.*"

He elsewhere states that healthy seasons are marked by no diminution of the number of applicants. "We hesitate not to assert that, during the last twelve months, there has been less disease in this town and neighbourhood than has been known for many years, and yet during this period the demands on medical charities have increased."

As a remedy to these evils, some benevolent persons, with the co-operation of a few of the more liberal of the medical profession, have instituted what are called *Provident Dispensaries*, the main feature of which is, that the working man contributes a small sum weekly from his earnings, to entitle him to medical attendance and the requisite medicines, in the event of illness entering his household—the united contributions of a few hundred members being sufficient to engage a respectable physician, and defray all the other expenses. Such institutions have been tried with marked success at Coventry, Derby, and some other places. They are limited strictly to the class who are unable to fee medical attendants in the ordinary way, but who are yet anxious to keep themselves in all respects above the condition of paupers. Individuals wishing to belong to the provident dispensaries must join when in good health, as the object is in reality an "assurance" against sickness, and the provident character of the institution could not otherwise be maintained. One penny a week is paid for each adult of the family, and a halfpenny for each dependent child. Individuals of the more affluent classes contribute without the design of benefit for themselves, in order to encourage the institution, and from them, in general, the directing body is chosen—the only part of the arrangement which we cannot fully approve of. From the proceeds a medical man is feed, and medicines are provided; and it is remarkable that a thousand sick persons connected with a provident dispensary have been found to cost considerably less than a similar number of patients resorting to the medical charities.* The tendency of such institu-

* An Essay on Dispensaries. By P. H. Holland, Surgeon, Manchester: 1838.

tions to maintain the moral uprightness of the working-classes is obvious; and it is already proved that, wherever they have been planted, applications for parochial relief have been diminished. It is to be lamented that medical men have a prejudice against them, probably from no other cause than that small copper sums are concerned in supporting them. But surely it is better even for medical men that the humbler order of patients should pay something within their means, and that regularly, than only pay in a few instances, and in others either resort to charities or leave a large debt unliquidated.

Whatever may be the sentiments of the profession upon this point, it must be evident to all that, for the working-classes themselves, the provident dispensary is a most unexceptionable species of institution. It carries them over one great difficulty in their career with the preservation of their independence; it does more, for, being on the assurance principle, it encourages habits of foresight. Some other advantages presumedly incidental to it are thus stated by Mr. P. H. Holland, in the pamphlet above quoted:—"Assistance in sickness is much more easily accessible in provident than in honorary dispensaries. The patient need not lose time, or degrade himself, by running about to beg a recommendation, but applies at once for an attendance ticket, and puts himself under the care of the medical officer of his own choice; in fact, procures assistance just as readily as the richest of the land. Consequently, as I am informed by Mr. Nankivell, at the Coventry Dispensary, the cases being seen by the surgeons at the very outset, the probability of a successful result is much higher than in ordinary dispensaries: for instance, at Coventry, they have lost, out of 6094 patients attended, 92, or 1 in 66; at the Chorlton-upon-Medlock Dispensary, in the same period, out of 6438 patients admitted, 210 died, or 1 in 30·6. All who have had experience in ordinary dispensary practice, well know the advantages of getting the cases early; for, at present, very many patients, rather than undergo the trouble, unpleasantness, and painful sacrifice of honest pride, will not apply for a recommendation until they dare delay no longer; consequently, many cases are not under treatment until the only time at which it could be available is past, and it is this which renders dispensary practice so harassing.

"It is probable, nay certain, that the large number of patients, in proportion to the deaths, is in a great measure owing to the very easy access to a provident dispensary, causing many to apply on very trivial occasions; but who shall say how many of these trivial cases would have become serious, or even fatal, if neglected? But this partial explanation will not at all account for the very gratifying result which, by the following analysis of the reports of the Coventry Self-supporting Dispensary, I have elicited, namely, *that the average mortality among the members of that dispensary is considerably less than the average mortality of the country generally.* This is the more remarkable, as it is fair to presume that the sickly will be more ready to subscribe than those in robust health, and therefore we might have expected a mortality somewhat greater than the average. The mortality of a town like Coventry is about 1 in 50 per annum. The following table exhibits the number of members, upon the presumption that each on an average contributes at the rate of 3s. per annum, which must be very near the truth, as adult members pay one penny per week, and children a halfpenny, while any more than two in a family, below twelve years of age, are not charged.

Years.	Calculated Number of Members on the average of the whole year.	Patients Admitted.	Deaths.	Computed Number of Members to each Death.	Number of Cases to each Death.	Amount of Honorary Subscriptions and Donations for Expenses of the Establishment.	Amount of Members' Subscriptions, from which Fund the Drugs are paid for, and the remainder	Paid to the Surgeons.
						£ s. d.	£ s. d.	£ s. d.
1834,	2670	1558	20	133	77	143 6 6	400 12 0	268 0 0
1835,	2771	1565	27	102	58	114 4 0	415 12 1	287 2 0
1836,	2650	1420	17	155	83	124 6 2	397 9 3¼	262 3 0
1837,	2614	1551	28	93	55	101 12 0	392 2 1	261 15 0
Averages,	2670	1523	23	121	68	120 17 3¼	401 9 1	269 15 0

"The average annual mortality among 2676 of the population, taken promiscuously, would be about 53; whereas the mortality among the Coventry Dispensary patients has been only 23. We must not suppose that the dispensary is saving lives at the rate of thirty a year, for much of this difference of mortality must be attributed to 'the circumstance of the members of the institution consisting almost entirely of the most frugal, industrious, and prudent of the work-people.'* Something ought perhaps to be attributed to there being probably a disproportionate number of adult members. But if we are ever warranted in ascribing to medical means the saving of life, most surely are we so among the patients of a self-supporting dispensary, where the members have medical advice at the very outset of disease, more promptly perhaps than any other set of persons in the country.'"

MINOR ECONOMIC FUNDS.

The Hon. and Rev. S. G. Osborne, of Stoke Vicarage, Buckinghamshire, has published an account† of several small economic funds, which have been formed in his parish—a large agricultural one—for the benefit of the humbler classes, apparently in a great measure by the active and well-directed zeal of the author himself.

One of these is a *Coal Fund.* The poor in Mr. Osborne's district are generally ill off for coal during the winter months; and, when the weather is unusually severe, it is found necessary in many parishes to subscribe to obtain for them a portion of that domestic necessary. In Stoke parish, the poor are induced to commence in June paying one shilling a week each into the parson's hands, until twelve shillings have been paid. Coal is there generally from 1s. 1d. to 1s. 5d. a bushel; yet the managers of the fund undertake that each person shall have twelve bushels of coal delivered to him, during the course of winter, at his door, free of all charge (a sack of three bushels being given every three weeks four times). The extra money required is contributed by the benevolent people of the neighbourhood. Charity is here partially employed; but it is to be remembered that the benefit is conferred upon a class who might otherwise be entirely dependent in this respect. Mr. Osborne considers it a great matter that the poor are induced to contribute the larger share of the funds: their spirit of self-dependence is encouraged to that extent. The reverend manager of the fund endeavours to save a little in good years, in order to be the more able to succour the poor in bad ones. The poor complain of this, but he waits

* Letter from Mr. Nankivell.
† "Hints to the Charitable." Price One Shilling. T. & W. Boone, London.

patiently till a bad year comes to show them the good of the system. In the severe winter of 1837-8, he had £24 in hand. "We thought the severity of the season such an extreme case, that we ought to do something more than usual for the poor. Accordingly, we took a part of the balance, and bought 114 sacks of coal, some of which we gave away, but sold the greater part at the low price of sixpence a sack. The poor were thus taught the advantage of having saved this balance, and we had the satisfaction of affording a most seasonable relief, without begging for a single sixpence from any one." It may be presumed that the parties on the coal fund will be more careful of fuel thus obtained than of that which is given them for nothing. "They can look forward to the winter," says Mr. Osborne, "with one heavy care for it removed. When the winter comes, with little or any addition, the tired labourer may ever find a comfortable fire at home to spend his evenings by; he is not forced to go to the beer-shop to warm himself."

The *Wife's Friendly Society* is designed to enable married women of the poorest class to have a small fund which they can draw upon, to defray the expense of a proper medical attendant at their confinements, and furnish some of the comforts required on those occasions. Generally, this class of persons have no provision for such occasions, and the consequences are that they depend on charity, and sometimes suffer from the indifference which the midwives in that case employed are apt to feel where their care is not to be remunerated. A poor woman recommended to the Wife's Friendly Society pays 2d. weekly for a year to the treasurer (the vicar's wife), making 8s. 8d. in all. To this the society from charitable contributions adds 2s. 10d., making 11s. 6d. If she is confined that year, she gets an order for 10s., which serves as payment for her medical attendant. The remaining 1s. 6d. serves to furnish gruel and other little comforts—a small sum for such a purpose, but better than nothing. The person who recommended the member guarantees, that, after this payment is made, she will continue to pay her weekly twopence till the end of the year. Should no confinement take place, the money is spent on clothes.

In the case of the *Penny Clothing Fund*, the proportion of charitable contribution is greater than in any other of Mr. Osborne's schemes. The object is to encourage the poor to exert themselves to furnish decent clothing for their children. A benevolent person pitches upon some child belonging to a poor neighbour: the patron and the child each pay 1d. weekly into the fund, that is, 8s. 8d. annually. Some persons take two, three, or more children under their care. Mr. Osborne speaks of 150 in all in his parish being clothed by these means in one year. "The buying of the clothing is thus managed: a linen-draper attends with his shopman on a given day at the expiration of the year, with a large supply of all such articles of clothing as the poor most need for their children; the school-room is allotted to him as a shop for the day. In addition to the linen-draper we have a person over from a neighbouring market-town, whose business it is to deal in ready-made clothing and shoes for boys; he has a room adjoining the school for his shop. Each lady (these clubs are almost always wholly supported by the female sex) appears with the children she has put in, together with their parents; they are served in turn, and it is the lady's duty to see that they have their 8s. 8d. worth of goods. The pence are received from the children weekly at the school; from the persons putting them in, at the end of the year." Clothing for children being one of the things which the poor, amidst the various difficulties which beset them, are least apt to provide for, we can well believe that this fund does much more good than the practice of presenting blankets at Christmas—a blanket being an article which the parent couple feel the want of pressingly themselves, and are therefore eager to provide from their own means.

The *Endowment Society for Children* is the last of Mr. Osborne's parochial schemes which are different from those already developed in these pages. The object here is to make a provision, by small payments, in the course of a few years, for an event connected with a child which will make a small sum of money necessary—as, for instance, to put him (or her) out to service or apprentice him, or to furnish him with tools for his trade when his apprenticeship is expired. One shilling, one and sixpence, and two shillings, are the various sums received, and they may be for two, four, or six years. The principle is the same as in a savings' bank, but the money is devoted to a particular object, and that a very interesting one, and a stimulus to saving is added. The managers of this fund place the money collected in the savings' bank; in the event of the nominated child dying, another is taken, or the money given back.

For further information on these economic institutions, we refer to Mr. Osborne's little volume. It may be mentioned that he has published some other small pamphlets (T. and W. Boone, London) connected with the subject of this sheet, and all of which seem to us well worthy of the attention of those who aim at benefiting the poor by evoking their own best powers in their own behalf.

AGRICULTURE.

Agriculture may be defined as the art of disposing the soil in such a manner as to make it produce, in the greatest abundance and perfection, those vegetables which are useful to man and the animals depending on him for subsistence. The earth, in a state of nature, unless where it is chilled by an ungenial climate, possesses a certain degree of fertility, so as to produce plants more or less suitable for the subsistence of man and beast; but its spontaneous productions are small in amount compared with those which can be drawn from it by man's industry and intelligence, and those productions are not sure to be of the kind which are most needful. Savage nations usually rest content with the natural produce, and they are accordingly found to be few in proportion to the surface which they possess, and generally in the lowest state of misery. But wherever man has possessed any intelligence, he has applied himself to cultivate the earth, so as to make it capable of supporting in comparative comfort a larger amount of population.

The earliest efforts in agriculture appear to have everywhere been simple, and limited in their object. The surface was ploughed, the cereal grains (wheat, oats, &c.) were sown, and such a crop as nature gave was contentedly reaped. It cannot be said that, by such a system, more was done than merely to take advantage of the natural fertility, in order to raise farinaceous grains instead of the spontaneous herbage. Here, however, agriculture seems to have in every country taken its stand for many ages. It has only been in recent times that men anywhere thought of cultivating the soil under certain advantageous circumstances, having a reference to scientific principles, so as to *increase the natural productiveness*, and consequently render the earth capable of supporting an increased population.

The rise and progress of agriculture among us have unavoidably been much affected by the natural peculiarities of the country. Great Britain and Ireland are islands, having the vast expanse of the Atlantic on the west and German Ocean on the east, and lie within the 50th and 59th degrees of north latitude. Both from relative situation and latitude, therefore, they are exposed to a variable, and, upon the whole, ungenial climate. For about five months in the year, or from November till March, the ground is liable to be covered less or more with snow, or to be frozen in its surface; and herbage in either case is so scanty, that, unless for sheep, and not always for them either, the open ground does not afford nourishment for the stock of pasturing animals required in husbandry, or for the dairy and markets. In a word, vegetable food must be produced in sufficient variety and quantity during seven months of mild weather, to store up as a provision for the remaining five. This necessarily gives a peculiar character to the husbandry of the British islands, or of any other country similarly situated. Independently of the circumstance, the natural character of the soil throughout is far from being uniformly suitable for agriculture. Some land is good, some is of a medium quality, and a large proportion is positively bad, being in a state of nature no better than an unproductive morass or waste. Hence, under a poor system of agriculture, only the good land was cultivated, and a large section of the country was of no use to man or beast, farther than affording refuge to tribes of wild animals. In former times, live-stock were either kept on such a limited scale as to render their amount of winter provender easily attainable, or they were half starved for several months while the inclement season lasted.

The improvements which were in time effected to remedy these deficiencies, consisted of a series of moves, each depending on the other. Two things were desirable—to increase the extent of culturable soil for grain crops, and to raise sufficient food for cattle and horses all the year round. Now, these desirable points involved a thorough change in the practice of husbandry. How was it possible to break up and profitably cultivate indifferent soils, much of which had hitherto been considered beyond all hope of improvement, without an abundant supply of manure? and how could this manure be procured without keeping a large stock of cattle, for which there was evidently no means of subsistence? To overcome these difficulties, it was found necessary, in the first place, to introduce what are called green crops, that is, crops of artificial grasses, including clover, turnips, and other roots and plants; for, by having a proper supply of these substances, two important ends were gained—the support of cattle for manure, and the alternation of green with grain crops; thus at once enriching the land, and relieving it from the scourging obligation to raise corn crops successively. On these main points, then, along with plans for drawing off by artificial drainage the surplus water lodged in or upon the soil, hang the great agricultural improvements of modern times.

SOILS.—CHOICE OF FARMS.

The soil, or that earthy substance with which the dry land is in most parts covered, forms more particularly the material on which the agriculturist has to operate. An investigation of its various qualities is absolutely necessary for all who would conduct farming business in an enlightened and liberal manner.

The soil is mainly composed of particles which have been disengaged by various means in the course of time from the rocks on which it rests. In some instances, and more particularly on hills, it is composed in the main of pulverized materials from the rocks immediately beneath; but in many others, the pulverized matter has been washed down from high into low grounds, or transported by floods from great distances. The action of air and water on rocks in dissolving them, and the power of the latter element in transporting the disengaged particles, are the chief causes of the present arrangements of the soil.

Notwithstanding the different appearances which the earthy covering of the globe exhibits, it is composed almost entirely of four substances, formed by an original union of simple elementary matters. These four substances, washed at a former period from rocks, and called primitive earths, are *clay, sand, lime*, and *magnesia*. It is in the due combination of these that fertility consists. We shall describe them separately.

Clay.—Clay, or, as it is often called, alumine, or argillaceous earth, is easily distinguishable. It is a compact substance, which absorbs water slowly, and when moistened throughout, is soft, pliant, and exceedingly tough or tenacious. In its ordinary condition it is so close in texture as to prevent the penetration of the roots of plants, and therefore is a serious obstacle to vegetation. Clay is one of the most obdurate and worst kinds of soil upon which a farmer is called to operate. If it rest on a substratum of gravel, or friable rock, or sand, it admits of easy melioration; but this is seldom the case; it too frequently rests on a cold and still more compact dark clay, called *till*, which is so close that no water can sink through it.

A clayey soil may be meliorated by a due mixture of sand or any other light substance, which will serve to sheer down its articles and keep them apart from each other. All kinds of calcareous manures, ashes, and the loose dung swept from the streets of towns, peat, and farm-yard manure, are serviceable in mingling with clayey soils, and bringing them up to a proper state of fertility. When so improved, they are calculated to yield good crops of beans, wheat, oats, clover, and Swedish turnips. They likewise answer well for meadow lands or pasturage. Clay soils ought, if possible, to be ploughed up before winter sets in, in order to expose the furrows to the action of the frost, which mellows and brays down the tenacious clods.

Sand.—Sand or gravel, called sometimes silex, silica, siliceous matter, or earth of flints, is distinguished by properties of a totally opposite character from clay. It has little or no cohesion among its parts; is incapable of retaining moisture; and powerfully promotes putrefaction, but permits the gases to escape. Sand is thus a corrector of alumine. These two earths may indeed be classed among the contending elements, of which a union heightens their common virtues, and rectifies and subdues their respective defects.

The bulk of the soil, generally, is composed of sand, to the extent of from four to seven-eighths of the mass. Sir Humphry Davy observes that "the term sandy should never be applied to any soil that does not contain at least seven-eighths of sand;" also, that, "sandy soils which effervesce with acids should be called by the name of calcareous sandy soil, to distinguish them from those that are siliceous."

We are informed by Sir John Sinclair that "the best mode of improving the texture of a sandy soil, deficient in retentive or adhesive properties, is by a mixture of clay, marl, warp (the sediment of navigable rivers), sea-ooze, sea-shells, peat, or vegetable earth. Even light sandy soils are thus rendered retentive of moisture and manure. In some parts of Norfolk, the farmers have availed themselves of these auxiliaries for improving a sandy soil in an eminent degree. They have thus entirely changed the nature of the soil; and by the continuation of judicious management, have given a degree of fame to the husbandry of that district, far surpassing that of others naturally more fertile."—(*Code of Agriculture.*)

If the farmer of a sandy soil possess the means of giving it a top-dressing of brayed down or broken peat, he will find it to be attended with good effects: in general, the materials of improvement are obtained with little difficulty. When properly prepared, a sandy soil is one of the most valuable which can be worked. It will produce good crops of common turnips, potatoes, carrots, barley, rye, buck-wheat, peas, clover, and sainfoin and other grasses. It seldom possesses sufficient strength for wheat, beans, or flax.

Crops on sandy soils are easily injured by drought, as the moisture too readily evaporates from the open particles. This may be in some measure remedied by deep ploughing, which has the effect of preserving a due degree of moisture in the substratum, as a reservoir for the plants. To assist further in preserving the moisture in the soil, any small stones which lie on the surface should not be picked off. In rainy climates, or when the soil rests on retentive clay, such expedients may not be necessary.

Gravelly soils are similar in character to those which are sandy, and equally acquire the administration of materials to give tenacity to the mass, also a due supply of compost manure. Both sandy and gravelly soils should have frequent returns of grass crops.

Lime.—Lime, commonly called calcareous earth, is never found naturally in a pure state, but in combination with the acids—chiefly with the carbonic, for which it has so strong an affinity that it attracts it from the atmosphere. The burning of limestone is undertaken for no other purpose than to expel by heat this gas, and reduce the base to a caustic powder, in which state it has a strong tendency to absorb first moisture, and then the carbonic acid of which it had been deprived. Lime blends the qualities of clay and sand, occupying a middle place between the two. In its caustic state it is a powerful promoter of putrefaction, or decomposer of animal and vegetable matter, to which circumstance is owing, to a certain extent, its efficacy as a manure. Lime also helps to fix the carbonic acid which is generated by the fermentation of putrescent manures in the soil, or which floats in the air on the surface of the earth, and it freely imparts this gas, in union with water, for the nourishment of plants. Lime is therefore an exceedingly valuable ingredient to the farmer; and, accordingly, wherever agriculture is carried on with spirit, it is eagerly sought after, though it sometimes bears a very high price.

Magnesia.—Magnesia is a primitive earth found in some soils, but in a much smaller proportion than the above three. Its properties are nearly analogous to those of lime, but of doubtful value, and it is certainly injurious when mingled in large quantities with the other earths.

On analyzing the various soils and subsoils, they have been found to resolve themselves into one or more of the foregoing primitive earths; and their barrenness or fertility has in no small degree depended on the mixing and assorting of these ingredients. Some soils are called *loams;* a loam, however, is by no means a distinct body but is a combination of clay, sand, or calcareous matter. Some loams are denominated clayey, from the excess of argillaceous matter; others, open and light, from the preponderance of sand. In fact, these two original ingredients seem capable of being compounded in such an infinite variety of ways, as to give occasion to that diversified texture of soils met with in all countries and all situations.

Besides these four primitive earths, which constitute equally the soil and subsoil, the upper of these, or mould, contains the putrid relics of organized substances that have grown or decayed upon it, or have been conveyed thither in the progress of cultivation. The decomposition of these is the proximate cause of fertility; and the richness of soils bears reference to the relative quantities. The residual earth remaining after the process of dissolution, is extremely light in weight, and always of a blackish colour. It is owing to this that a garden, which has been under long-continued culture, approaches to a black shade, progressively deepening according to the abundance of this matter. In addition, nearly all soils are found to contain certain various chemical compounds, mineral salts, and metallic oxides; some of which are beneficial, others harmless, and a few injurious to vegetation, and which either pre-existed in the strata from which the surface has been formed, or have been carried to it by subterranean springs or by factitious causes.

The nature of soils is sometimes indicated by the kind of vegetables which they appear spontaneously to produce. This, however, is not a safe test of the nature of soils, or rather of what can be produced from them in a state of tillage; for the seeds of weeds which grow upon uncultivated ground may have floated to them from a distance on the winds, and vegetated where they have chanced to fall. All that can usually be expected from this kind of investigation is, whether the field be moist or dry—as, for instance, rushes will invariably indicate superabundant moisture and a necessity for draining. The *quantity* of herbage or plants produced in a state of nature will also serve as a test of the soil and its capacity for production. A surface which exhibits thin scanty herbage is a sure indication of poverty of soil, or a defect of moisture in the climate.

Choice and Size of Farms.

It has been justly observed by an eminent practical agriculturist, that too much can hardly be paid for a good soil, and that even a low rent will not make a bad farm profitable. The labour of cultivating a rich and a poor soil is nearly the same, while the latter requires more manure, and consequently is more expensive than the former, and the returns bear no proportion in value. It is a wise maxim in husbandry, of whatever nature the soil may be, that, like the cattle by which it is cultivated, it should always be kept in good condition, to enable it to do the work it is expected to perform. The ordinary height at which common grain crops can be raised in the British islands is from 600 to 800 feet; but in some situations, from particularly favourable circumstances, tolerable crops of barley and oats may be produced at a height of nearly 900 feet, and even higher. In proportion as the climate is improved by sheltering plantations and drainage, the height at which grain crops may be realized becomes the greater. In general, it is more appropriate to devote high grounds to sheep pasturage than to tillage; and a consideration of this circumstance will guide the selection and rent of land.

In making a choice of land for farming, let it be a rule to prefer a gently sloping surface, or level, to a hilly and irregular surface. The labour of working land of irregular surface is very great, independent of other disadvantages; and if taken, it should be at a proportionably low rental. If possible, select land that lies with an easy slope to the south; though, if well sheltered, the inclination in other directions is of little consequence. If the land require drainage, or be exposed to heavy rains, observe if there be sufficient inclination to carry off the water. If there be no lower point to which the water may be conveniently drawn, avoid the risk of taking the land, for this defect in its character will prove a frequent source of trouble and loss. In the case of dry calcareous soils, and in moderately rainy districts, the inclination of the surface and means of drainage are immaterial.

Land on the banks of a running stream is likely to be more salubrious for crops than that which is near sluggish brooks or dull sedgy lakes. From dull inert waters there arise, in certain conditions of the atmosphere, heavy pernicious vapours, which steal along the surface of the adjacent grounds, and tend to blight and otherwise injure the crops. These waters, also, are a fertile hotbed of insects. Running waters purify the air, and are of great advantage for cattle. See, however, that the land is not liable to be flooded in winter, for a contingency of that nature should cause a diminution in value.

Considerations respecting climate, soil, elevation, &c., are, however, of subordinate consequence in comparison with the very important matter of *distance from markets and roads*. A long carriage to market, particularly if the roads be indifferent, is one of the greatest drawbacks which the agriculturist can possibly encounter. We have a striking example of this in some parts of North America, where the finest lands, such as would bring an annual rent of £5 or £6 per acre in England, are not, for their entire proprietorship, worth as many shillings. Where bad roads interpose, a distance of a few miles is practically as bad as a distance of hundreds, or even thousands, of miles. The means of procuring an abundance of *labour*, at a reasonable rate, also forms an important matter of calculation for all persons before settling on a farm.

Farms vary considerably in size and mode of working. The first class which we may mention are small farms of from six to eight acres, conducted exclusively by the labour of a cottager, or, as he may be called, small farmer, and his family, and who, by dint of great personal exertion, and scarcely any outlay of money capital, fulfils the moderate expectation of realizing a plain livelihood, and, if he be a tenant, paying a rent to a landlord. The second class of farms, are those which are to be wrought on the most extended principles of rural economy, either by a tenant or proprietor, a large capital embarked, the best implements and machinery, hired labour, and the highest professional skill. Farms of this nature, when almost entirely laid out in tillage for grain crops, such as are common in Norfolk, Northumberland, East Lothian, and Berwickshire, range from 300 to 400 acres in extent, and are divided into eight or ten large fields, by carefully arranged thorn or stone fences. Some farms, however, where the soil is light, and cattle and sheep feeding is an object with the farmer, are as large as from 700 to 1000 acres. In those districts where the climate is moist, and attention is directed mainly to dairy husbandry, the farms are of more moderate size, being in general from 60 to 160 acres. Notwithstanding all that has been written on the practice of agriculture, it remains undetermined, by rigid examination of facts, whether small cottage farms, wrought by spade husbandry, or the large farms of capitalists, are most advantageous to the country—that is to say, which class produces the largest quantity of produce at the least expenditure of means, taking those means on both sides at their market value, and which can afford to pay the highest rent. It being, we think, very important that clear notions should prevail on this subject, we shall in the present article notice the routine of procedure on farms of the larger and more common class, and in that which follows proceed to an account of *cottage farming*, concluding with a few general observations on both.

A farm of the larger class, whether conducted by a tenant or a proprietor, may be described as a *factory* of agricultural produce, every part of the proceedings being conducted as in a factory of articles of trade, by ths employment of capital and the division of labour. The master farmer with his apparatus occupies a large establishment, such as we represent in the following cut. Such is the establishment, at least, common in Scotland. The whole, it will be observed, form a quadrangle, with the farmer's residence in front; feeding-houses for calves and cattle on the left; cattle-sheds in the rear, over which is a straw-room connected with the edifices behind for the thrashing-mill, for which steam or horse-power is employed; and on the right, stables, saddle-rooms, &c. In the centre are three fold-yards, open to cattle from the sheds behind, and into which straw may be thrown from the straw-room. The edifices on each side of the farm-

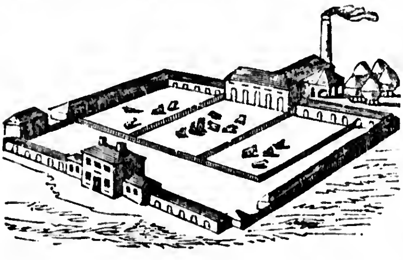


Fig. 1.

house in front are for cart-lodges, boiling food, lodges for unmarried male servants, or other purposes. A granary is supposed to be connected with the thrashing department.

If the farm be rented, it is superintended by the farmer himself, and this is the most common plan; but if kept in the hands of the proprietor, it is generally placed in the charge of a deputy, who is named factor or grieve. The farmer's family interfere very slightly with any of the arrangments. The whole of the labours of the field or in the farm establishment are performed by hired servants; and it is a leading principle in the economy of the farm to keep as few of these as possible.

It is found from experience that farms of this description cannot be conducted properly, for the legitimate advantage of either landlord or tenant, except a lease of considerable duration be granted; for if the tenant be at all times liable to be dispossessed at the mere will of the proprietor, he can have no interest in improving the land, and therefore cannot afford to pay a sum suitable to the actual capabilities of the ground. In all cases, for mutual comfort and pecuniary advantage, there ought to be a properly defined lease or contract for a term of years.

According to the modern practice of agriculture, the profits of a farm are frequently prospective; a number of years must sometimes elapse before the ground repays the farmer for his sunk capital, and his trouble in effecting improvement. The duration of a lease consequently depends on the nature and condition of the soil, as well as some other minor circumstances. It is understood that a long lease is a much greater stimulus to spirited farming than a low rent. If the lease be long, and the rent high, great exertion is used by the farmer; but if the lease be long, and the rent low, a slovenly mode of farming may in general be expected. It appears, from all experience on the subject in Scotland, that a lease should neither be too long nor too short, but of a fair moderate duration, as nineteen or twenty years. In Ireland it is customary to make the length of a lease depend on the contingency of two or three lives, one of which is the life of the landlord. But this is a clumsy and far from beneficial practice as respects the improvement of the land, and is not to be commended.

Furnished with a long lease; a capital of one, two, or three thousand pounds, according to circumstances; the best implements, and active servants, the agriculturist enters on a great undertaking, which demands all his energy and skill. He has to calculate rotations of crops; to procure manure at all hazards, either by purchase or by feeding cattle; if by the latter expedient, he has to attend fairs, to purchase cattle in a lean state, with the hope of selling them after being fatted by winter keep; and to provide for this winter keep, he must necessarily raise a sufficiency of turnips. The keeping up of fences, the attending of markets, and the general contrivance of ways and means, are also among his onerous round of duties. Let us now glance at what must be the nature of his proceedings in the ordinary culture of his possessions.

TILLAGE—FARM UTENSILS.

Tillage comprehends the ploughing, cleaning, and fallowing of the fields, with a view to their proper culture and improvement. The object of ploughing is to delve and turn over the soil in the ridges, to destroy the surface vegetation by burying it underground, where it rots and becomes a kind of manure; to bury the dung spread on the land; to form furrows for different purposes; and, generally speaking, to prepare the land for cropping. In old times ploughs were exceedingly clumsy in construction, and dragged with much difficulty. This great defect was at length removed by the invention of the swing plough, about seventy years since, by James Small, a Scottish ploughwright. Small's plough, which is an elegantly shaped instrument formed on scientific principles, was originally composed of wood and iron, and did not weigh altogether above seventy-six pounds; it was afterwards made of malleable iron, and of a light appearance; but latterly the practice of making it of wood and iron has again become pretty general. The chief merit of this plough consists in the fore part being formed in such a slender and tapering wedge-like manner, as to cut the land with the least possible resistance. The mould-board for turning over the furrow is beautifully curved from the point of the sock to the heel of the wrest, so that it turns over the mould with a small degree of friction and in the best manner.

A sketch is here presented, fig. 2, of the profile or side appearance of this valuable instrument. The degree

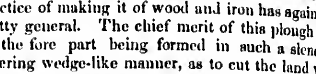


Fig. 2.

of bend in the mould-board is observed in Fig. 3, which represents the lower part or sole turned up to view. Small's plough, under different modifications, is adapted

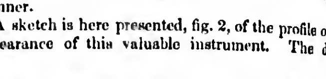


Fig 3.

for every species of tillage which the plough is required to perform. In its own proper form it is particularly well suited for light soils, and proceeds actively through the ground, cutting to a depth of from seven to nine inches; but it may be made to go much deeper, if additional power be attached to it. In Scotland, and other countries in which it has come into use, it is almost invariably drawn by two horses, yoked abreast, and is guided and tended only by the ploughman, the reins coming to each handle of the plough. Considerable skill is required to steady and guide this sharp instrument as it advances through the ground; but this is a point on which properly-bred ploughmen pride themselves, and does not form the subject of complaint.

Small's plough may be said to be the parent of all those modern improved ploughs which are strictly adapted to peculiar kinds of work. In its ordinary form it is not very well suited for ploughing up moor or heathy land from a state of nature, as the heath and other tough vegetable matter is liable to collect upon the coulter, and so choke and retard the instrument. To remedy this deficiency, Mr. Finlayson, an Ayrshire farmer, about twenty years ago contrived an instrument called the rid plough, a representation of which is given in Fig. 4. In

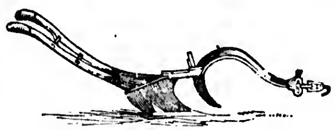


Fig. 4.

this plough the beam is curved so as to terminate in the coulter; and when the heathy matter collects, it is pushed up as the plough advances, and falls off, so as to rid or clear itself of all kinds of loose fibrous rubbish. The sock and mould-board are also so contrived as to cut and lay over the slice, without the power of its springing back to its old position.

There are various kinds of ploughs with one or two wheels, and adapted to particular purposes, but chiefly designed to suit an unskilful class of ploughmen. Wherever agriculture is in a backward condition, there are wheel-ploughs in use.

With Small's or Finlayson's plough, a skilful ploughman and a couple of active horses will make excellent work. The following are among Mr. Finlayson's directions to ploughmen :—"Nothing can be more beautiful than a field commodiously laid off, and neatly ploughed. There is even none of man's handiworks that can please the eye more, and at the same time show more of its unrivalled accuracy, than a lawn which presents ridges of the same width, with furrow-slices running in straight equidistant lines; and that, too, with such minute exactness as scarcely to be equalled by the gardener.

"It is not the man who makes the greatest ado with the horses who opens his ridges best, but more commonly he who goes steadily and directly forward himself, and keeps such a command, by the reins, as to prevent them from deviating far from the right path, yet without laying *too much stress to their precision*, or checking them suddenly from one side to the other; and he who can take a straight furrow at first, and continue so to the last, even on a ridge of fifteen feet, will finish with one, two, or three bouts less than one who is all along undoing, and overdoing, and that, too, independently of the ease to himself and his team, and the preference of the work in every respect.

"If broadcast ridges are of unequal breadth, bent, or zig-zag, the work cannot be so uniform, and in the turnings much time is lost, and harm done to the land which is ploughed, and with crooked drills there is a loss of ground, an unequal distribution of manure, if such has been applied, and the hoeings cannot be so effectually done where they are far distant, or done at all, without soddening the mould, and injuring the crop, where they are narrower.

"In fine, the grand criterion of ease and proficiency is that of the ploughman's walking between the stilts, and in the furrow, with a free step and erect body, for thus he is more convenient for himself, has the horses and the plough better at command, and increases not the friction by his weight; for thus *he cannot go*, excepting the horses and the plough are properly adjusted, and proceeding with the least possible obstruction, and thus, too, he is more graceful to look on, than when wriggling with one foot foremost, or moving as if part of his muscles were under the domination of violent spasmodic contraction.

"It would perhaps be impossible to give any thing like *a system of rules* for the most proper and convenient make, size, weight, turn, &c., of a plough for all the varieties of soil, or of diversity to be met with, even in the same ridge; neither shall I make the attempt; but a few rules may be laid down, and observed as axioms in all ordinary circumstances, viz:—

"1. The horses should be yoked as near to the plough as possible, without too much confining, or preventing them from taking a free step.

"2. When at work, they should be kept going at a good pace.

"3. The chains or theets should, from where they are suspended over the backs of the horses, point in a direction leading through the muzzle to the centre of the cutting surfaces of the coulter and share.

"4. The implement, when taking the form of the dimensions required, should stand upright, and glide onwards in the line of progression, without swerving in any particular way.

"5. The ploughman should walk with his body upright, and without using his force to one point, or showing appearance of inclination.

"The untamed and liveliest, or most forward horse, should be put in the furrow, and only bound back to the right or off theet of the land-horse, at or near the place where the backband joins it, at such length, when stretched at the width required, as to prevent his end of the beam, or double tree, from being before the other. And further, the heads of the two should be connected together by a small rope or chain, at the distance wanted, giving the furrow-horse power over the other, that is to say, if tender-mouthed, it must be fixed well up on his head, and in the rings of the bit or curb of the other, so that he may have the power of the head over that of the mouth of the land-horse."

Let the draught of the horses go in a direct line to the plough or swingle-trees; for if the line be in any way bent, a portion of the power will be lost. Sometimes in England as many as five horses are yoked to a plough, two and two, with one in front; and in most cases of this kind, the power of the foremost horses is partially thrown away, or probably distresses the hind pair of animals. It is not convenient to yoke four or five horses abreast, but it should be fully understood that in that manner they would exert their power to most advantage. Two horses will, in general, do more work yoked abreast to a plough, than four yoked before each other in single file; because some of the power of the foremost horses is always lost in its passage along the sides of the hind horses, and, in turning, the whole draught is imposed upon the hindmost in the row. Wherever the practice of yoking four horses in single file prevails, we recommend it to be discontinued as a waste of animal power, and in its stead to try the more efficacious plan of working the plough by only two horses abreast. Unless on very strong soils, or where a great depth is required, two horses with a well-made plough will be found amply sufficient. Where four horses must be employed, yoke them two and two abreast, and let the draught of the foremost pair proceed by a chain from their centre swingle-tree to the centre swingle-tree of the hindmost pair, thus passing between the hindmost and going in a direct line to the muzzle of the plough. By this means, the power of both pairs of horses goes unimpaired to the resisting object. Never, on any account, let the power of the foremost pair proceed by two chains along the sides of the hind horses to the outer ends of their swingle-trees, for this would only cause a needless expenditure of draught. In Scotland, where the economizing of animal power has been carefully studied, all ploughing whatsoever, be the land light or heavy, except when exerted on the subsoil, is performed with but two horses, and these invariably yoked abreast.

It is a well-known maxim in tillage, that clay or tenacious soils should never be ploughed when either too wet or too dry. When too wet, they are tough, and the clods difficult to break, and when too dry, the plough will scarcely penetrate the soil. In ploughing the first time for fallow or green crops, it is of importance to begin immediately after harvest, or as soon after wheat-sowing as possible, in order that strong tenacious soils may have the full benefit of the frost. On wet stiff soils frost acts as a most powerful agent in pulverizing the earth. It expands the moisture, which, requiring more space, puts the particles of earth out of their place, and renders the soil loose and friable. On such soils there is no rule of husbandry more essential than to open them as early as possible before the winter frosts set in. If left till spring, clay soils may be too wet for ploughing, or, if the season be dry, the earth, when turned up, will be in hard clods, very unfit for vegetation. Therefore, on farms having a proportion of clay and of light soils, it is necessary that the strong wet land should be ploughed first, providing the weather will allow.

Subsoil-ploughing is a new feature in husbandry. The object of it is to trench or loosen the soil beneath the ordinary ploughed surface, so as to allow of its gradual assimilation with the mould above, into which it may afterwards be brought. The process of subsoil-ploughing is effected by a powerful instrument, constructed according to the design of Mr. Smith of Deanston. As subsoil-ploughing, however, is intimately connected with the methods for improving waste land, we postpone any account of it till the article which follows the present on that subject. For an account of the proper steps to be taken to drain the land, if in a moist condition, we also refer to the same article.

The Harrow.—The plough leaves the land cut in longitudinal slices, and is therefore less intended to pulverize the soil than to turn up a fresh surface to the atmosphere. Another kind of instrument is required to break the upturned sward, reduce it to powder, and also to clear it of weeds or other foul substances. The harrow is the implement chiefly employed for this purpose, as well as for covering the seed. According to the diversity of soils, and the particular use to which the harrow is to be applied, its form undergoes considerable changes.

The harrow is a frame of wood, consisting of at least four bars lengthwise and crosswise, with iron teeth set on one side. Usually a pair of harrows is yoked and drawn together, as represented in fig. 5. The figure represents the most perfect implement of the kind, or such as is generally used in Berwickshire and the Lothians. The teeth are set only on the long bars; and the harrows are drawn at such an angle as to preserve the tracks of the teeth in separate lines, and at regular distances from each other. Strong heavy lands require heavier harrows than those of a light nature. In some cases the teeth of the harrow are of different lengths, those forming the front row being half an inch longer than the second, the second a little longer than the third, and so on diminishing backwards. In drilling crops, an implement called the drill-harrow is employed. A light single harrow is in most instances sufficient for drilling or harrowing over the young wheat in spring.

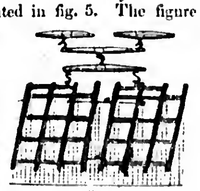


Fig. 5.

When the land is very foul, and calculated to choke the teeth of the harrow, a powerful instrument is now used, called Finlayson's patent harrow, or self-cleaning cultivator. It runs upon three wheels, one in front and two behind. The teeth are curved in such a manner as to bring up and disengage the couch or other weedy matter, the implement thus clearing itself as it advances. By means of a lever above, affecting the frame, the teeth can be depressed or raised, so as to work to any required depth.

The Grubber, &c.—In certain conditions of the ground, a harrow is incompetent to cut up and clear it of its under-surface weedy matter. In such cases, grubbers, eradicators, or scufflers, are used, according as circumstances require. The common Scotch grubber resembles a strong harrow frame, running upon four wheels, and guided like a plough. On the lower side of the frame are placed eleven long prongs, each of which terminates in a triangular sharp foot. On being dragged forward, the prongs scuttle the ground to a depth as great as that of the plough, effectually cutting the roots of weeds, and bringing all loose matter to the surface. The grubber, or scarifier, may be used to advantage in the following cases:—" 1. Barley and turnip land, after being once ploughed, may be made both clean and fine by its means, and the harrowings and subsequent ploughings are thereby rendered unnecessary. 2. Where lands have been ploughed in autumn, the objection to the sowing of spring crops on the winter furrow may be obviated by the use of the scarifier, as not only barley, but oats (if not grain after grass), beans, peas, and tares, may be sown without an additional ploughing. 3. Summer fallows may likewise be advantageously carried on with fewer ploughings, earlier in the season, and at less expense. 4. It may be effectually employed to forward operations in the preparation of land for potatoes or turnips, and afterwards for raising the potato crop; and, 5. Its utility in mixing lime or compost with the soil is of the highest importance, as it not only incorporates these manures more effectually than the plough, but never places them beyond the proper depth. Hence the scarifier or grubber is considered to be one of the greatest improvements in the culture of the soil that modern times can boast of."—(*Code of Agriculture.*)

Sowing Implements.—There are various machines for sowing grain, seed for turnips, &c., in drills, or rows, in the hollow of furrows, or ridges, or on a flat surface, as may be required. For sowing turnip-seed, a barrow on wheels, and pushed along by the hands, is generally used. For sowing grain, one of the best implements in use is

Morton's improved Grain Drill-Machine.—This machine, as represented in fig. 6, consists of a box or hopper supported on a frame with wheels, and is drawn by one horse, and guided behind by one man. The seed escapes from three conductors, the lower points of which act as coulters on the soil, making drills for the seed. In the inside of the box is an axle with projecting teeth, kept in motion by the axle of the machine, and preventing the seed from getting clogged. The seed passes into the conductors through holes, which can be made of any size by means of a sliding-board. The width of the coulters admits of being regulated by means of a screw and other apparatus; and five coulters may be used if necessary. A rod projects from the handle half

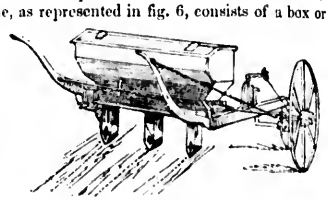


Fig. 6.

the breadth of the machine (not shown in the cut), to mark the ground, and by this mark the next advance of the machine is regulated.

There are other drill-sowing machines of greater breadth and size, likewise machines for dibbling beans; but they require no particular description. The rollers of wood or stone, employed to roll or press down the land which has been lately sown, are so common, that it will also be unnecessary to describe them.

Hoeing Implements.—The light implement called the hand-hoe is of use in cleaning turnips and other plants, but is altogether unsuitable for stirring the soil between the rows of extensive crops of turnips, potatoes, beans, &c. This heavy duty requires to be performed by animal labour by means of the horse-hoe. One of the best instruments of this kind is

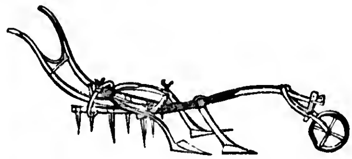


Fig. 7.

Wilkie's Horse-Hoe and Drill-Harrow.—This implement, a sketch of which is here presented (fig. 7), is guided and drawn like a plough. As soon as the infant plants appear above the surface, it is drawn betwixt the rows, thoroughly scuffling or cleaning the land from its numerous weeds. The depth to which its prongs and feathered feet go in the soil, is regulated by elevating or depressing the wheel in front. It likewise answers as a rake, by dragging along with it the heaps of destroyed weeds. Some horse-hoes are fitted with a movable mould-board at each side, by which the earth is heaped up on rows of plants; this is also done by a variety of the plough.

Weeding.

All lands are less or more infested with weeds, which are of no value either for ornament or use; on the contrary, they injure the crops by extracting the nourishment from the ground, and greatly impede cultivation by spreading their entangled roots beneath the surface. The manure deposited on the soil is destined exclusively for the support of what is meant to be raised, and every useless plant, therefore, which lives upon it, is so far noxious, and ought to be extirpated. Hence the common maxim, "A farmer should let nothing grow but his crops."

As prevention is always better than cure, the farmer should begin by preventing the growth of weeds. The seeds from which weeds spring are brought in some manner to the land from somewhere. Try to cut off this vicious produce at its source. Let all *bawks* or natural embankments forming boundaries to fields, be cleared of every species of weeds, such as thistles, docks, ragweed, rank grasses, &c., and let all road-sides near the fields be similarly cleared of their gay but unprofitable vegetation. If this were done generally over the country, a fertile source of foulness in land would be in a great measure destroyed. It is also desirable to sow clean seed for grain or other crops, and to use, if possible, those manures only which are free of the seeds of noxious vegetables.

Notwithstanding all ordinary precautions, lands, it is acknowledged, will develop a crop of weeds, because some seeds will lie uninjured for centuries in the soil, and the winds will waft others from great distances; such, in fact, is one of nature's provisions for covering the earth with vegetation. It has been ascertained that upwards of fifty different weeds infest arable lands, some of which are annuals, others biennials, but the principal part perennials, whose seeds will lie for a long period in the soil. The more common of these various weeds are the wild oat, the common thistle, dock, coltsfoot, ragweed, dent-de-leon, and chorlock or wild mustard, the latter particularly. To these is to be added that most tormenting weed, cough-grass or rack, which spreads its long cord-like roots beneath the surface, weaving the soil into a kind of matting. Annuals and biennials may be partially extirpated by a well-wrought summer fallow, or, if the soil be light, by the culture of potatoes or turnips, for the land in that case is well cleaned and dressed in spring, as well as hoed in summer. Hand-hoeing for this purpose is sometimes necessary. If, however, no ordinary process of teasing and cleaning the land extirpate the weeds, the more tedious and expensive operation of pulling must be resorted to. This will be absolutely necessary for the extirpation of chorlock, that flowering yellow weed which tinges the fields with its brilliant lustre in summer. When the crop is about a foot high, women or children should be employed in going carefully over the field, trampling down as little as possible, and pulling and carrying away in their aprons every stalk of the chorlock. The same thing may be done with the tall seeding-grass called the wild oat.

This process of weeding may be expensive, but it generally cleans the land, and repays itself by the increase of grain crop. According to experiments adduced by Sir John Sinclair, the increase of a wheat crop on a weeded over an unweeded land, was four and a half bushels per acre, and of other crops much more. "A six-acre field was sown with barley, in fine tilth, and well manured. The weeding, owing to a great abundance of chorlock, cost twelve shillings per acre. The produce of an unweeded acre was only thirteen bushels; of the weeded, twenty-eight bushels; difference in favour of weeding, fifteen bushels per acre, besides the land being so much cleaner for succeeding crops." With regard to oats:—"Six acres were sown with oats; one acre ploughed but once, and unmanured, produced only seventeen bushels. Other six acres, ploughed three times, manured and weeded, produced thirty-seven bushels. Ten bushels may be fairly attributed to the weeding, and the other ten to the manure." It is justly observed by the same authority, that however anxious farmers may be to have their lands *tithe-free*, it is of still greater importance to have them *weed-free*. There is much truth in the observation; for the agriculturist who suffers his lands to bear crops of weeds, pays dearly for his neglect in his diminished produce, and has the additional guilt of injuring his neighbours.

Dry and gravelly plains and hill-sides are frequently overrun with ferns, which occupy the space that ought either to be covered with good pasture or laid under the plough. The fern is so tenacious of life, and so firmly are its roots fixed in the soil, that repeated cutting, or the ordinary course of tillage, is unable to extirpate them. It has been mentioned as a good plan for eradicating ferns, that the land in which they grow should be partially flooded, or at least well moistened, by leading small surface water-channels across it.

Fallowing.

Fallowing signifies leaving the land for a certain time in a bare unproductive condition, during which it receives a rest from the labour of cropping, and is subjected to various processes of ploughing and harrowing, to pulverize the soil and destroy its noxious weeds. The value of fallowing for these purposes is a subject of considerable controversy; some ascribing to it numerous virtues, and others altogether condemning it, where green crops and good husbandry prevail. The truth seems to be, that fallowing is extremely useful for the purpose of working, pulverizing, cleaning, and otherwise improving, lands of a poor quality, after their first subjection to tillage; and that there its value rests.

The operations necessary for a well-wrought naked summer fallow commence after harvest. The first winter fallow ploughing is begun as soon as the hurry of harvest and wheat-sowing is over. If deferred till an advanced period of the season, and the weather sets in wet, the land becomes unfit for the operation. To prevent the bad consequences of too much rain at this period, that manner of ploughing and laying the ridges should be adopted which will best keep the land dry during the winter months, this being a most essential point. Strong retentive soils to which a summer fallow is more particularly applicable, should get an end-long ploughing, so deep as completely to turn up the soil from where it mingles with the subsoil or till.

When thoroughly pulverized, and freed from roots and weeds by the process just described, the fallow is ploughed end-long into gathered ridges, which are usually from fifteen to twenty feet broad. When the land is gathered into a furrow as deep as the soil will permit, the manure may be laid on. This is a very critical period; for if the weather becomes wet, the carting of the manure on fallow land of retentive wheat soils, is apt to poach and puddle it very much, by the pressure of the horses' feet and wheels of the carts. To prevent this as much as possible, the manure should be carried to the ground in single horse carts, with broad wheels, as they are less apt to poach the land than others. The manure is carted along the crown of the ridges, and is thrown out into heaps, of a size and at distances proportioned to the quantity intended to be applied; experienced workmen can generally measure both ground and manure accurately with the eye. People are now employed spreading the manure, and the plough immediately follows, in order that the dung may lie exposed as short a time as possible. The dung being covered, and the ridges raised, so as to admit the rain to run freely into the furrows, the land should remain untouched for a few weeks, that the manure may become decomposed. The period of decomposition is shortened, if the dung has been previously fermented.

The land may now be considered as ready to receive the seed furrow, which is generally given to it previous to the sowing. The ridge is again gathered; but as this ploughing is very slight, it does not raise the ridge much higher. Lime is frequently applied to fallow as well as dung, sometimes before the dung is laid, and sometimes after. In the first case, the lime is laid on just before the land is formed into ridges, and, if possible, a calm dry day should be selected for the purpose. After the lime is laid, the land should be immediately harrowed, to incorporate it with the soil. The second method is to lay the lime on just before the seed furrow is made; and if the ground be dry and the dung decomposed, this method will be found good.

The system we have described is referable to the heavier soils; when those of a lighter nature are to be fallowed, the cleaning process is not so difficult, and there is not the same risk from wet weather. If summer fallowing be judiciously conducted in the manner described, strong soils may carry repeated alternate crops of grain and pulse, without any intervening naked fallow, for perhaps six or eight years. But to preserve the beneficial effects of fallow on ordinary farm land, which is manured alone from its own produce, it is certainly the best and most economical plan to lay it down to grass with the crop immediately succeeding the fallow. Afterwards, successive crops of grain and pulse may be taken as its condition will allow, when broken up from lea previous to next fallow. Sir John Sinclair says: "It may be foretold of every farmer on a strong soil, in such a climate as Scotland, that his affluence and prosperity will always be in proportion to the excellent state of his fallows, every thing else being equally well conducted." Indeed, if fallowing is negligently or imperfectly performed, no land, however cheaply rented, can yield much profit to the farmer.

Farm Carts and Implements.

Two kinds of machines are in use for conveying produce to market and other purposes in husbandry—wagons and carts, and of these there are several varieties. Wagons with four wheels, and drawn by two or more horses, are acknowledged to be best adapted for conveying great loads to a great distance, and that is their principal merit. For all ordinary purposes connected with husbandry, the one horse cart with two wheels is preferable.

The Scotch cart, as it is called, is a most convenient and useful machine; and to add to its uses it may be rendered serviceable for carting hay or straw by placing a movable frame on its sides, as it is represented in figure 8.

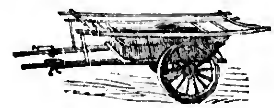


Figure 8.

The Scotch cart (without the frame) is suited for conveying any kind of material, dung, turnips, grain in sacks, &c., and usually carries from eighteen to twenty-two hundredweight, when drawn by only one horse; with a horse in trace, the weight may be augmented. In Scotland, all grain for market is carried in these one-horse carts, and to any distance. On such occasions one driver takes charge of two carts.

The following advantages of one-horse carts are enumerated in Loudon's Encyclopædia of Agriculture, the passage being apparently copied from a paper in the Annals of Agriculture, by Lord R. Seymour. "A horse, when he acts singly, will do half as much more work as when he acts in conjunction with another; that is to say, that two horses will, separately, do as much work as three conjunctively: this arises, in the first place, from the single horse being so near the load he draws; and, in the next place, from the point or line of draught being so much below his breast, it being usual to make the wheels of single-horse carts low. A horse harnessed singly has nothing but his load to contend with; whereas, when he draws in conjunction with another, he is generally embarrassed by some difference of rate, the horse behind or before him moving quicker or slower than himself; he is likewise frequently inconvenienced by the greater or less height of his neighbour: these considerations give a decided advantage to the single-horse cart. The very great ease with which a low cart is filled may be added; as a man may load it, with the help of a long-handled shovel or fork, by means of his hands only; whereas, in order to fill a higher cart, not only the man's back, but his arms and whole person, must be exerted." To these just observations it need only be added, that in many parts of England there is a wasteful expenditure in horse power, a couple of horses being often set to draw a clumsy wagon to market, containing a load which could with the greatest ease be drawn by one horse in a machine of less ponderous dimensions.

Every well-conducted farm establishment is now, or ought to be, provided with a variety of small but useful machines—for slicing turnips or potatoes, chopping hay or peas straw, bruising beans, peas, or oats, weighing-machine, &c., all which, of the newest construction, are to be seen at the establishments of agricultural implement makers. Utensils for cooking food for cattle, dairy utensils, and tools for manual labour, need not here be particularized.

There are now agricultural implement makers in cal towns both in England and Scotland; for a list of the newest implements and their prices, at some of these establishments, we refer to Jackson's Treatise on Agriculture, published in connection with Chambers's People's Editions.

MANURES.

By repeated cropping, the best soils become exhausted of their fertile properties, while naturally indifferent soils require the administration of certain qualities, before they will yield a due return to the labours of the husbandman. There are, no doubt, soils so naturally rich in some parts of the world, that, though used for twenty or more years in growing successive grain crops, they show no indications of impoverishment; yet even these must in time be exhausted, and therefore, in all circumstances, manures, or artificial fertilizers, require the consideration of the husbandman. In our own country they are of the first importance.

Manures are of two classes, both of which have distinctive characters, and perform different offices in the economy of vegetation. The first of these comprehends all animal and vegetable decomposing matter, and is principally employed in feeding the plant, augmenting its size, and sustaining the vital energy. The second operates more on the soil and decomposing matter than in directly contributing to the support of the vegetable. The first kind has been called animal and vegetable, and the second fossil, manures. Under this second class are ranked not only lime, marl, and gypsum, but sand, gravel, and clay, so that all the meliorations which are effected on soil by blending and compounding the original earths, are compressed within its limits.

The animal and vegetable manures, which are putrescent in their nature, are foremost in importance and dignity. They consist of certain elementary parts of animal and vegetable substances, elaborated by a natural chemical process in the course of the decomposition or decay of the bodies. The excrementitious matter, or dung of all animals, is no other than the remains of the vegetable or animal food which has been received into the stomach, undergone there a partial dissolution, and been thrown out as unserviceable for the further nutrition of the system. From this universal decay of organized matter, and its conversion into fluids and gases, it would seem that animal and vegetable substances, and excrementitious matter, are resolvable into each other, and are only different parts of the same original principles. The essential elements of them all are hydrogen, carbon, and oxygen, either alone, or in some cases united with nitrogen. Conveyed by liquids or moist substances into the ground, these elements are sought for as nourishment by the roots of plants, and so form the constituent principles of a new vegetation. Inasmuch as flesh consists of a greater concentration of these original elements than vegetables, the manure produced by carnivorous animals (man included) is always more strong in proportion to its bulk than that discharged by animals who live only on herbage. Experience fully proves that all animal and vegetable manures are but varieties of one kind of principles; their actual shape and appearance being of much less consequence than the degrees of strength in which these principles reside in them.

Whatever be the value of the elementary principles of manures, practically they are of no use as manure till they are disengaged by putrefaction. It may be further observed, that putrefaction is in every instance produced by the elementary principles being set at liberty either in a fluid or volatile state. If a quantity of stable dung be piled into a heap, and freely exposed to all varieties of weather, it soon heats and emits a stream of vapour, which is often visible as a cloud over it. These vapours, and also the odours sent forth, are gases escaping, and the heap is constantly diminishing in weight and volume; at the end of six months, if there have been alternate moisture and warmth, not above a fourth of the original essential material remains to be spread on the field; there may be in appearance nearly as much substance, but it is comparatively of little value—the real manure is gone, and what remains is little better than a mass of unputrefied rubbish.

It may be safely averred, that no principle connected with agriculture is so little understood or thought of as that which has been now mentioned. We therefore crave the most earnest attention to it by every reader of these pages. Generally speaking, the excrementitious matters thrown to the dung-hill are treated with perfect indifference as to the effects of exposure and drainage away in the form of liquids. It cannot be too strongly stated that this is a gross abuse in farming. The putrescent stream contains the very essence of the manure, and should either be scrupulously confined within the limits of the dung-hill, or conveyed to fresh vegetable or earthy matter, that it may impart its nutritive qualities.

A knowledge of this important truth has led to the practice of making compost dung-heaps, in which the valuable liquids and gases of different kinds of manure are absorbed by earth, or some other substance, and the whole brought into the condition of an active manure for the fields. Hitherto, it has been customary to speak of dung-hills, but there ought to be no such objects. The collection of manure from a farm-yard and offices should form a dung-*pit*, not a dung-*hill*; and the manner of making and managing the contents of this pit on the best principles is well worthy of our consideration.

Farm-yard Manure.—The situation of the dung-pit should be near the stables and cow-houses, and placed so low that all streams of urine from them should flow at once into it, so that nothing be lost. It may be three or four feet deep, and of a size proportionate to the stock of cattle usually kept by the farmer. It is not necessary that it should be built round with a wall, or have a perpendicular descent, as it may slope gently inwards, and deepen gradually towards the centre. It should, if possible, be covered by a roof, to prevent the action of the sun. If the bottom be found firm, impervious, and capable of containing the juices, no further trouble is requisite, and the work is complete; in many instances, however, it will be necessary first to puddle with clay, and then line the bottom with flag-stones. Into this pit, earth, with refuse straw, should be brought, and strewed over the bottom and sloping sides, to the thickness of from nine to twelve inches, and this will form an inferior layer to absorb all that portion of the liquid manure which naturally runs to the bottom. The pit is now prepared to receive all kinds of animal and vegetable manure, which, when brought, should be always laid evenly over the surface. In Scotland, such dung-pits are common, and in the course of accumulation, a young or wintering stock of cattle is allowed to go at large upon the whole; the animals being at the same time fed on a proper allowance of straw. Care is also taken to mix, in laying on, the dung brought from the cow-house, stable, and piggeries, so that the rich excrement of the well-fed animals may be incorporated with that of a poor description from others. It is likewise of the utmost importance, though too frequently neglected, to convey to the pit the entire liquid refuse of the farm-yard, provided the quantity be not so great as to make it advisable to have a separate pit for its reception.

It is customary to cart away the material of the dung-pit at convenient opportunities (usually during the frosts in winter), to a place in the fields, near where it is to be used, and there pile it up in a quadrangular heap of about four feet in height. Dung, carted out in this manner, is ready for the turnip husbandry in June, and the practice is otherwise convenient. It may, however, be stated, that for want of attention to principles already explained, such dung-heaps, by exposure for months to the weather, must lose some of their valuable properties. In every instance, the dung-heap in the fields should be placed in a hollow situation, with a substratum of earth, and should have a scattering of a few inches of earth over it, and around the sides, to keep in the volatile gases. When the dung-pit has been thus emptied, it may again be progressively filled as before; and when it is carted out in any of the spring months, it will be found necessary to turn it once, or oftener, for the purpose of accelerating the decomposition of the strawy part of the mass. It may be of use to know, however, that the dung required for fallows for wheat in autumn, may be less putrefied than that for turnip crops.

Liquid Manure, Bone-Dust, &c.—The urine of cattle is of great value as a manure, and this is so well known to the farmers of Belgium, that they use tanks for collecting the liquid from the cow-houses, and thence they pump it up, and pour it over the land at the proper season. When mixed with vegetable refuse, moss, or earth, it forms an excellent compost. It is deeply to be regretted that so little is known on this subject; and such is the carelessness of farmers and cottagers, that the urine from the cattle stalls is in most cases suffered to go completely to waste. The value of night-soil and human urine as manures is equally great, but both are much neglected in British agriculture. Without entering minutely into details on this point, it may be stated, that the offensive odour of all excrementitious matter may be neutralized by an intermixture of gypsum, or lime and earth, and in this state be used as most valuable manure. Bone-dust is now used as a highly nutritious manure on light soils; and it is reckoned that 100 bushels are equal to 40 cart-loads of farm-yard manure. Common sea-salt, when judiciously administered in moderate quantities on arable land at the time of fallowing, has been found of great value for its manuring and cleaning properties. It promotes fertility, is a remedy against smut and rust, preserves the seed from vermin, and is particularly useful in increasing the produce of grass lands.

Guano.—The sterile soils of South America are manured with a substance called guano, consisting of urate of ammonia and other ammoniacal salts, by the use of which a luxuriant vegetation and the richest crops are obtained. Guano is the excrement of sea-fowl, accumulated for centuries on the ground; being collected by the natives, it is now imported into Britain by merchants for the use of agriculturists. The increase of crops obtained by its application to land is said to be very remarkable. According to one authority, the crop of potatoes is increased forty times by it, and maize thirty times. This may be an exaggeration; but it is certain that guano contains ammoniacal salts in abundance, and other inorganic constituents which are indispensable for the development of plants. Like bone-dust, it is now sold by merchants in sea-port towns.

Lime.—Dry lime from the kiln is a powerfully exciting agent in agriculture. It possesses the power of decomposing animal and vegetable matter, and enters as an element into the fabric of plants; in certain cases it only alters the constitution of the soil. The great use of lime is to prepare newly broken-up land for successful cultivation. If moorish or waste soil is much infested with the tenacious roots of rushes, heaths, and other weeds which resist the mechanical action of the harrow, and yield slowly to putrefaction, the best mode is to till the ground, and allow it to lie in this state for twelve or eighteen months, or even two years, before applying the lime. It is then generally applied in autumn, and tilled in as soon as possible; but if not immediately tilled in, the soil with the lime on it should be harrowed, so that its decomposing effects may act as powerfully as possible upon the vegetable matter. After these operations, the land is sown two successive years with oats, without any fallowing but that described, and along with the second crop of oats some tenants sow it out in grass seeds for pasture. Others, after the first or second crop of oats, give the land a summer fallow for one season, or a green crop with manure. On the following season, another crop of oats is taken, along with which grass seeds are sown, and in this state is committed to pasture. In some cases, after tillage, the soil is allowed to lie for one, two, or more years, according to its nature, after which it is reduced to a complete state of pulverization by a well-wrought naked summer fallow. On the spring following it is limed, and the lime is well harrowed in along with grass seeds alone; and in the following season the land is committed to pasture. This, however, is a very expensive mode, and cannot be recommended to tenants whose lease is of a moderate length. It is decidedly the most enriching mode of laying down waste land with lime only for pasturage, as the energy which the lime communicated to the soil is not exhausted by grain crops.—(See article Improvement of Waste Lands.)

CROPPING.

Difference of crops successively on the same piece of land is essentially necessary in a right system of husbandry. Crops of the same kind have an exhausting effect, and experience proves that there must be a regular round or rotation, involving in particular a change from grain to green crops. A material use of green crops occasionally, is to weed and clean the land, for the land being in open furrows, may be trenched or hoed in such a way as to extirpate the weeds that spring up. Some lands become so foul, from negligent farming, that the only method of cleaning them is by putting them through a course of potato and turnip cropping.

Rotation on Clay Soils.—Clay soils are of various depths and fertility; and, like all others, differ materially according to the climate in which they are situated. All other circumstances being favourable, good clay soils are particularly adapted for the production of wheat and beans, and may be continued under these crops alternately, as long as the land can be kept free from weeds by drilling the bean crops. This is the most profitable course of cropping that can be followed, providing a sufficiency of manure be procured, and the drilled beans be alternately horse and hand hoed. The nature of the soil or other circumstances may render a crop of clover or rye-grass necessary occasionally for one year, and this can be succeeded by oats. This course may continue for six or eight years, or even longer, and will run thus:—1. Fallow; 2. Wheat; 3. Clover and rye-grass; 4. Oats; 5. Drilled beans; 6. Wheat. In this rotation, to procure full fertility and luxuriant crops, the soil ought to be recruited with manure every third or fourth year, the dung being first applied in the fallow year, and next to the bean crop. Whenever the soil gets foul with root weeds, which it will sooner or later do, another naked summer fallow must in most cases be resorted to, in order to extirpate the weeds; and this begins a new rotation.

Where circumstances are not favourable to the above rotation, the following may be advantageously substituted. It contains a variety of the crops usually cultivated, and by dividing the labour more equally throughout the year, may be carried on with a smaller number of horses, and consequently at less expense; 1. Fallow; 2. Wheat; 3. Drilled beans; 4. Barley; 5. Clover and rye-grass; 6. Oats; 7. Drilled beans; 8. Wheat; after which a new fallow begins a new rotation. In this rotation it is absolutely necessary that the land should have dung twice or thrice if possible, to ensure abundant crops throughout the course; and the proper periods of its application are—on the fallow before the first crop of wheat, on the clover stubble in the fifth year, and to the drilled beans the seventh year.

A favourite rotation on the strong lands of Essex is—1. Summer fallow, limed; 2. Barley; 3. Clover, first fed and afterwards kept for seed; 4. Wheat; 5. Beans, dunged; 6. Wheat; 7, Oats. It is a rule in Essex never to put in wheat in a fallow. Although two successive crops of white corn are justly objected to, on the best principles of cultivation, yet upon land of this nature both wheat and oats are frequently taken either before or after each other, without doing material injury to the soil. On the strong soils in the neighbourhood of Edinburgh, clover is found not to succeed when sown along with wheat, on which account barley is taken after wheat, and the grass sown along with it succeeds well. In the colder parts of Scotland, beans will not ripen in some seasons, and in these districts the clay soils are uniformly thin and sterile. On such soils and situations, the following rotation may be found to answer:—1. Fallow, with dung; 2. Barley, beans, or oats; 3. Clover, cut in the first year, and depastured for two or three years; 4. Oats; and a new rotation begins. By this method, the rotation is kept up for six or seven years, a period quite long enough, as the pasture on these cold and meagre soils, after the second or third year, will be found of little value; and after this, the soil will rather fall back than improve in fertility. But, as already mentioned, from the practice of furrow-draining, to which, even in exposed situations, these soils are subjected, a fallow crop of turnips is now superseding the naked summer fallow, which is of great advantage, as dairy farming is the principal object in these secluded districts.

In the south of England, the farmers consider that a clover ley is the best preparation for a crop of wheat; while in the north of England, and in Scotland, clover is more commonly sown with wheat or barley, and followed by oats, both because the oats are almost invariably found to produce a large return after clover, and from the wheat being better placed in the succession immediately after the fallow.

Rotation on Loams.—Every soil intermediate between absolute clay and sharp sand, has received the name of *loam*. Clayey loam, and loamy soils, in the rotation of crops, may be ranked as clay soils, and cropped exactly in the manner already explained, even though they should approach to the nature of light lands, from which they only differ in degrees of quality. Rich loam is the most profitable and the most agreeable to cultivate of any description of soil, as it almost uniformly produces abundant crops of all kinds, and affords excellent pasture. The mode of its management depends upon the nature of the subsoil. If this be retentive, and not furrow-drained, the soil will require to be subjected to a naked summer fallow every six or eight years, to free it from root weeds; and in this case, the steps of the rotation will be similar to those already described as suitable for the best clay soils. When completely furrow-drained, or if the soil lies on a porous bottom, a fallow crop of drilled turnips or potatoes will be found an effectual cleaning, and from the great value of these roots, they are in every way preferable to naked fallow. The rotation may then be as follows:—1. Turnip fallow; 2. Wheat, on such parts of the land as are freed from the turnips in time for that crop, and barley or oats on the rest; 3. Clover and rye-grass; 4. Oats after grass; 5. Drilled beans; 6. Barley; 7. Clover and rye-grass; 8. Oats; and this to be succeeded by turnips, or other green crop, to begin a new rotation. Some stop at the sixth crop, and make it wheat instead of barley, and then commence with turnips. To keep up the fertility of the soil, manure should be applied with the beans.

Rotation on Light Lands.—Light lands include all soils called sandy loam and loamy sand, which are merely gradations of the same. The general principles of management for this description of soil are precisely the same as those already described, and every rotation should be established on a well-wrought and well-dunged turnip fallow. The course of crops best suited for these light soils is—1. Turnips in drills; 2. Wheat or barley; 3. Clover and rye-grass; 4. Oats; and round again to a new rotation. On good turnip soils this rotation may be repeated indefinitely, provided the turnip crop be eaten on the ground, that the grass crop be pastured, or that the manure derived from the hay be returned to the ground. It will be necessary, however, to introduce occasionally the alternate system of pasturage, for without this, even with the most liberal treatment, it will scarcely be possible to keep up the fertility of the soil.

On good turnip soils, when what is produced on the farm is the only manure used, the following rotation may be found advisable:—1. Turnips; 2. Wheat or barley; 3. Clover and rye-grass; 4, 5, and, if necessary, 6. Pasture; 7. Oats; and round again. When manure is within reach, alternate white and green crops may be followed for a number of years, in this rotation:—1. Potatoes or turnips; 2. Wheat; 3. Drilled beans or peas; 4. Wheat or barley; 5. Potatoes or turnips; 6. Wheat or barley; 7. Clover and rye-grass; 8. Oats. The advantage of this course is, that it secures a good crop of clover, and it is practised near Edinburgh for this purpose; but wheat occurs too often in the rotation.

In the vicinity of London, Edinburgh, and Glasgow, the rotations are frequently—1. Potatoes; 2. Wheat; 3. Clover and rye-grass. By some, the clover is followed by oats, and the rotation again begins; others end the rotation with clover. Even with the manure which these short rotations secure to the soil, occasional pasturage must be had recourse to, if the soil is in any way exhausted.

Rotation on Sandy Soils.—Sandy soils are such as approach to the nature of sharp sand, having so little clay in their composition that they possess no adhesive quality, either in a wet or dry state. These soils require the most liberal cultivation, to produce either grain or green crops; for in the event of dry weather, they become so parched as to be unfit for the growth of almost any species of plant. The application of clay, marl, peat, earth, and manure, will be found materially to improve the texture of such soils, and their constitution will be ultimately changed to a sandy loam. When well manured, sandy soils produce good crops of potatoes or turnips: if possible, the latter should be consumed on the ground by sheep or cattle. It is difficult to make these soils too rich, and, from their nature, all the manure given them is soon consumed. Wheat, beans, or peas, do not succeed; barley, oats, and rye, are the only grain crops which yield a profitable return on these soils; and pasturage for a term of years is absolutely necessary. The following six years' rotation has been recommended for these soils:—1. Turnips, with dung, which are to be consumed on the ground by sheep; 2. Barley or oats; 3, 4, 5. Grass, pastured by sheep; 6. Rye or oats. The rotations on peat or moorish soils will be treated of in the section Improvement of Pasturage and Grass Lands by Topdressing, Tillage and Irrigation, on which account little may be said of them here.

In land situated in exposed and remote districts, the only grains which are cultivated are early varieties of oats, bear or bigg, and potatoes, as a change of seed for the more genial and fertile grounds. The following course of crops, proportioning the quantity sown to the manure supplied to the turnips and potatoes, may be followed in such situations:—1. Oats from old ley; 2. Turnips and potatoes, 3. Oats, barley, or bigg, sown with clover or grass seeds; 4. Hay; and then restored to pasture.

Rotations according to the state of Culture.—Having treated of rotations of crop under a variety of circumstances, we shall now consider the culture which arable lands may require; and this may be—1. The restoration of land to fertility which has become exhausted by over-cropping; 2. The management of land which has become very rich from being long in pasture; 3. The method of laying land for pasture which has been long under tillage; 4. The improvement of pasture-land by a short course of tillage.

To restore over-cropped land to fertility, the most liberal course of culture is necessary, and a tenant should therefore receive every indulgence from the proprietor. Where lime has been previously applied to the soil, it will not alone restore the ground to fertility. A summer fallowing with dung, or a fallow crop of turnips, and laying the land gradually down to pasture, are the true methods by which it may be brought back to fertility. If the turnips are consumed on the ground by sheep, bone-dust may be advantageously used, especially if the soil is light and friable. If composed of thin clay, and manure not easily obtained, a series of years will be necessary to restore the land, as the pasturage will be thin and unproductive. On light soils, pasturage will be found the most suitable for their improvement.

With regard to land which has become rich from long tillage, little need be said, the method of management being simple and well known. Over-cropping must be avoided, and care taken to keep up rather than diminish its fertility.

Summary of Rotations.—The rotations, as it will be perceived, vary considerably, according to the nature and wants of the soil, yet all possess a general resemblance, and embrace alternations of green with grain crops. It is necessary, however, to mention, that the land in time is apt to be injured by an unvarying routine, and seems to require changes in the character of those green crops which are usually reckoned to be so beneficial. In other words, there is a necessity for a change of rotations. This is done by either changing the green crops in the rotation, or alternating one rotation with another. The latter plan, which is called shifting from one course to another, is adopted by many of our best agriculturists.

Choice of Seed.—In choosing seeds, there are three rules that should be attended to:—1. That the variety to be sown is suited to the soil and climate; 2. The propriety of changing the seed; 3. That the seed has the appearance of being sound. Every species of grain has varieties which differ from each other considerably. In many districts the seed long used is still commonly sown, either from ignorance of better varieties, or fear that a change will not be attended with good consequences.

All seed should be allowed to arrive at full maturity before being sown, for the nourishment which the seed must yield to the plant in the first stage of growth can never be so great when this is not the case. The best cultivators choose the finest qualities of each species for seed; sowing them on the land best adapted for their growth. Some varieties are remarkably attached to particular soils, and certain degrees of fertility and moisture seem to suit them best. Others require a greater degree and duration of heat, and frequently take four or five weeks longer to ripen. Early sowing of these sorts ought to be resorted to.

Too sudden a change in climate and situation is hurtful; hence, Yorkshire seed has been found to answer better in Scotland than that brought from Essex. Many varieties may be introduced gradually, which would not answer if the habit of the variety were not a little consulted. The particular varieties of grain will be described under their respective heads, and the soils to which they are best suited.

Sowing.—The oldest established mode of sowing is by *broadcast*, or scattering the grain from the hand over the land which has been prepared for it. But this plan is not so economical, or otherwise so valuable as sowing in drills by machines. In Scotland, the usual method of sowing broadcast consists in the sower walking along the ridges, and at very regular intervals, so as to keep time with his steps, throwing a handful of grain before him by a wide sweep of the arm. He carries the grain in a sheet, which is slung round his neck and is open to the hand in front. A servant attends, to afford fresh supplies at the end of the ridges.

Culture of Wheat.—Wheat is the most important of all the grains, and its varieties are numerous. Among those now in cultivation, the following may be enumerated:—The bearded, the Dunglass, the golden ear, the velvet ear, the egg-shell, the hedge-wheat, the Essex dun, the Kentish yellow, the white and red Essex, the Mungoswell's, the Burwell red, the Hunter's, and the Georgian. A general division of wheats is made into white and red, with several shades between, and summer and winter. Winter wheat may be brought into the nature of summer, by altering the time of sowing. If winter wheat be sown at the period for putting summer wheat into the ground, in the course of two seasons the winter will become of a similar habit as the summer, and the same process will bring a summer wheat to be a winter one.

In general, the fine white wheats are preferred to the brown and red; but the latter is most profitable for wet adhesive soils and unfavourable climates, on account of its hardiness and ripening early. A red wheat, of great productiveness, has been recently introduced into Scotland from Mark Lane.

The variety of wheat most profitable to be produced must depend upon the nature of the soil, as land which has produced an indifferent crop of one may yield an abundant crop of another kind; and land is frequently found to yield better crops if the varieties be alternately changed. It has been observed, that a mixture of grain produces the heaviest crops, and that mixed flour makes the best bread.

The richer description of clays and strong loams are the best adapted for the production of wheat; but if properly cultivated and well manured, any variety of these two soils will produce excellent crops of this grain. Good wheat land ought always to possess a large quantity of clay and little sand; for although light soils may be made to produce good crops, yet the strong clay lands in general yield the heaviest grain. Sandy soils, being deficient in firmness, do not afford sufficient support to the roots of plants such as wheat, which do not sink far into the soil. There are light soils, however, made from decomposed granite, felspar, or clay-stone, compounded with vegetable matter, which produce excellent wheat.

"The season for sowing wheat is necessarily regulated by the state of the land, as well as of the season; on which account it is not always in the farmer's power to choose the moment he would prefer. After fallow, as the season allows, it may be sown from the end of August till the middle of November. On wet clays, it is proper to sow as early as possible, as such soils, when thoroughly drenched with moisture in autumn, are seldom in a proper state for harrowing till the succeeding spring. In the opinion of many experienced husbandmen, the best season for sowing wheat, whether on fallow, rag-fallow, or ploughed clover stubble, is from the beginning of September to the 20th of October; but this must depend upon the state of the soil and weather. In East Lothian, on dry gravelly loams, in good condition, after a clover crop, and well prepared, wheat has been known to succeed best when sown in November. After drilled beans, whenever the season will admit of ploughing and harrowing, wheat may be sown from the middle or end of September to the middle of November; after this season, the sowing of wheat ought not to be hazarded till the spring quarter returns.

"After turnips, when the crop is consumed or led off, and the ground can be properly ploughed, wheat may be sown any time betwixt the 1st of February and the middle of March; and it is customary to plough and sow the land in successive portions as fast as the turnips are consumed. It is only on turnip soil of a good quality, verging towards loam, and in high condition, that winter wheat, sown in spring, can be cultivated with success. When circumstances are favourable, however, it will generally happen that such lands, when wheat is not too often repeated, will nearly produce as many bushels of wheat as of barley. The wheat crops therefore, on an average of seasons, will exceed the value of the barley crop considerably; hence its culture is an object which ought not to be neglected."—(*General Report of Scotland.*)

Wheat is liable to certain fungous diseases, as, for example, smut, mildew or rust, &c. With a view of reserving the grain from these most injurious disorders, it is customary to prepare the seed by steeping or pickling it in a kind of saline brine, or diluted urine. Steeping or pickling is performed after the seed has been washed, by allowing it to lie for a time among stale urine, diluted with water, or salt brine, of sufficient strength to float an egg. The seed is put into tubs, containing as much liquid as will cover the grain a few inches, and allow it to be well stirred, so as to bring all the light grains to the surface, which are skimmed off as long as they continue to rise. Another way is to put the seed into baskets, which are immersed in the water, are easily taken out, and can be conveniently placed over an empty tub to drain. The seed is left for three or four hours in the chamber lye, or full six hours in the pickle, after which the liquor is drawn off, and the wheat spread thinly on the floor of the granary, where it is well sprinkled over with quick-lime slacked in the liquid. About half a peck of lime is sufficient for a bushel of wheat, and it should be well stirred, so that every grain may get a portion. If the seed is to be drilled, it should be passed through a coarse sieve after being limed, which will facilitate its progress through the machine. The grain will thus be quickly dried: and it should not lie more than six hours in the heap, then be spread out, and used the following day.

Some caution should be used in having the lime properly slaked, for if this is not done, too great a heat may be raised, which will destroy the vegetative principle. Doubts have been expressed of the efficacy of lime, and a solution of copperas is used on the Continent instead. Dry powdered lime would certainly have no effect, but when newly slaked it is very efficacious, as has been proved from experiment. It was found that a steep of lime-water alone, in which wheat was immersed for four-and-twenty hours, proved a powerful preventative of disease, while the good effects of unmixed brine were very inconsiderable.

Of the two kinds of steeps mentioned, urine is thought the most efficient, and it should be used neither too fresh nor too stale, as in the first state it is ineffectual, and in the second injurious. The seed should be sown as soon as dry; for if allowed to lie in sacks or heaps beyond a day or two, the lime may be very hurtful. Another steep, which is recommended by Sir John Sinclair, and is much used in Flanders, France, and Switzerland, is a weak solution of the sulphate of copper, or blue vitriol. The modes of using it are as follow:—

Into eight quarts of boiling water put one pound of blue vitriol, and while quite hot, three bushels of wheat are wetted with five quarts of the liquid; in three hours the remaining three quarts are added, and the wheat is suffered to remain three hours longer in the solution. The whole should be stirred three or four times during the six hours, and the light grains skimmed off. After the wheat is drained, slaked lime is thrown on it to facilitate the drying. Another way of using it is to dissolve five pounds of the sulphate of copper in hot water, and add as much cold water to this as will cover three bushels of wheat. The wheat is allowed to remain five or six hours, or even longer, in the liquid. After two or three bags, of three bushels each, have passed through the liquid, one pound more of the sulphate for each bag should be added; and after twelve bags or so have passed through, new liquid will be required.

To this we may add, that sowing the land with salt is considered an excellent means of preventing liability to any of these fungous disorders.

Rye.—Rye is usually sown on light soils, and does not require so much care as wheat; it suffers less by being sown on the stubble of another corn crop, or upon its own, and it is not unusual to grow it on the same land two years in succession. This grain is frequently sown to be cut for soiling instead of winter tares, and in England it is frequently used for early sheep-feeding, cut green, without obtaining a grain crop from it. It is extremely useful to breeding flocks, as it comes forward earlier than tares, and affords good food when other sustenance is scarce. Sometimes it is sown on the margins of fields of other grains, to protect them from poultry, which do not use it as food, and will seldom go amongst it.

Barley.—Barley is a much hardier grain than either wheat or rye. There are six varieties of this grain, distinguished by the number of rows in the ear, four of which are cultivated in Britain. The kinds which have been recently introduced into Scotland are the Chevalier, Annat, and other sorts; but the two-rowed and four-rowed, called bere or bigg, have been most extensively cultivated. In its culture, barley requires a clean, rich, mellow loam, moderately retentive, and on clays, tempered with sandy mould, or containing a certain portion of chalk and sand, it is found to succeed well. On poor wet soils it is never successful; and every kind of land on which it is cultivated should be well wrought and thoroughly pulverized. If the preceding crop has been wheat, the land should undergo three ploughings before barley is put into the soil. Barley usually follows turnips in the rotation, but it is found to grow very well after potatoes. It is thought best to have the turnips eaten on the ground when this can be accomplished; and if the preceding crop has been potatoes, the land should be well ridged up, in order to have it as dry as possible. The application of lime and earth, earth and dung, or urine, is thought of great advantage to the barley crop, and even to plough in the turnip leaves is beneficial. If the plough is not sufficient to pulverize the land properly, the harrow and roller ought to be used to accomplish this. In most cases more than one ploughing is given, but after a winter furrow the grubber may be used instead. When turnips have been consumed on the ground, it is much trodden down, and will require two ploughings; if this is not given, the soil should be well harrowed and rolled. If grass is sown along with barley, the land should be harrowed after the roller has passed over it, which covers the grass seeds. Barley should be sown as soon after ploughing as possible, when the land is fresh and moist, in order to obtain equal and speedy vegetation. The best season for sowing barley is from the beginning of April to the middle of May; but it has been sown a month after this with success. The bere or bigg sort is sometimes sown in October, and called winter barley.

In Scotland, clover and rye-grass are sown immediately after barley, and the seeds are covered by the last harrowing; a light grass harrow being sometimes used for the purpose. Rolling is practised by some immediately after, while others prefer allowing the plants to come above ground; the small clods in this case act as a shelter to the plants, which is of great service in frosty weather.

Oats.—The oat is suited to climates which are too cold for wheat or other grain crops, and therefore thrives in high regions better than in low-lying countries. When land is broken up, either from a state of nature or from pasture, oats form the first crop, as they may be repeated for a series of years without injuring the soil. They are also the best crop to follow clover, and are sometimes sown with clover and grass seeds. They often follow potatoes and green crops, and in either of these cases, the land should be well ridged up in the winter. When the seed is sown, the land should be completely harrowed, and then rolled across the ridges. A mixture of oats is generally sown along with tares, to prevent them from falling and rotting on the ground. In this state they are cut green, and form an excellent food for cattle and horses. A change of seed from hot to cold, and cold to hot, is always to be recommended; and the quantity of seed must depend on the nature of the soil and the variety to be sown. On poor soils, from the plants not spreading, oats should be sown thick. The Hopetoun, and many other varieties, do not tiller out, and therefore require more seed to be sown. The quantity of seed necessary, varies from four to seven bushels per English acre, and broadcast sowing is generally practised.

The usual time of sowing is from the beginning of March to the end of April: early sowing is to be preferred, as the grain is of better quality; but late sowing produces the greatest bulk of straw. Sowing in autumn has been practised with success in some parts of Ireland, the seed being put in early in October; but this is only done on dry sandy loams. This period of sowing is not likely ever to become common in Scotland, from the coldness of the climate. Scotland and Ireland seem better adapted for growing oats than England, and in the former countries greater attention is paid to their cultivation than in the latter, where the poorest soil and the worst tillage are thought sufficient for them. The produce differs materially according to the soil, climate, and the fitness of the particular variety for the land. The maximum quantity, soil and climate being favourable, may be estimated at seventy bushels, and the minimum twenty bushels per acre; the average being about four quarters. Oat straw is preferred to any other as fodder for cattle, as it is considered more nutritive.

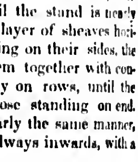
REAPING AND HARVESTING.

The ripeness of grain is shown by the straw assuming a golden colour from the bottom of the stem nearly to the ear, or when the ear begins to drop gently, the corn may be cut. Although the straw may be green from the ear for some distance down the stem, yet if it be quite yellow at the bottom, and for some distance upwards, the grain requires no further nourishment from the earth, and if properly harvested will not shrink. These indications of ripeness may suffice for wheat, barley, and oats. It was formerly the practice to cut grain with a saw-edged sickle; but this has given place to a larger instrument, with a smooth edge like a scythe. The reapers are usually divided into bands of six or seven, with a binder to each band. When the ridges are less than eighteen feet broad, three reapers are usually placed upon each ridge, the middle reaper making the bands with which the sheaves are bound up. When four reapers are placed upon one ridge, as is usually the case when the ridge is eighteen feet broad, two bands are laid upon one ridge; and we are enabled in this way to manage twelve reapers, placed on three ridges, stooking the corn all in one row upon the middle ridge. When the crop is very strong, however, it is often found necessary that each binder should stook by himself.

In harvesting oats and barley, each shock or stook is formed of ten sheaves placed in two rows, the head of each sheaf leaning upon the opposite one, and a sheaf on the top at each end. They stand usually due north and south, so that each side may receive equal benefit from the sun. The straw of wheat being longer than that of oats and barley, the stooks of the former are made larger, having six sheaves in each row, and one on the top at each end. When the crop is thin, half stooks are frequently set up; and to forward the drying process, the end sheaves are now generally omitted when the weather is good; but this should never be done where the climate is uncertain, as it exposes the corn to rain.

Oats and barley are now frequently cut with a scythe, which is either plain, or furnished with a bow or cradle, in order to lay the grain evenly in one direction. Wheat is almost universally cut with the sickle; and if the weather keep good after this operation is performed, it will be ready for stacking in the course of five or six days. Barley is frequently cut with the scythe in England, but the sickle is generally used in Scotland. Barley and oats require to lie ten or twelve days, as they are more or less mixed with clover, before being ready for stacking. The clover ought to be completely withered before the corn is stacked; and, indeed, it requires the greatest caution on the part of the farmer, in ascertaining whether his crops are in a proper state for being carried to the stack-yard. The best way for judging of this, is to take out a handful from the centre of the middle sheaf on the lea side of the stook, repeating this on several parts of the field; and if the knots or joints of this are dry and shrivelled, the crop may be led home in safety. All corn crops should be cut as near the ground as possible, for by this a great addition is made to the straw, and consequently to the future manure.

Stacking.—When the crop is thoroughly dry, it is led home to the stack-yard on open spar-built carts, and built into stacks so constructed as to afford complete shelter from the weather. The stool or bottom upon which the stack stands was formerly made of loose straw or brushwood; but in the best managed farms, it is now the practice to construct the stacks on stands made of stone or brick, or upon pillars made of stone or cast-iron, sparred across with wood or iron. These stands are formed so as to prevent the access of vermin, which is calculated to effect a saving of two bolls in thirty; and many have funnels from the top to the bottom of stacks, to admit a free current of air. In Scotland, the stacks being mostly round, a sheaf is first placed on its butt-end, in the centre of the bottom or stand; around



this others are placed, also upright, but with a slight inclination of the head inwards, until the stand is nearly filled. The stacker then places a layer of sheaves horizontally on the outside of these, lying on their sides, the ear-ends inwards, and, pressing them together with considerable force, he continues to lay on rows, until the outside sheaves are as high as those standing on end. The whole stack is filled up in nearly the same manner, the ear-ends of the sheaves being always inwards, with a regular inclination downwards and outwards to their butts, and the centre of the rick being higher and not so compressed as the outside. Proper attention to the sloping of the sheaves is necessary from the foundation of the stack, but particularly so at the intake of the inner layers, that part being always left more open. When this is done, the stacker sets up an outside circular row of sheaves, having their butt-ends projecting a few inches beyond the body of the rick, after which the outside layers come gradually inwards, until the roof is drawn to a narrow circle, when two or three sheaves placed upright completely fill up the stack. The topmost sheaves are then firmly bound with a few turns from the middle of the straw rope, the two ends of which are fastened on opposite sides of the stack. When carefully built and thatched, a stack will completely keep out rain, and be quite secure from high winds. Materials for thatching, and straw ropes, should always be made before harvest, so that no delay may arise from this, in the event of wet weather. The thatcher stands upon a ladder, placed on the sloping roof of the stack, and lays on the straw in handfuls from a quantity placed within his reach. One end of the straw he thrusts into the butt of a sheaf, and the other end hangs over the stack. He thus progresses up to the top, making each handful overlap the other; and on the top of the stack a thick covering of short straw is placed, over which a straw rope is carried perpendicularly, dividing the roof into equal sections. He then covers the topping of short straw with long thatch coming to a point, and ties the upper end of this with a straw rope into a peak, the form of the top resembling in appearance an umbrella. With the aid of two assistants on the ground, the thatcher now places a number of tough oat-straw ropes over the covering, to secure it firmly. These ropes are made to cross each other at angles, and are fastened either to the butts of the sheaves, or to a rope firmly bound round the body of the stack.

Stacks are sometimes constructed in England on a timber platform raised upon stones, and over the stack the framework of a perfect barn is placed, which can be either tiled or thatched. This is said to afford greater security to the crop, and to be less expensive than annually thatching. The price of erection is said to be comparatively trifling, when the convenience of such buildings is considered; and they have been known, when well put up, to last for thirty years.

Thrashing is either performed with the flail or the thrashing-mill. The use of the latter we by all means recommend in preference, on arable farms of above one hundred acres in extent. The machine may be driven by water, horse, or steam power, according to circumstances. Several improvements have been made on thrashing-mills since their first invention: the unthrashed corn is now made to pass through two revolving rollers, while it is acted on by beaters placed lengthwise upon a larger cylinder or drum, which moves at the speed of 2500 feet in a minute. The great essential in thrashing is to have regularity of motion, and the grain to be equally fed into the rollers. One man should be employed to feed in the corn; one man, or two boys, to carry the sheaves, and a woman to untie and place them on a table near the feeder. Other persons are employed in raking and carrying the thrashed straw to the straw-house, where it is built. When the machine is driven by steam or water, it is generally the case that one or two winnowing-machines, according to the power employed, are attached to the thrashing-mill, and thus the expense of preparing the grain for market is considerably lessened. A powerful machine will thrash from two to three hundred bushels in nine hours, and, allowing for wages and wearing of machinery, the expense of preparing grain for the market by the use of water or steam, is under one penny per bushel.

Winnowing or dressing.—Winnowing is a process performed by the aid of wind, by which the chaff of corn is separated from the grain. Winnowing-machines, or fanners, as stated before, are sometimes attached to thrashing mills, and they are a necessary appendage to every farm, either in conjunction with the thrashing-mill, or separately. Some farmers winnow their grain by hand-fanners, which are thought to be steadier in their motion than when driven by machinery, and consequently the grain is more thoroughly cleansed. After thrashing, the grain is regularly dressed in the clean corn room, by means of fanners, riddles, and sieves; and this final dressing is regulated according to the state in which the grain comes from the thrashing-mill. By the process of winnowing, chaff, bits of straw, the seeds of weeds, and other refuse, are separated from the grain; and it is a wise precaution to boil the latter before putting them on the dunghill, which will effectually destroy their vegetative powers. The different qualities of grain are also separated from each other, by which it is rendered more valuable than when the good and bad are mixed together. The thorough cleaning and dressing of grain are of great importance to the farmer, and he will find it added to his profit in the end to have this effectually done.

If wheat has been injured by wet, it is thought advisable to kiln-dry it moderately, and allow it to lie for some time before being ground. When grain is infected with smut, it should undergo three washings before going to the mill, which will be found an effectual way of cleaning it. Mere ventilation has been recommended for this purpose, but washing is as simple, and a far more certain operation.

Barley undergoes a process called hummelling, by which the awns are broken off from the grain. The machine is composed of a vertical spindle enclosed in a cylinder, and furnished with arms which act upon the grain. It is sometimes attached to the thrashing-mill, and sometimes driven by a separate power. The grain is put in at the top of the cylinder, and as it passes through, the awns are broken off by being struck by the arms attached to the spindle. A more simple process is, after the barley is thrashed, to take off the head of the drum and put on another cover of tin, perforated with small holes about three sixteenths of an inch wide. The barley is passed through the rollers, and by this the awns are rubbed off. Another method is to lay the barley on the barn floor, and beat it with a square instrument consisting of parallel bars of iron fixed on a frame, with a handle attached, which is worked in the same way as a pavier's rammer.

After being dressed and made ready for market, grain should be kept very dry, in a granary free from damp, and which is impervious to the incursions of vermin. It is, however, the best plan not to thrash grain till it be required for market, because it loses in weight, or shrivels in bulk, by keeping. It also loses in weight, though to a much less extent, by being kept long in ear in stacks; and therefore the sooner grain is thrashed and carried to market, the greater will be the return, supposing there be no rise in price.

GREEN CROPS.

No farming can be said to be perfect unless it involves a due alternation of *green* with *grain* crops. The more foul the land is with weeds, green crops of the drill kind are the more necessary, because, in the course of cultivating green crops, we have an opportunity of hoeing and trenching the land, not only once, but repeatedly, and of thus exhausting the seeds of weeds lodged in the soil. By administering manure, and this mode of cleansing, the necessity for *fallowing* is in a great measure obviated. But green crops also fulfil the important purpose of feeding live-stock and producing manure. The constant exhaustion of the soil, be it even very fertile, demands a periodical nourishment, and this is best done by means of live animals. It is customary on the well-organized farms of Norfolk, East-Lothian, &c., to manufacture manure on a large scale by means of *soiling;* that is, feeding cattle in houses or an open yard with turnips, the cattle at the same time treading on the waste straw of the farm, and thus using up a material which would be otherwise lost. Sheep are also turned into pens on turnip-fields, to eat up the turnips from the drills, and the droppings greatly enrich the spot. It is customary in Scotland for low-country farmers to buy cattle lean at the end of autumn, and sell them fatted to a certain extent in spring; and all this trouble is taken only for the sake of their manure. We shall now mention what constitutes the principal green crops.

Beans require the same sort of soil as wheat, namely, heavy clays, and should be sown in drills. Some suppose that beans exhaust the soil; but this is scarcely probable, from wheat always yielding a good crop after them. In preparing the ground for beans, it ought to be ploughed after harvest, or early in winter, that the soil may be mellowed with the winter frosts. The furrow should be deep, but, before sowing, the land should be drained of its superabundant moisture. Sow as soon as winter is over, or never later than the end of March in Scotland Four bushels of seed to the acre are sufficient; but it is common, for the sake of improving the fodder, to mix peas with the beans, to the extent of one bushel of peas to six of beans. Beans require frequent weeding with the horse-hoe. The crop, if late, should be carried to another field to dry, and thus leave the land for operations necessary for the wheat crop.

Peas grow best when mixed with beans, as they by that means gain a support for their slender trailing stalks. They, however, grow on a poorer soil than beans, such as a sandy loam, and neither too moist nor too dry. They are improved by lime and marl manures. Drilling, as in the case of beans, is greatly preferable to broadcast; and from four to five bushels of seed per acre is reckoned a proper allowance. The early kind of peas may be sown at any time till the end of May, but the late must be sown in February or March.

Tares are a valuable crop, both for soiling and feeding cattle. Tares are of two sorts, winter and summer. The seed of the summer tares should be put into the ground at intervals, from the end of March till the end of May, so as to furnish successive cuttings. The winter tare requires to be sown in September or October; and in early spring it is a very valuable food for cattle and sheep.

Clover and Rye-grass.—These are the most valuable artificial grasses that can be grown by the farmer. They should never be sown except when the land is in the best condition; if possible, with the crop immediately following a summer fallow, or after turnips or potatoes. Thus, in all well-manured and well-dressed land, clover and rye-grass are mixed with the crop of grain, being either sown at the same time or at a suitable period after. When the grain crop is cut in harvest, the tops of the young clover are perhaps cut at the same time, but this is of little consequence; the great bulk of the grass crop comes into maturity among the remaining stubble, and is then either scythed for hay or for feeding animals in a green state. When sown on land on which grain has been sown, it is customary to roll the ground, to assist in covering the light seeds. Great care requires to be employed in choosing proper kinds of clover and grass seeds, as there are many worthless sorts.

Many farmers [illegible] purpose to prolong the rotations, and prevent the too frequent repetitions of the clover crop, substitute a crop of peas or tares after the barley, sowing the clover after the wheat or barley in the next rotation, which makes the time between the two clover crops to be seven instead of four years. The crop of peas they consider as by no means remunerative, yet from the additional crop of clover reaped in the second rotation, they find themselves compensated for the deficiency in the peas. Surface applications are now administered on an extensive scale in improved districts, for the sole purpose of procuring an abundant crop of clover and rye-grass. Soot is one of the ingredients which is applied to the greatest extent, and it has uniformly the effect of strengthening and forwarding the crop. Liquid manures are also extensively used, and the urine of the cows is collected with great care, for the purpose of being applied to the soil. Liquid manures are much more lasting in their effects, and seem better adapted for clover than soot. Saltpetre is likewise much used, and forms an excellent top-dressing for seedling-grasses. It is by such means as these that the agriculturists of the Netherlands have been able to keep up the fertility of their lands, in the cultivation of clover, through time immemorial; and those, therefore, who neglect such measures, have themselves to blame when their clover crops fail. The whole of the agriculture of the Netherlands rests upon the cultivation of clover, which not unfrequently yields a heavy crop the first year, two and even three abundant crops the second, and, if allowed to stand another year, will yield a good crop, and afterwards be excellent pasture for cattle, till ploughed up to receive wheat seed.

Turnips yield a most profitable crop for the maintenance of live-stock; and they are also useful as a green crop, by permitting an effectual cleansing of the land from weeds. The leaves being large and spreading, they afford a shade which retains the moisture, and tends to decompose any vegetable matter in the ground. Turnips are divided into various classes, in each of which there are several varieties. The more common classes are the round or globe-shaped, the depressed or Norfolk, and the fusiform or oblong, the latter being better known by the name of Swedish. They are also sometimes known by their colour, as the white, the yellow, (including the Swedish,) and the purple-topped. The white, with the purple-topped, is early, particularly suited to those light soils where sheep are fed, and requires less manure. It must be consumed, however, as soon as possible, or is apt to run to seed or to be injured by frost. Upon the whole, the Swedish or yellow turnip is now preferred to most others, and yields the heaviest crop. It requires to be sown early, or from the beginning of April to the end of May; the seed should be given liberally, or at the rate of about three pounds per acre. In all cases, the sowing ought to be in drills, to permit an effective hoeing when the crop is getting up. After being sown on a well-ploughed field, the roller must be employed to press all smooth on the ridges. The plants will in general make their appearance about ten days or a fortnight after they are sown, according to the quality of the soil and the state of the weather. When the leaves are about two inches high, a horse-hoeing is given between the ridgelets, to cut up the weeds close to the plants. The hand-hoe is then introduced, to thin the crop, leaving plants standing at intervals of from eight to ten inches apart, the Swedish kind being somewhat [illegible] This distance is thought quite sufficient [illegible] neither too large nor too small in size. The [illegible] turnip, when allowed too great a distance, is apt to become very large, and its nutritive juices are found to be quite lost. The Swedish and other hard turnips should be allowed sufficient room to become as large as possible, for their nature is such that there is no fear of their ever being over bulky. The hand-hoeing and thinning are generally performed by women and boys, and three expert hoers will go over an acre a-day. A few days after the hoeing, a small swing-plough is used to make small ridgelets between the rows; and when weeds are still in abundance, it will be necesmay again to horse or hand-hoe the ground, which levels the intermediate ridgelet. After all weeds are thoroughly destroyed, and the thinning is accomplished, the earth is sometimes gathered up about the plants by means of a small plough with two mould-boards. This operation, however, is objected to, on the plea that the earth prevents the bulbs from growing, and also when the produce is to be consumed on the ground, the sheep may be injured by falling into the hollows between the rows. On wet soils, the earthing up is very beneficial, as it allows the free discharge of superabundant moisture; and when the weather is frosty, the earth is an excellent protection to the plants. Turnips may either be consumed on the fields where they grow, on grass fields, in fold-yards, or in feeding-houses; and in the vicinity of large towns they are sold to cowfeeders. A cheap and expeditious mode of lifting turnips has been practised in Ireland. The tops are first shaved off with a scythe, and given to young cattle, and the bulbs are ploughed out of the soil, which being afterwards harrowed, they are left entirely free of the ground. The turnips are then gathered into carts, commencing at the top of the field and going regularly down, so that none may be bruised; and it is calculated that six labourers will lift an acre of turnips by this method in a day. *Mangel wurzel* is introduced with advantage as a variety in green husbandry, and, as a food for cattle, supersedes turnips.

Potatoes.—Crops of this valuable plant usually enter into a course of husbandry, particularly in the neighbourhood of populous towns, where a ready market can be obtained. The usual period of planting in the British islands is the end of April or beginning of May, for the late and more common sorts. The early kinds, which are not kept for permanent stock, are planted in March. The potato harvest is in October or beginning of November. It has been customary to plant by sets or cut pieces of the potato, each having an eye or point of germination; but the numerous failures of the crops have introduced the practice of setting the whole tuber, which is preferable. In the large farms of Scotland, they are set in drill furrows (previously well manured), at a distance of eighteen inches apart, and six inches of earth is turned over upon them by the horse-hoe. When the plants appear above the surface, they are repeatedly earthed as may be required; this, with the weeding of them, is done by hand-hoeing. Potatoes are very susceptible of diseases, which cause failures of crop; but there is reason to believe that this arises from some kind of mismanagement, as, for example, producing again and again without change of seed, lifting of seed after frost, rot from wet seasons, heating of heaps after lifting, &c. Recommending all who feel interested in potato husbandry to consult the treatise of Mr. Jackson, formerly alluded to, for information, we need here only say, that the preventives of disease, likely to be most successful are frequent changes of seed, bringing seed from quite a different soil, not too frequent cropping from the same land, spreading out to dry after lifting, and careful protection from frost during winter. They are best preserved in pits, a layer of potatoes and earth alternately to a height of four feet, and finally covered with earth on the top and sides. This is considered the condition most natural to the potato, and is found to succeed well.

Hay-making.—When the grass has arrived at or near its full growth, but before the seed is perfected, it should be cut down by the scythe for hay. A short time after being mown, it should be turned over in full swathes, without being scattered. If not in a fit state to be cocked the first day after cutting, it should be put into small hand-cocks, as soon as its state of dryness will allow; from these it should be gathered into larger ones, and when its condition permits, put into tramp ricks. The gathering of the hay is generally performed by women and boys, some carrying and others raking up what may remain. Let it be remembered that the less the hay is exposed to the sun, the better is its flavour and strength. In wet seasons, the utmost care will be required not to stack the hay while moist; for then, like moist sheaves of grain, it will heat, and either burst into a flame, or be seriously damaged in quality. The criterion for good hay is, that it should be greenish in colour, be perfectly dry, and possess a sweet odour. In this state it will be eaten with avidity by horses

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Within the limits assigned to us, it is impossible to impart directions for every step in husbandry; and we shall consider our task accomplished if we have impressed certain leading principles of agriculture on the minds of those hitherto ignorant of them. Not to be misunderstood, we shall specify, in conclusion, what we consider important truths in connection with this subject:—1. Land, to be well cultivated, must either be the property of the farmer, or be let on a moderately long lease. 2. The husbandry must be *convertible*, that is, on a precise system of rotation of grain and green crops. 3. Cattle must be kept, to produce a due share of manure for the fields. 4. If the land be moist, or liable to heavy rains, it must be effectually drained. (See next article.) 5. Deep ploughing, and thorough pulverizing of the soil are essential. 6. The fields must be properly fenced and of easy access. And, lastly, no land will be profitable as a speculation, unless closely superintended by a farmer whose mind is alive to all its varied wants, and neither rash in running into experiments, nor prejudiced against well-authenticated improvements.

IMPROVEMENT OF WASTE LANDS—SPADE HUSBANDRY.

According to the best authorities on the subject, it appears that the British islands contain upwards of thirty millions of acres of waste lands. Much of this large division of our territory is situated at an altitude which places it beyond the possibility of improvement; but at least one half is believed to be improvable, and capable of being rendered suitable, if not for tillage and grain crops, at least for the feeding of cattle. The question as to the propriety of improving the really improvable waste lands of the country, is, in any individual case, to be satisfactorily answered by ascertaining at what expense, in relation to the probable profit, the process may be performed. A barren rocky desert may be rendered productive by covering it with soil and manures brought from a distance of miles, aided by years of skilful tillage; but will the cost of these operations be fairly returned by the profits of the produce? Gold itself may be purchased too highly, and so may agricultural improvements. We do not throw out this idea for the purpose of discouraging, but of cautioning proprietors and farmers of lands. In all projected improvements, they will require to ascertain, in the first place, what will be the probable return, within a moderate length of time, for their outlay—always keeping in view the prospective prices of rural produce during the period. Such, at least, is the principle of calculation which ought naturally to guide all proprietors of extensive tracts of waste ground, the outlay on which is to be strictly pecuniary. With reference to those who propose to improve wastes chiefly by an expenditure of time and personal labour, the calculation will take a similar turn; and the question will be, whether that time and labour could not have been employed more profitably in another line of pursuit. Leaving this, however, for further discussion in the sequel, we proceed to point out, *first*, to those whose situation in life and inclinations lead them that way, the means to be adopted, according to the best principles of science and lights of experience, for reclaiming large or small portions of waste lands, and the results which may be expected to reward their enterprise; and, *second*, the best plans which may be followed for improving patches of ground by spade-husbandry, and establishing thereupon small cottage farms, suitable for the support of a comparatively humble class of families. In the treatment of these certainly not unimportant subjects, we shall of course refer chiefly to the condition of waste lands in the United Kingdom; but the improvement of wastes in the colonies or in foreign countries will also be understood to be included, and in each case we will endeavour to adhere closely to practical details.

IMPROVEMENT OF MOSS LANDS.

The greater portion of what are usually called waste lands, are stretches of peat-bog or moss, covered by a thin benty grass and tufts of heath. This remarkable species of land is found to a very great extent in Ireland and Scotland, often in the midst of beautiful and productive tracts of country, but generally in high-lying districts, which are somewhat defective in point of climate.

Peat-mosses are supposed to be occasioned by the destruction of ancient forests, either by the hatchet or from natural decay. The trees found at the outskirts of these mosses appear to have been cut down, while those in the interior appear to have decayed by the gradual process of time. It is believed that the trees thus left upon the ground would soon become covered with moss, lichens, &c.; and the free drainage of the land being obstructed, aquatic plants, such as reeds, rushes, horsetail, and marsh trefoil, springing up and decaying, would leave a strata of soft vegetable matter, which every succeeding year would increase. These plants grow in greater or less abundance, according to the quantity of moisture on the ground; and this may account for mosses being deeper in some parts than in others. The hollows would naturally retain moisture in larger quantities than the level ground, and here the aquatic plants would be most prolific, and the hollow gradually become filled up. The peat, which has been in this manner formed, is therefore a compound vegetable substance, which, although it has undergone a change, has not been entirely decomposed; probably the cellular tissue, or transparent vegetable matter has decayed, while the woody fibre still remains. Water is indispensable in the formation of moss; and according as the ground is very wet, or only so to a certain extent, different plants will be produced. On ground completely saturated with water, various species of moss grow, to the almost total exclusion of other plants; but if the land should in any way become drier, reeds, rushes, marsh trefoil, horsetail, and other plants, spring up in the place of the moss. The quality of the moss may be judged of from the plants which grow upon it; all the moss tribe, the horsetail and the marsh trefoil, are fibrous, and difficult to decompose, while reeds, rushes, and sedge, are comparatively easy of decomposition. Peat-moss possesses an astringent quality, which has the power of preserving bodies immersed in it, and even keeps itself from entirely decaying. This power is supposed to arise from the carbonic and gallic acids which issue from decayed wood; and vegetable gums and resins will also have the same effect. The tannin principle exists, as is well known, in the oak; and the pine contains much both of resinous and astringent matter. Many mosses are formed upon decayed trees, and the wood most commonly found is either pine, birch, hazel, or oak; and in these cases the presence of the tannin principle is easily accounted for. It is also highly probable that the plants themselves, by the action of natural agents, may have acquired an antiseptic or antiputrefying quality. It is certain that acids of considerable strength exist in some mosses; and it is mentioned by Lord Meadowbank, that in preparing peat-moss for manure, he used lime to destroy a vitriolic salt of iron, which he says abounds in peat-mosses. In some cases, lakes and pools of water have been filled up by the accumulation of moss; and it has been observed that fermentation occurs where this has taken place. Gaseous matter is evolved, and the neighbourhood of such a moss is generally unhealthy; but true peat soils are always salubrious.

The reasonable question has sometimes occurred to inquiring minds—whence the substance of peat-mosses? for stagnant water alone could not have produced many feet deep of solid matter. This question is answered by chemistry. The vegetation which springs up in the form of aquatic plants, absorbs carbonic acid gas from the atmosphere, and a carbonaceous deposit is made in the form of vegetable fibre, or dead vegetables in the form of mould. Mr. Johnston, in his Lectures on Agricultural Chemistry, makes the following observations on this subject:—

"When lands are impoverished, you lay them down to grass, and the longer they lie undisturbed, the richer in vegetable matter does the soil become. When broken up, you find a black fertile mould where little trace of organic matter had previously existed. The same observation applies to lands long under wood. The vegetable matter increases, the soil improves, and when cleared and ploughed, it yields abundant crops of corn. Do grasses and trees derive their carbon from the soil? Then how, by their growth, do they increase the quantity of carbonaceous matter which the soil contains? It is obvious that, taken as a whole, they must draw from the air not only as much as is contained in their own substance, but an excess also, which they impart to the soil.

"But on this point the rapid growth of peat may be considered absolutely conclusive. A tree falls across a little running stream, dams up the water, and produces a marshy spot. Rushes and reeds spring up, mosses take root and grow. Year after year new shoots are sent forth, and the old plants die. Vegetable matter accumulates; a bog, and finally a thick bed of peat is formed. Nor does this peat form and accumulate at the expense of one species or genus of plants only. Latitude and local situation are the circumstances which chiefly affect this accumulation of vegetable matter on the soil. In our own country, the lowest layers of peat are formed of aquatic plants, the next of mosses, and the highest of heath. 'In Terra del Fuego (says Darwin), nearly every patch of level ground is covered by two species of plants, which, by their joint decay, compose a thick bed of elastic peat. In the Falkland Islands, almost every kind of plant, even the coarse grass which covers the whole surface of the islands, becomes converted into this substance.'

"Whence have all these plants derived their carbon? The quantity originally contained in the soil is, after a lapse of years, increased ten thousand fold. Has the dead matter the power of reproducing itself? You will answer at once, that all these plants must have grown at the expense of the air—must have lived on the carbon it was capable of affording them, and as they died must have left this carbon in a state unfit to nourish the succeeding races." In other words, the substance of peat-mosses is a deposit from the atmosphere, which is evidently a universal source of subsistence to vegetable life.

Though thus composed of a deposit of dead vegetable matter, which is a basis of fertility to new vegetation, peat-mosses are not in a condition to be actively useful till freed of superabundant moisture, and compounded with siliceous (sandy) materials. Where the subsoil, however, is composed of gravel or sand, it is necessary that the peat and these bodies should be mixed together, so as to form a soil The first of these methods was planned by the late Lord Kames, and performed with distinguished success on his estate of Blair-Drummond, in the county of Perth. The first process performed by Lord Kames, was to construct a ditch through the centre of the moss, through which a stream from the river Teith was directed. Branch ditches were cut in all directions from the main one, the water from which poured itself into the river Forth. The whole estate was divided into portions, and let to small occupiers of land, who received the most favourable terms from the proprietor, as an inducement to carry out his views. The peat earth was cut into small pieces, and cast into the running waters, by which they were carried into the Forth, and thence to the sea. After the moss was cleared away, the trees of the ancient forest appeared, and presented new difficulties to the workmen, which were only overcome with great labour and expense. The roots of these trees were firmly fixed in the earth. and the tanning process which they had undergone in the moss seemed to have added greater strength to their root-branches. They were completely eradicated, however; and in the year 1782, no fewer than 336 acres of ground were reclaimed and brought into cultivation. His son, who inherited his father's spirit of enterprise, pursued the same plan; and in ten years more, the population on the estate had increased to 764 persons, who cultivated 444 acres of land. In 1805, by survey, 577 acres were cleared; and in 1814, between 800 and 900 acres were under cultivation. Lately (1842), the whole has been cleared. Thus, an extensive tract of country, which at one time was entirely useless, has been brought, by labour and perseverance, to bear rich crops; and the land is now worth from £3 to £5 per acre of annual rent. In this case, the subsoil was good earth, and the operation necessary was the removal of the peat-moss, so that the subsoil might be made the surface soil.

Where the subsoil is gravel or sand, a very different operation must be performed; and this, perhaps, is the most common species of moss ground. Of whatever nature moss ground be, it is evident, that, so long as the stagnant water remains, no useful crop can be cultivated; and to remove the superabundant moisture, by means of draining, must be the first operation of the improver. In some cases, where the moss is not too wet, a road may be run through the land, which will greatly facilitate the after-operations. Should such a road be cut, and a deep ditch on each side of it formed, the next operation is to open drains leading to some main channel, by which the water can be carried away. The moss land should be sounded in different places, to ascertain where the greatest depth lies, and when this is found, the main drain should be drawn as nearly in that tract as possible. Where there are beds of great depth, it does not appear expedient that the drain should be cut to the bottom at first; and, indeed, a difference of opinion exists as to whether moss land should be thoroughly drained at first, so as to render it perfectly dry. Mr. Boroughs, the author of a treatise on waste land, is of opinion that the surface water only should be drained off at first; while Mr. Blackadder of Stirling asserts that there is no danger of over-drying moss by draining. This may depend upon whether or not the moss be in a decomposed state. When moss is rendered too dry, it becomes a fibrous inert matter; and, as is the case with all other lands, it will be easier to work afterwards when moderately moist. With regard to the size and form of drains, it was formerly the practice to make these wide and deep, and at about fifty yards apart. The lateral pressure of the water upon the sides of these drains, however, pressed them so much together, that in the course of years they were scarcely traceable. The depth of the main drain will depend in some measure upon the depth of the moss; and if the average depth of this be twelve feet, the drain may be seven or eight feet deep, and about the same width at the top. The sides should be made sloping, so that the bottom of the drain will not be above two or three feet wide; and this difference between the top and bottom will gradually diminish in consequence of the lateral pressure. It may in some cases be necessary to perforate the main drain with holes, if any water appear to be coming up from below. The next operation is to form smaller drains leading into the main channel. Experience has shown that the most effectual way of draining deep moss is to insert drains at small distances from each other, and as deep as the nature of the moss will allow. They may be either of tile or stone, and guarded from choking by overlaying turf. Moss ground drained in this effectual way, will be, first, surrounded with the main drain which carries the water entirely away from the field; second, cut into divisions with open drains, at from forty to sixty yards apart, leading into the main drain; third, these divisions will be again divided into smaller portions by the covered drains at five yards' distance from each other.

In this manner the moss will be effectually relieved from its superabundant moisture, and the next operation is to level the land with the spade. In cases of dry moss, of course the draining is needless, and may be omitted. The land being either naturally or rendered artificially dry, should never be ploughed with a peculiar kind of plough made of wood, and covered with sheet-iron, which can be freely used if the ground is free from rushes, heath, &c. If these plants be growing in profusion, however, it is thought better to burn them down to the surface before ploughing. After the ground is ploughed, some prefer rolling and others burning, as the next operation. If a roller is used it should be made of iron, with plates of thin iron six inches deep, five inches from each other, and placed at right angles to the cylinder. Repeated rollings from this will cut the sod fine enough to allow the mixing of it with sand or gravel. Instead of rolling, it has been found advantageous to burn the soil turned up, as a more effectual way of decomposing the roots of such plants as the cotton-grass, mat-grass, marsh trefoil, &c. If the land is burned, it should be ploughed immediately after, preparatory to being mixed with other substances. The next step in the process is to cart sand or small gravel to the field, and spread it over the whole to the depth of three inches. Now plough all down, as the first regular dressing and culture. Thus prepared, the land is ready for cropping, and it is generally allowed that the best plan is to sow with grass seeds; the kinds recommended for this purpose are the timothy grass, cocksfoot-grass, and ribwort. Wheat, however, has been taken from newly reclaimed moss land; and potatoes, if the moss is in the neighbourhood of cultivated ground, will be found a very valuable crop to be disposed of for seed. Italian rye-grass has been highly recommended for bog land, and also rape, to be followed by oats or barley.

One of the most remarkable experiments ever made in reclaiming peat land, was performed some years ago in the neighbourhood of Edinburgh, and is mentioned at length in Jackson's Agriculture. It was as follows:—"On the high and bleak grounds which lie on the boundaries of Mid-Lothian and Tweeddale, at the distance of twelve or thirteen miles south from Edinburgh, there existed, from time immemorial, an extensive tract of moss, which was dug for its fuel, and exhibited the appearance of precipices of peat rising from sour pools of water, the whole broken and disorderly, and of little or no value whatever for pasture. A portion of this dismal-looking land, which lies about eight hundred feet above the level of the sea, being purchased by Mr. John Carstairs, a gentleman in Edinburgh, he commenced operations for reclaiming it. The purchase was made twenty-five years ago, at which time there was neither tree, house, nor road, upon the whole moor; and a more hopeless attempt than that of bringing such a tract of utterly waste land into cultivation, cannot well be conceived.

"The first effort of Mr. Carstairs was to gain access to the ground, by forming a road to it from the great road between Edinburgh and Dumfries. He extended the road at a great expense through the centre of the moss, and built a handsome suit of farm offices at the western extremity. The moss was then subdivided into fields of various sizes, by running stripes of plantation in squares, protected by ditches and turf dykes; and the fortunate formation of a new line of road between Edinburgh and Peebles, going through a corner of his property, gave energy to his exertions. Well-formed metal roads, made at his own expense, now intersect and cross each other all over the property, affording easy access to every part of it.

"The extent of the land to be improved was from 500 to 600 acres; and this he partitioned into fields, protected by plantations and turf walls, as we have just described. The land was also effectually furrow-drained, and levelled on the surface by manual operations. The remainder of the process of reclamation consisted in the application of lime and sandy materials, and tillage. Year after year the land gradually assumed a better appearance, and yielded a better crop. At first, the oats which grew upon it were scanty in the extreme, but now the land is in heart, and yields good crops, and also excellent pasturage.

"To quote the words of Mr. Carstairs himself upon the state of this moss when he got possession of it—It was mostly composed of white foggy stuff, standing from two to twelve inches deep of water, and not worth sixpence an acre of rent, as it would carry neither man nor beast. In 1834, he commenced cutting sheep drains twelve inches wide and twelve inches deep across the whole moss, dividing it into regular riggs of from twelve to fourteen feet broad each, which has had the desired effect of drying the moss completely, the hollows being filled up with the sods taken from the drains. This drainage cost him £43, 11s. In the summer of 1836 and 1837, a great extent of it was top-dressed with earth and lime; and now it bears the horses and carts over its surface freely, although the moss is from ten to forty feet in depth.

"The application of gravel and sand effects perhaps more improvement, in consolidating and decomposing the moss, than either lime or dung. This is shown to be the case from the circumstance, that moss land, when overflowed, is rendered fertile by the deposit of earthy matter from the water. In imitation of this operation, Mr. Carstairs is in the habit, at every breaking up of the reclaimed moss land from pasturage, of giving a liberal application of clay, gravel, or sand. This he effects in an easy manner, by means of a portable railroad. The application of the gravel, and the committing of the land to pasturage, or irrigated meadow, for a given number of years, have the effect of consolidating it so much, as in most cases to render it capable of being ploughed by horses; but when rather soft, pattens are put upon their feet to prevent them from sinking.

"By the means detailed, some very large fields of the moss ground have been so reduced in depth as to allow the subsoil, formed from the application of clay, gravel, &c., to be brought up by the plough and incorporated with the moss. Complete furrow-drainage keeps the soil and subsoil always dry; and now this ground presents fields of as fine and as fertile vegetable loam as can be seen in the whole county, which nothing but their great elevation prevents from being equally valuable. The chick, the sorrel, the nettle, and other weeds, which usually infest moss land when first brought into cultivation, have entirely disappeared—a sure indication that a complete melioration of the land has been effected.

"When the depth of the moss is considerable, the under stratum, from being more decomposed and consolidated, is uniformly of a much better quality for agricultural purposes than that on or immediately below the surface. To get rid of this inferior soil, Mr. Carstairs has frequently resorted to burning; and even in this operation, the effects of lime and other earthy applications, some years previously put on, is singularly valuable. They not only make the moss burn more freely, and at a more uniform degree of depth, but the ashes are rendered highly valuable as a manure to the succeeding crops, by being mixed with the lime. Thus, by frequent applications of any earth or lime, but particularly clay, and occasional burning, the worthless moss soil becomes progressively reduced in depth, and fertilized."

The expense of draining and preparing moss land depends on many local circumstances. The usual cost is from £12 to £15 per acre; but much has been done at £7 or £8 per acre. The expense, in either case, is far the most part repaid in a very few years; and then good land, which may be let for £2 or £3 an acre per annum, may be said to have been absolutely conquered from the wilderness, and added to the productive soil of the country.

DRAINING.

In some countries the ground is naturally so dry, and the climate possesses so little moisture, that instead of drainage, the land may require to be irrigated profusely with water at certain seasons of the year. The lands, generally speaking, of England, Scotland, and Ireland, are of a very different character. There are few parts of the country where drainage, from superabundant moisture, is not requisite; and, therefore, the operation of draining should be thoroughly comprehended by every practical agriculturist.

The necessity for draining arises either from the water rising to the surface from springs beneath, or from the subsoil being of a retentive quality, by which water lying upon the surface, or absorbed in the upper stratum, cannot escape. According as either of these causes predominate, or are associated with each other, so must the process of drainage be regulated and conducted. All soils, those of a very sandy or gravelly nature, in some situations excepted, are more or less liable to over-wetness, either from their own nature or the nature of the subsoil on which they rest. Clay, whether on the surface or beneath, is, from its adhesive nature, very retentive of moisture. A mixture of clay, sand, and sometimes iron, is also found very impervious; and even loams, although they absorb water freely, generally retain too much. Rich black loams usually lie on a clay subsoil, of different colours and textures, according to which the land will be in various degrees wet. The wetness in these loams is not so apparent as on other soils, but it is in every case as injurious, and as great a necessity exists for its removal. Land subject to springs is usually very varied in its surface, and may require a number of drains before water is effectually removed.

Draining is the operation of drawing off the water from the over-moist land, and of reducing the soil to that proper degree of dryness which renders it available for productive tillage. Many moist lands, though undrained, will produce crops of grain, and the crops will be the heavier the dryer and finer the season; but, taking these lands on a common average of seasons, it will be found that they often greatly fail in yielding even moderate crops, and that, at the very best, their crops are inferior in bulk and weight to those of grounds which have been subjected to a thorough process of drainage, and the kind of tillage consequent upon such an improvement. The outward mark of all undrained arable land is, that little or no grain grows in the furrows. The crop is seen to run along the centre of the ridges, dwarfing gradually off to the sides, where it disappears, thus leaving a large portion of every field with no crop at all. Wherever land is observed in this condition—and apparently the greater part of that in England is so—there is a want of drainage. The practice of making narrow heaped-up ridges, and deep furrows at their sides, is a proof of the land being badly drained. With a right method of drainage beneath, no portion of the surface is lost for cropping; the crop is at liberty to grow all over the field, and the furrow is only a slight indentation, to mark off the divisions for the reapers in harvest.

Drains are of several kinds, according to the nature and situation of the land. Some drains are conduits built with stone, others are conduits filled entirely with loose stones, between which the water percolates and escapes, and others are constructed with tiles of a particular form. Of whatever description, main and tributary drains are required. We shall describe a main and an inferior drain, in the language of one of the most experienced writers on the subject, Mr. Smith of Deanston:—

"The main drain should be directed along the bottom of the chief hollow or valley of the grounds, where the whole or greater portion of the drains can be led into it. If any lesser hollows occur in the field, they must also have their proportional mains or leaders. The bottom of the main drain should be at least 3 feet, and, if possible, 3½ or 4 feet under the surface where it passes along; and it should have throughout as uniform a fall as the nature of the ground will admit.

"It should be flagged in the bottom, or, where flag-stones are expensive, built as an inverted arch, to prevent the possibility of washing away under the side building. The dimensions necessary will depend on the fall or declivity, and the area of the land from which it has to receive water. With a fall in no place less than one foot in 100 yards, a drain 10 inches wide and 18 inches deep will void the rain water from 100 acres. It is of great importance to make the open area of such drains narrow and high, as smaller bottoms and covers will suit, and be less liable to give way; and the current of water being more confined, mud and sand will be less apt to settle in the bottom. Let the sides be smoothly and securely built with flat stones, either with or without mortar; and let strong flat covers be placed over, or, where such are not to be found, rough simple arches may be built with thin stones and mortar, for the bottom and cover, packing the haunches of the arch well up to the sides of the cut. Where lesser hollows occur crossing the fields, it is necessary to cut submains along their bottoms, about 3 or 3½ feet deep, and having openings of suitable dimensions formed by inverted stone couples, or with drain tiles, or, where a very large flow of water has to be provided for, with an inverted tile, and a covering tile placed above the bottom one, or with larger tiles made on purpose.

"There should be a cross submain at the bottom of every field or stretch of drains, to receive the water from all the parallel drains; and such drain should always be cut six inches deeper than the drains running into it, that the water may have a free drop, which will prevent the lodgment of mud or sand at their junctions or mouths. Open cuts or ditches, either as mains or submains, should never, except from necessity, be adopted, being apt to get filled with mud and grass, by which water is thrown back into the drains, which often chokes them; besides, the loss of land, annoyance in ploughing, constant expense of cleaning, and the unsightly appearance of the thing, are serious objections.

"Having thus provided a main drain, with submains flowing into it, matters are prepared for setting off and executing the parallel frequent drains in the body of the field. The drains can be executed at any season, when the weather will permit; but the spring and summer are most suitable for the work. It is best to execute the drains when the field is in grass, as it can then be done in all weathers in a more cleanly manner.

"In laying off the drains, the first object for consideration is the nature of the subsoil. If it consist of a stiff strong till, or a dead sandy clay, then the distance from drain to drain should not exceed from 10 to 15 feet; if a lighter and more porous subsoil, a distance of from 18 to 24 feet will be close enough; and in very open subsoils, 40 feet distance may be sufficient. When the ridges of the field have been formerly much raised, it suits very well to run a drain up every furrow, which saves some depth of cutting. The furrow being thereafter made over the drains, the hollow is filled up, and the general surface ultimately becomes level. When the field is again ridged, the drains may be kept in the crowns or middle of the ridges; but if it is intended to work the field, so as to alternate the crowns and furrows, then the ridges should be of a breadth equal to *double* the distance from drain to drain; and by setting off the furrows in the middle between two drains, the crowns will be in a similar position; so that, when the furrows take the place of the crowns, they will still be in the middle betwixt two drains, which will prevent the risk of surface water getting access to the drain from the water furrows by any direct opening."

Small tributary drains, made with broken stones, and covered with turf, to prevent the earth from filling them up (called *rumble drains* in Scotland), are in most places falling into disuse, and are superseded by drains made with tiles. The tile drains are peculiarly available over the greater part of England, where there is a scarcity of stone; and both there and elsewhere they will soon constitute the only kind of field drainage in use. The tiles for these drains, which are made at most brickfields, are simple in construction. There is a flat tile for the bottom, and a semicircular tile to place upon it, with the concavity undermost. In hard-bottomed land, the sole tile is sometimes disused. The tiles measure from 12 to 14 inches in length; and being placed neatly in a row, close to each other, a channel of 4 inches wide and 6 inches deep is formed; the water is admitted by the seams or interstices, so as readily to flow away. A little straw, stubble, or loose furze, is placed immediately over the upper tile, by which the chance of stoppage by the intrusion of earth is removed. The depth at which the tile drain is laid is 24 or 36 inches, as above, which, being covered with 10 or 12 inches of gravel or stones, allows a sufficient depth of soil above for the operations of subsoil-ploughing. When the depth of the drain is three feet, and the soil a retentive clay, it is frequently filled up for about a foot with stones above the tile, and turf laid above the stones, the rest being made up with surface earth. Figure 1 represents a section of a tile-drain of the proper construction. It will be observed that the bent tile laid on a flat sole, is advantageously placed for carrying off all the water that may trickle through the earth and stones above, and cannot be easily choked up with soil.

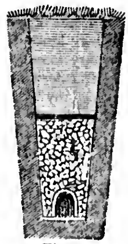


Fig. 1.

In cutting drains, three kinds of spades will be required—a common working spade, one a little narrower, and the third the breadth of the bottom of the drain. The cuttings should be done smoothly and neatly, preserving a descent throughout; and the tiles should not be laid till the cuttings have been carefully inspected. The terminations of the tile-drains may be led into subterranean mains, or into the shelving banks of open rivulets or sunk ditches; but in the latter case, their mouths will probably require to be protected from the intrusion of vermin, or from external injury. In planning the lines of drains, the straightest side of the field should be selected, the first being laid off as parallel as possible, and the others formed at the distances thought necessary.

In some places, from the extreme levelness of the land, or from obstructions in the subsoil, it will be found difficult to carry off moisture by drainage in the regular manner, and the leading of converging drains to a pit in a low part of the field, will be the only course open for adoption.

The drainage of sheep pastures is often not less necessary than land for tillage: it improves the grass, and, by drying the surface, renders the ground more salubrious—dry pasturage being indispensable for sheep. The mode of draining adopted for hilly sheep-walks is very simple. On the sides of hills, open drains a foot in depth, and from eighteen inches to two feet broad at the top, are cut, with a gentle slope towards a rivulet into which they are to discharge themselves. They are made to slope in different directions, and thus form so many furrows, which draw off the trickling moisture of land springs, and the superabundant rain which falls. In the south of Scotland, the sheep-walks have been prodigiously improved by these simple and unexpensive drains.

SUBSOIL-PLOUGHING.

It has been seen, in treating of mosses, that ground chiefly composed of inert vegetable matter, or peat, may be greatly improved by supplying a due proportion of sand or gravelly material, carted from a distance or raised from the subsoil. The same thing may be said of all lands which have been deteriorated by repeated cropping. A time comes when the silica and other earthy bases are found to have been abstracted in the crops, and fresh materials must be added.

The process of earthy restoration may be accomplished by scattering new materials upon the fields; and this might be easily accomplished in many parts of the country, so far as silica or fine sand is concerned; but the readiest and cheapest process in most situations will consist in trenching the subsoil, and gradually assimilating it to the mould above. The subsoil, or that portion of the under stratum which lies out of reach of the ordinary plough, may already be so good as to be available for bringing towards the surface, and in such cases it admits of easy and profitable management; but in most instances in our country, the subsoil is hard and stony, and will require to be trenched, and lie for a time in its underground position, before it is ready for mixing with the upper mould.

The most efficient instrument for trenching the subsoil on a large scale, is the subsoil-plough, invented by Mr Smith of Deanston, whose account of it we shall take the liberty to introduce.

"In the design, two essential points were kept in view:—1. The construction of an instrument that would effectually open up the subsoil without throwing any of it to the surface, or mixing it with the active or surface soil; 2. To have an implement of the easiest possible draught for the horses, while it was of sufficient strength and weight to penetrate the firmest ground, and resist the shocks on the largest stones. The extreme length of the plough is about 15 feet. From the socket at the point of the beam to the first stile or upright, 6 feet; from thence to the back of second stile, 19 inches; from thence to the outer end of holding handles, 7 feet; from the sole to the bottom of beam at stiles, 19 inches; length of head or sole-bar, 30 inches; from heal of sole to point of sock, 46 inches; broadest part of sock, 8 inches.

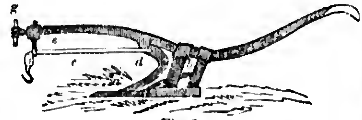


Fig. 2.

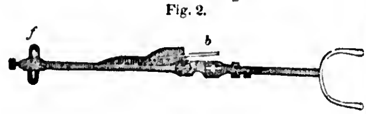


Fig. 3.

The coulter is curved, and in order to prevent its point being driven from its place by stones, it is inserted to the depth of an inch in a socket (*a*). The lateral dimensions of the sole-piece are 2 inches square. This is covered on the bottom and land side with a cast-iron sole-piece, to prevent wear. The sock goes on the head in the usual way, and from its feather rises the spur-piece (*b*), for the purpose of breaking the subsoil furrow. When the subsoil consists of very firm clay, or other hard and compact earth, the feather and spur-piece may be dispensed with, and a plain wedge or spear-pointed sock, such as those of the old Scotch plough, may be used. The draft-bar (*c*), of 1¼ inch round iron, is attached to the beam at the strong eye (*d*), and passing through an eye in the upright needle (*e*), is adjustable to any height or lateral direction, being movable in the socket (*f*), at the point of the beam, and can be made fast at any point by a pinching-screw wrought by the lever (*g*.) By the proper setting of the draught-rod, the direction of the power of the horses is so regulated as to render the guiding of the plough easy at any depth or width of furrow. The beam is about 5 inches deep at the middle, and 1¼ inch in thickness—towards the draught end it tapers to 3 inches deep, and 1 inch thick—at the holding end, where the handles branch off, it is 2 inches by 1. The whole weighs 440 lbs. imperial. This appears an enormous weight, and most people are alarmed at the strength and weight of the implement; but after repeated trials with lighter ploughs, those of the dimensions and weight now described have been found to be at once the most efficient, the most easy of draught, and the easiest for the ploughman to manage."

When a field is to be trenched, a common plough, drawn by two horses, goes before, throwing out a large open furrow of the active soil. The subsoil-plough follows in the wake of the common plough, slits up thoroughly and breaks the bottom, and the next furrow of active soil is thrown over it. This large subsoil-plough is a kind of *horse-pick*, breaking up without raising the under-stratum to the surface. The atmospheric air being by this means freely admitted to the subsoil, the most sterile and obdurate till becomes gradually meliorated, and the common plough may ever after be wrought to a depth of from ten to twelve inches without obstruction. For this heavy ploughing most likely three horses yoked abreast will be required. The charge for subsoil-ploughing may be estimated at twenty-four to twenty shillings per statute acre, being one-fifth of what a similar depth with the spade would cost, and, upon the whole, be as effectually done. The expense of subsoil-ploughing is no doubt considerable, but its advantages are incalculable. "All who have ever studied or experienced the most common gardening, must be aware of the important advantages of deep working; and when it can be attained in the broad field of farming at so small a cost, they may easily believe that the whole will be more than doubly repaid in every succeeding crop, and abundantly even in pasture. When land has been thoroughly drained, deeply wrought, and well manured, the most unpromising sterile soil becomes a deep rich loam, rivalling in fertility the best natural land of the country, and from being fitted for raising only scanty crops of common oats, will bear good crops of from 32 to 48 bushels of wheat, 30 to 40 bushels of beans, 40 to 66 bushels of barley, and from 48 to 70 bushels of early oats per statute acre, besides potatoes, turnips, mangel wurzel, and carrots, as green crops, and which all good agriculturists know are the abundant producers of the best manure."

LIMING.

Lime is the most important earthy substance which is usually applied to land. It is found in the form of rocky material, in which condition it is in combination with carbonic acid gas. On being burnt, this gas is expelled, and it assumes the form of a whitish brittle mass, easily reducible to powder. On being exposed to the atmosphere in its soft powdery condition, it has a strong tendency to imbibe moisture from the air, and soon becomes as heavy as it was previous to burning. It also recombines with itself carbonic acid from the air.

The use of this artificially prepared earth in agriculture is well known; but certain peculiarities in its action have never been satisfactorily ascertained. It possesses the power of decomposing animal and vegetable matter, and enters as an element into the fabric of plants; in certain cases it only alters the constitution of the soil, and in some instances its application would be positively injurious. Speaking of this remarkable fossil, Sir Humphry Davy observes—"When lime, whether freshly burned or slaked, is mixed with any moist fibrous vegetable matter, there is a strong action between the lime and the vegetable matter, and they form a kind of compost together, of which a part is usually soluble in water. By this kind of operation, lime renders matter which was before comparatively inert, nutritive; and as charcoal and oxygen abound in all vegetable matters, it becomes at the same time converted into a carbonate of lime. Mild lime, powdered limestone, marls, or chalks, have no action of this kind upon vegetable matter; by their action they prevent the too rapid decomposition of substances already dissolved, but they have no tendency to form soluble matters. It is obvious, from these circumstances, that the operation of quick-lime, and marl or chalk, depends upon principles altogether different. Quick-lime, on being applied to land, tends to bring any hard vegetable matter that it contains into a state of more rapid decomposition and solution, so as to render it a proper food for plants. Chalk and marl, or carbonate of lime, will only improve the texture of the soil, or its relation to absorption; it acts merely as one of its earthy ingredients. Quick-lime, when it becomes mild, operates in the same manner as chalk; but in the act of becoming mild, it prepares soluble out of insoluble matter. The solution of the question, whether quick-lime ought to be applied to a soil, depends upon the quantity of inert vegetable matters that it contains. The solution of the question, whether marl, mild lime, or powdered limestone, ought to be applied, depends upon the quantity of calcareous matter already in the soil. All soils are improved by mild lime, and ultimately by quick-lime, which do not effervesce with acids, and sands more than clays."

Let us now proceed to the practical application of this valuable fossil manure, commencing with its use in the reclaiming of waste lands. If moorish or waste soil is much infested with the tenacious roots of rushes, heaths, and other weeds which resist the mechanical action of the harrow, and yield slowly to putrefaction, the best mode is to till the ground, and allow it to lie in this state for twelve or eighteen months, or even two years, before applying the lime. It is then generally applied in autumn, and tilled in as soon as possible; but if not immediately tilled in, the soil with the lime on it should be harrowed, so that its decomposing effects may act as powerfully as possible upon the vegetable matter. After these operations, the land is sown two successive years with oats, without any fallowing; and along with the second crop of oats some persons sow it out in grass seeds for pasture. Others, after the first or second crop of oats, give the land a summer fallow for one season, or a green crop with manure. On the following season another crop of oats is taken, along with which grass seeds are sown, and in this state it is committed to pasture. In some cases, after tillage, the soil is allowed to lie for one, two, or more years, according to its nature, after which it is reduced to a complete state of pulverization by a well-wrought naked summer fallow On the spring following it is limed, and the lime is well harrowed in along with grass seeds alone, and in the following season the land is committed to pasture. This, however, is a very expensive mode, and cannot be recommended to tenants whose lease is of a moderate length. It is decidedly the most enriching mode of laying down waste land with lime only for pasturage, as the energy which the lime communicated to the soil is not exhausted by grain crops.

It will now be observed that lime is a most important engine of improvement for waste lands; for it decomposes and brings into active use the inert vegetable matter, and also serves as an elementary earth for the growth of plants. For peat lands, after being drained, and generally all rough lands reclaimed from a state of nature, lime is invaluable, and equally so for either tillage or pasture. In connection with turnip husbandry, it has been the grand reclaimer in many parts of Scotland, and will effect similar ends in any district of country not possessing a sharp and active soil; in such places it is not required, and its application may do harm. Laid on merely as a top dressing—that is, thinly powdered over the land—lime is found to have very extraordinary effects. Mr. Aiton, in his treatise on moss, observes—"If lime or other calcareous substances are laid on the sward, though the land be neither laboured nor any seed sown, such are the effects of hot lime, that the moss plants will instantly disappear, and a rich and beautiful sward of clover, daisies, and the richest poa or meadow grasses, will rise spontaneously."

From the result of experiments in many different situations, it seems satisfactorily proved, that the proprietors of waste lands within reach of lime have themselves to blame for the grounds continuing in sterility. Their complete melioration, however, is not to be expected at once; but upon proper arrangements being entered into between the landlords and the tenants, a great proportion of the pastoral grounds, lying in a state of waste, might by these means be progressively improved.

It seems to be a general wish of farmers to use lime rather in tillage than by top-dressing, which is much to be regretted, as the lime, when used in tillage, conjoined with over-cropping, eventually exhausts the soil; whereas, by applying it in top-dressing, it will prove highly beneficial. Therefore, in a climate rising six hundred feet above the level of the sea, top-dressing is the most effectual way in which lime can be applied for improving barren pasture-grounds. The land is never in this way exhausted by any species of cropping; it is put in a state of being benefited by the dung of the animals grazing upon it; and by due attention being paid to keeping the land free from wetness, by draining, it will be progressively fertilized. In the application of lime, it is a rule which should invariably be attended to, always to give abundance, and in a newly slaked condition, in order that it may have its full effect. If slaked a considerable length of time before it is applied, it does not act so powerfully either in reducing the natural herbage or neutralizing the acids, as when applied in a hot powdery state. There are very thin moorish soils, however, where lime by itself will not improve the herbage, these requiring a nourishing before a stimulating manure; and on such lands, a dressing of good earth will be found to have the same effects as lime has on a strong soil. Top-dressing with clay or sand may also be performed with advantage in mossy moorish tracts, where lime cannot easily be obtained. These earthy materials have a wonderful effect in improving the pasturage; they entirely destroy the growth of most plants; and if applied to the depth of an inch or so, will generate a sweet herbage, rendering the ground capable of being benefited by the droppings of the animals it supports.

IRRIGATION.

While some lands can be reclaimed only by draining, others, which are naturally dry, may be rendered equally serviceable by irrigation, or artificial watering. Lands in the dry climate of Australia seem to be in this condition; instead of depriving them of water, they require all that can be conveniently led towards them. Much of the land in the inner parts of North America is likewise so dry, that drainage is altogether undesirable, and irrigation is in many cases a means of fertilization. It may happen that lands naturally marshy are as much the better for irrigation as dry deserts; but in all such cases the lands must in the first place be drained. This leads to an explanation of the principle of irrigation.

When water lies in or upon the land, it stagnates and produces a marsh, which is alike insalubrious and unproductive. The extensive Pontine marshes in the neighbourhood of Rome present a remarkable example of both these conditions. In order that water may not be injurious, it must be kept flowing, always running amongst and from the blades of herbage. Regarding the theory of irrigation, Sir Humphry Davy says—"Water is absolutely essential to vegetation; and, when land has been covered with water in the winter or in the beginning of spring, the moisture, which has penetrated deep into the soil and even the subsoil, becomes a sort of nourishment to the roots of plants in the summer, and prevents those bad effects which often happen in lands in their natural state, from a long continuance of dry weather. When the water used in irrigation has flowed over a calcareous country, it is generally found impregnated with carbonate of lime, and in this state it tends, in many instances, to ameliorate the soil. Common river water, also, generally, contains a certain portion of organizable matter, which is much greater after rains than at other times, and which exists in the largest quantity when the stream rises in a cultivated country. Even in cases where the water used for flooding is pure, and free from animal and vegetable substances, it acts by causing the more equable diffusion of nutritive matter existing in the land; and in very cold seasons, it preserves the tender roots and leaves of the grass from being injured by frost.

"In general, those waters which breed the best fish are the best fitted for watering meadows, but most of the benefits of irrigation may be derived from any kind of water. It is, however, a general principle, that waters containing ferruginous impregnations, though possessed of fertilizing effects when applied to a calcareous soil, are injurious to soils that do not effervesce with acids; and that calcareous waters, which are known by the earthy deposit they afford when boiled, are of most use on siliceous soils, or other soils containing no remarkable quantity of carbonate of lime." Whatever be the actual properties communicated by the water, it is certain that the general effect of meadow irrigation is greatly to increase the quantity of herbage, and render it more sweet and nourishing for cattle than if grown on dry grounds.

In order to irrigate a field, there must be a difference of levels, the water being made to run in a main channel along the highest side, and thence sending small rills all over the lower parts of the ground. The principle of adjustment is by sluices. When the slope is considerable, the water requires to be sent diagonally across the field, and being catched in mains at intervals, is again distributed, if need be, in new directions. This is called catch-work irrigation. The following observations on the subject occur in Stephens' Practical Irrigator and Drainer: —"In the formation of an irrigated meadow, there are two rules of the greatest weight: one is, that no part of the works be made on the dead level; and the other, that every drop of water be kept in constant motion; but to give exact directions for the formation, is beyond the ingenuity of man; for no two pieces of land are precisely alike, which renders it impossible for the irrigator to follow the same plan in one field that he has done in another. Each meadow, therefore, requires a different design, the construction to be varied according to the nature of the ground and the quality and quantity of water. Inclined plains are absolutely necessary for the purpose of irrigation; and the benefit of irrigation depends so much upon the good management and patient perseverance of those who have the superintendence of it, that I do not wonder it has so often proved unsuccessful. However simple the construction of a water meadow may appear to be on a superficial view, those who enter minutely into the detail will find it much more difficult than is commonly imagined. It is not an easy task to give an irregular surface the equal slope requisite for the overflowing of water. It is very necessary for the irrigator to have just ideas of levels; a knowledge of superficial forms will not be sufficient. Few people unacquainted with the art of rrigation and the regularity of form which the adjustment of water requires, have any idea of the expense of modelling the surface of a field. Where land is very uneven, it is sometimes advisable to break it up with the plough, and take a crop of oats before the formation; by which means the land can be properly cleaned and pulverized before levelling it into form with the levelling plough and spade the following year—an operation which may be executed at half the expense of doing the whole with the spade and wheel-barrow. But there is one advantage by doing the whole work with spade and barrow, especially where the turf is strong, which is, that the water can be applied as soon as the beds are formed; but by breaking up, and taking a crop of oats, it will require two or three years after the grass seeds are sown before the water can be used, which some proprietors think too long to wait, therefore will rather be at an additional expense to have the turf lifted and laid down again; by so doing, the whole operations may be performed in one season. The grass seeds generally used for laying down land for water meadow are, vernal grass, crested dogstail, soft meadow grass, rough-stalked meadow grass, foxtail, fiorin grass (*agrostis stolonifera*), which last is one of the prevailing grasses in all good meadows; and the best way of planting it is to cut the whole into short pieces, the same way as cutting straw into chaff, and sow it with other sides. It is not always that those grasses give a good crop the first year; therefore, to obviate this evil, some perennial ryegrass seed should be sown along with the others, to produce a crop of hay before the watering commence."

It must be understood that the irrigation of any meadow is not to be incessant. There are times when the water must be altogether turned off, and the ground left to dry; it is at these times that the herbage is to be cut and removed. In large meadows, it is customary to turn off the water from different parts at different times, by which a constant succession of crops is obtained. Speaking on this part of the management, Mr. Stephens observes:—"One of the greatest defects in the management of irrigated meadows in this country, is the not paying proper attention to freeing the ground from subterraneous and stagnant water; for experience shows that, wherever there is too much moisture beneath the surface, or if the water lodges too long upon it, the crop will always be coarse and scanty. Another great error generally committed is, allowing the water to run too long at a time, without properly drying the ground. I know some instances in this neighbourhood where the ground is not attempted to be dried from the time the water is put on the meadows, in the autumn, till eight or ten days before the cutting of the hay; the consequence is, that the grass is of the coarsest quality, and the ground has become so very boggy, that the whole crop of grass is obliged to be carried by people to some other place to be made into hay. Another inconvenience arises from bad management, which, I am sorry to say, is too prevalent in this country; that is, permitting the grass to stand too long before cutting; the consequence is, coarse hay, badly made, and in many instances half rotten before being put into the stalk; and, moreover, owing to the lateness of the season, the aftermath is entirely lost; so that the proprietor has not received half the value of his meadow which he ought to have received, if the hay had been made in the proper season.

"The first operation of the irrigator is to adjust the water in the conductor, or, if the meadow is in more parts than one, the water in each conductor must be first regulated; then he commences anew by regulating the stops in the first feeder; but should there not be sufficient water in the feeder, a little more must be led in, by making the aperture wider or deeper, till the water flows regularly over the sides from one end to the other; from the first, he proceeds to the second feeder, and so on, until the water in all the feeders is adjusted. Let the beds of a water-meadow be ever so well formed, yet, by some places sinking more than others, or by the ice raising the surface of the ground, although the water along the banks of the feeders have been ever so nicely adjusted, it often happens that there may be some places between the feeders and drains with too little water, when it will be advisable for the manager to make a third round, redressing inequalities of the surface, so as to give every spot an inch deep of water. Every part of the works being regulated, the water should be allowed to run through the whole of October, November, December, and January, from fifteen to twenty days at a time, without intermission. At the expiration of these periods, the ground should be made completely dry for five or six days, to give it air; for there are few species of grasses, which form the most nutritious part of the herbage of water meadows, that will long exist under an entire immersion of water. Moreover, if the frost should be severe, and the water begin to freeze, the watering must be discontinued, otherwise the whole surface will become one sheet of ice; and wherever the ice takes hold of the ground, it will undoubtedly draw it into heaps, which is very injurious to the plants. The object of this early preparation of the meadows is to take advantage of the autumnal floods, which bring along with them a variety of putrescent matter, which is found very enriching to land." At the most convenient period of the year, the various channels will require to be cleaned out, and the works repaired.

PROTECTING RIVER BANKS.

Much valuable land on the banks of rivers and rivulets is often laid waste by the encroachments of floods. A few words on this important subject seem to be necessary. It may be laid down as a principle in natural science, that water is irresistible, and therefore it must not be resisted—it must be humoured. All windings in streams are causes by resistance. The water, in rushing onward, dashes against a projecting stone or hard part on one of its banks; this sends it in an opposite direction, and it strikes against whatever obstacle is presented. This process of interruption soon causes a mouldering of the banks in opposite directions, so that at length the water runs in a zig-zag or serpentine course. All this might have been avoided by allowing the water a perfectly free course.

The damage done to lands by flooding, has led to numerous experiments for keeping the water in its channel, but seldom with any degree of success; because the attempts have been to hem in the current by sheer force. In all cases in which it is desirable to keep out tides or high floods from lands, the only secure method consists in giving the banks such a slope that they will present no resistance whatever, but allow the water to rise and subside with equal ease and tranquillity. As a general truth, the greater the slope the better; and it should never be less than a foot and a half for every foot in the height. Employ no stones or stakes, or any thing else, for the current to catch upon; but cover the slopes with smooth turf, at a season which will allow of its growth before the floods set it. If any patches get broke, let them be annually mended. To keep out high floods, the banks must be made correspondingly high. Artificial embankments, in a flat country, should assume the form of a long mound, sloping on both sides.

Notwithstanding the obvious utility of this simple and unexpensive mode of protecting river banks, instances of damage are constantly occurring from projects of an opposite kind. Mr. Stephens mentions the following as one of many within his knowledge:—"An embankment was thrown round the small island Mugdrum, in the river Tay, to protect the land from being overflowed by the tide; but it was made so steep, that the first spring tides levelled the greater part of it to the ground. A second attempt was made, with the additional expense of a stone wall facing the water, which shared the same fate with the former bank. Since these failures, a third embankment has been erected with nothing but the natural soil of the land, and the whole covered with thin turf. The length of the present slope next the sea is five times the perpendicular height of the bank, and the inner slope three times; the water, meeting no resistance, rolls down the long slope without doing any injury." We refer to Mr. Stephens' useful treatise for further information on this subject, as well as on irrigation and draining.

In connection with the protection of river banks, we may say a few words on the method of gaining land from rivers and tidal estuaries. This may be done if the river appears to struggle over an unnecessarily wide space, and brings down quantities of mud so as to produce impediments to navigation. The process usually followed with most advantage, is to run out at intervals short rows of stakes, matted with twigs, calculated to catch the confluent particles of mud, but to allow the water to pass through. A sediment is thus gradually formed between the rows; in time it rises above the water, and ultimately forms a green productive surface. When the water is affected by the tides, a row of loose stones laid between high and low water-mark will similarly catch mud and sand, and while forming new land, will, by narrowing the channel, give greater impetus to the stream, and help to deepen its bed. When done on a great scale, the bed of the river is scooped by mechanism, and the rubbish brought up may afterwards assist in elevating the newly formed banks. In point of justice to all parties, any of these processes of river-bank improvement should be done on both sides of the river at the same time; for if effected only on one side, the water may be driven to the opposite shore, to the serious damage of the land in that quarter.

SPADE HUSBANDRY.

The reclaiming and culture of small pieces of land by means of the spade and other instruments of manual labour, is usually spoken of under the name of spade husbandry; but is also sometimes called cottage-farming, or field gardening—the operations of the culturist bearing an intimate resemblance to those applied in ordinary kinds of gardening. The apparatus supposed to be employed by the cottage farmer is simple and unexpensive. It consists of two or three spades of different sizes, a pickaxe, three-pronged digging-fork, hoes, rake, light harrow which he can draw, scythe, reaping-hooks, hay-forks, flail, wheelbarrow, &c., according to means. It is of great importance for the cottage farmer to be able to sharpen or mend his tools, and for this purpose he should have a grinding-stone and small forge, also some carpenter's tools. No horse or paid servant is kept. All the work is done by the manual labour of the farmer and his family. The only live stock is a cow or cows, pigs, and poultry. The homestead consists of a cottage with several apartments—a cow-house, pig-stye, and barn. The size of the farm is supposed to vary from four to six or eight acres, and to be laid out in six or eight distinct fields, properly fenced.

Trenching.

The basis of cottage farming is deep trenching with the spade; but before regular trenching can commence, the land if in a rough state, must be cleared and drained. We have already shown how these preliminary operations are performed on a large scale, and they may very easily be modified for manual labour. Suppose the patch of land is part of a moss, dig open drains round it to draw off the water; scarify the surface with the spade, and burn the heaps of turf; scatter the ashes on the land along with any sandy material or lime which can be procured, and then delve all from one end to the other. This process will cause a large portion of the mossy fibre to decay, and the exposure to the atmosphere and draining will be found to meliorate the soil. In twelve months, the face of the land will be more like *earth* and less like peat than it was at the time of delving.

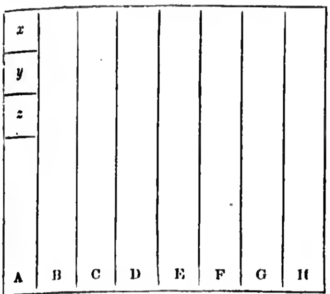
If the land be choked with stones or roots, all these encumbrances should be removed to the depth to which you design your trenching should go; and the sooner you get rid of them the better. The whole ground should be free of every thing which can present the slightest impediment to the spade. Stones of even an ounce in weight should be removed. Where subdraining is required, the stones may be employed to lay in the drains. With respect to the first crops taken from the delved field, it will depend on the natural fertility of the ground and other circumstances. If the land be comparatively dry and fertile, as, for instance, the forest land of North America, a good meliorating and opening crop is potatoes; but in the case of poorer soils, manuring will be required, and the first crop may be grass. If the land can be conveniently partitioned into separate fields, a different crop may be taken from each, thus commencing a regular rotation. In proportion as the upper layer of earth is meliorated and exhausted, it will be necessary to go the deeper down. On large farms, certain fields are occasionally left fallow, that is, doing nothing, unless it be gathering what strength can be procured from the atmosphere. In cottage farming, this wasteful practice must be unknown. Instead of trying to recruit the land by giving it a rest, you must recruit it by turning up the layer of mould immediately below that which has been affording nourishment to your crops. This stratum, which we shall call layer No. 2, extends from 9 to 18 inches below the surface, supposing you to have been employing a nine or ten-inch spade. It is, generally speaking, neither soil nor subsoil, but partakes of the qualities of both; and after two or three years' cropping, will be found to have imbibed a share of the manure delved in for the crops. The art, then, consists of raising up this layer No. 2, and turning down No. 1 in its stead. By doing so, perhaps manuring may be omitted for a year, and, at any rate, a light manuring will suffice.

In some districts the depth of available soil may not be so much as 18 inches, the layer beneath being rock or chalk, in which case the stirring of the soil cannot be carried deeper, unless at an immense cost of labour; but in the greater number of instances, the soil rests on a till or clayey-hardish substance, usually called subsoil; and this which we may call layer No. 3, must be stirred and gradually brought up in aid of the upper soils. As mentioned under the head *Subsoil Ploughing*, the proper method of nourishment consists of first stirring or breaking up the hard subsoil. Get down to it, and go over it with a pickaxe. Next year it may be incorporated with layer No. 2, and in two or three years the whole three layers may be indiscriminately mingled or made to change places. Such is the principle of trenching, by which three layers of soil are alternately, or at proper intervals compelled to do duty; and thus a farm of six acres, by being, as it were, three story deep, is practically as extensive as one of eighteen acres but one story deep. When we add, that while the plough leaves lumps of earth unbroken, and comparatively useless to the crop, the spade dashes and pulverizes the whole soil, bringing all into effective play on the roots, the value of spade over plough husbandry will be at once apparent. Another important advantage of deep trenching with the spade, is the turning down and destroying the larvæ of insects and seeds of weeds which may be about the surface; and it will be found that the first crops of trenched ground are always remarkably free of these nuisances.

The process of trenching to effect these important advantages is no doubt very toilsome; this, indeed, is a fact not to be concealed; but, without almost constant [illegible], and labour in which a pleasure is taken, cottage farming will generally come to nought; and he who is disinclined to undergo the trouble, should not commence the undertaking. To render the work as easy as possible, it should be methodic, and bit by bit, and always the more the ground is tilled, the less difficult will the trenching be.

Trenching, either for gardening or farming, is usually performed as follows:—Mark off the field in strips of two feet in width, as in the annexed diagram. Commence at x and y at top of the field, and take from each

Top of the Field.



Bottom of the Field.

the top layer, which wheel across to a and b beyond the top of the strip H. Then dig out the lower layer or subsoil from x, and wheel it away to a separate heap near where you have laid the top earth. The patch x being now empty, fill it two-thirds, first with layer No. 2, and next with layer No. 3 of y, and cover it with layer No. 1, or top earth of z. Thus go on wheeling and shifting till you come to the bottom of A. You now turn and trench upwards the strip B in the same manner; trench down C and up D, and so on till you have in every patch laid a layer No. 2 undermost, and a layer No. 3 above it. The overplus, wheeled aside, will fill up the strip H. You may vary the process in many different ways; and, if you think proper, place layer No. 2 uppermost, and layer No. 1 in the centre; but all this must be left to your own ingenuity, and your ideas of what will be best on the occasion. As a further means of melioration, some trenchers stir the bottom of each strip when it is exposed with a pickaxe, which is a good plan; for the more the subsoil is loosened and prepared for being brought into activity, the more fertile will the fields be.

General Management.

Whether the land of a cottage-farmer be part of a reclaimed bog or waste, or a section of fertile soil, or whether it be his own property, or rented, he must necessarily exert unremitting industry not only in digging and trenching his small fields, but in all the ordinary routine of manuring, cropping, and in attending to the other affairs of his establishment. To procure manure in sufficient abundance, he must keep one or two cows and a pig, and into a pit adjoining the cow-house, all the solid refuse, including all that may be collected from the family, must be removed. The urine from the cow-house should be collected in another pit, or a barrel sunk in the ground, protected from the air. This will be found a most valuable liquid for throwing over the land, to excite a young growing crop. While on the subject of manures, it cannot be out of place to mention that most surprising results have been effected in agriculture and market-gardening, by the use of night-soil. In some foreign countries, where this is well understood, the night-soil is carefully saved, and to destroy its offensive effluvia, is mixed with gypsum or earth, for a few shovelsful of earth thrown over it at once removes all offensiveness in this respect, besides bein, [illegible]erwise useful. So little thought and trouble are us[illegible] taken in Britain to preserve this material for manure, that for the use of enterprising agriculturists, quantities are now imported from France in a dried and prepared condition.

There are other means of increasing the quantity of manure. From every piece of ground a quantity of rubbish may be collected, as withered leaves, stalks, clippings of branches, roots, &c. Improvident persons burn much of this refuse, but we strongly advise the cottager or gardener never to burn any thing, except it be stumps of trees, or pieces of branches as fuel. Collect all the inferior stuff into a heap, to which scrape or carry all the mire that can be gathered from the pathways, and the whole will make a compost dung-hill; a pailful of cow urine thrown occasionally over the heap will be a valuable addition, and so likewise will be a shovelful of night-soil. A little lime will hasten the rotting of any compost. If properly managed, in twelve months all will be rotted, and then begin taking from one end for manure. To the other extremity you may keep adding new matter that is collected. The treatment of the ordinary dung-pits is to be on the same plan. Do not remove the manure till it has lain a sufficient length of time to decompose, but keep taking from one that is ready, while another is collecting.

If a rivulet can be made to run upon a meadow, as previously described under the head *Irrigation*, the cottager will add prodigiously to his stock of grain, fodder, and hay. From a single acre, well irrigated, as much as 200 stones of sweet, nourishing hay may be gathered every year, besides a quantity of green stuff. The proper saving of this meadow hay requires considerable tact; if any way spoiled, the cattle will probably not touch it.

In the scheme of working a cottage farm, it should be an object to make the very most of every day out of doors, when the season and weather permit, and to occupy the dead of winter and days of bad weather at work in the barn or house. The Swiss small farmers do much by working at some handicraft employment, particularly weaving and making toys, during those seasons when prevented from labouring out of doors; and in many instances they keep one member of the family at the loom. In short, none must be idle; the grown-up children, when not at school, being made useful as far as their capacities will admit of.

It is calculated that an active spadesman would find little difficulty in bringing half an acre annually into an improved state; for as 80 rods make the half acre, and there being 313 working days in the year, to accomplish this it would require little more than a quarter of a rod to be trenched daily, whereas a moderate day's work, even where the soil is stony and difficult to trench, would considerably exceed a rod. But where there is a boy or two to assist, an acre might with perfect ease be brought into an improved state yearly.

Whether it would be preferable to devote a cottage farm to a mixture of green and grain crops, as in ordinary husbandry, or make it chiefly a dairy farm, in which the raising of green crops for fodder is the principal if not the only object, must depend on local circumstances. If near a city, where fresh dairy produce could be profit ably disposed of, dairy farming might be most suitable, although the large rents usually exacted near populous towns would prove an obstacle. Several experiments have been made in order to ascertain the quantity of produce in roots, artificial grasses, &c., that an acre of ground, under this sort of culture, could be made to yield; and the result has been that even less than 80 rods, or half an acre, will produce food sufficient to maintain a cow. This calculation is founded upon the well-known fact, that 100 lbs. weight of green food, a considerable portion of it roots, is a sufficient daily allowance for an ordinary cow. But cows kept upon such produce must not be allowed to pasture on those portions of the ground that are devoted to grass crops, such as clover, lucern, tares, &c.; but for the better health of the animals they should have an open space to move about in adjoining the shed or out-building, where they find shelter from the storm and cold; for in soiling cattle during the hottest part of summer, an open shed, with a rack for their food, is to be preferred to shutting them up in close stables. Mr. Allen, in his *Colonies at Home*, very properly remarks—"Whenever it is possible to make a rod of ground produce 500 lbs. of the artificial grasses, in the several cuttings during the season, I greatly prefer it to any thing else, for cows thrive best upon grass and hay." He afterwards observes, in reference to this sort of food—"As it sometimes suffers much in dry seasons, we must not depend entirely upon it; but I have proved that it is possible to keep a cow all the year round upon the produce of half an acre of land if it be carefully cultivated." He then proceeds to give a list of the produce he raised, which consists of lucern, cabbage, tares, mangel-wurzel, potatoes, turnips, parsnips, and carrots; and as a portion of hay is indispensable along with some of the root-crops during the winter season, he did not attempt to grow it, but sold a portion of his potatoes, and laid out the sum he received for them in hay. We need only add, that whatever number of cows be kept, they must be fed entirely within doors, and only suffered to go out in any small enclosure for the sake of air and exercise.

Plan of a Three-Acre Farm.

With the view of keeping up in the country a certain number of peasant families who should be able to assist farmers at particular seasons, the late Sir John Sinclair planned a system of cottage farms of three acres each; these were individually to be cultivated entirely by manual labour, and by the cottager and his family. From the account of the method of managing these cottage farms, which he has given in the second volume of the *Farmer's Magazine*, we select the following particulars:—

"*Course of Crops.*—The three acres proposed to be cultivated should be divided into four portions, each consisting of three roods, under the following system of management:—

	Roods.
Under potatoes, two roods; under turnips, one,	3
Under winter tares, two roods; spring tares, one,	3
Under barley, wheat, or oats,	3
Under clover, with a mixture of rye-grass,	3
Total,	12

"Other articles besides these might be mentioned; but it seems to me of peculiar importance to restrict the attention of the cottager to as few objects of cultivation as possible. It is proposed that the produce of the two roods of potatoes shall go to the maintenance of the cottager and his family, and that the rood of turnips should be given to the cow in winter and during the spring, in addition to its other fare.

"The second portion, sown with tares (the two roods of potatoes of the former year to be successively sown with winter tares, and the turnip rood with spring tares), might partly be cut green, for feeding the cow in summer and autumn; but if the season wi permit, the whole ought to be made into hay for the winter and spring food, and three roods of clover cut green for summer food.

"The third portion may be sown either with barley, wheat, or oats, according to the soil or climate, and the general custom of the country. The straw of any of these crops would be of essential service for littering the cow, but would be still more useful, if cut into chaff, for feeding it.

"The fourth portion, appropriated to clover and rye-grass, to be cut green, which, with the assistance of the orchard, will produce, on three roods of land, as much food as will maintain a cow and her calf for five months, namely, from the end of May or beginning of June, when it may be first cut, to the 1st of November, besides some assistance to the pigs. It is supposed that an acre of clover and rye-grass, cut green, will produce 20,000 pounds' weight of food for cattle. Three roods, therefore, ought to yield 15,000 pounds' weight. A large cow requires 110 pounds' weight of green food per day; a middling cow, such as a cottager is likely to purchase, not above 90 pounds; consequently, in five months, allowing 1320 pounds' weight for the calf and the pigs, there will remain 13,680 pounds for the cow. Were there, however, even a small deficiency, it would be more than compensated by the rood of land proposed to be kept in perpetual pasture as an orchard.

"*Mode in which the family may be maintained.*—It is calculated that three roods and eight perches of potatoes will maintain a family of six persons for about nine months in the year, but according to the preceding plan, it is proposed to have but two roods under that article; for however valuable potatoes are justly accounted, yet some change of food would be acceptable; and the cottager will be enabled, from the produce of the cow, and by the income derived from his own labour, and from that of his family, to purchase other wholesome articles of provision.

"*Manner in which the Stock may be kept.*—It appears, from the preceding system of cropping, that ten roods of land, or two acres and a half, are appropriated to the raising of food for the cow in summer and winter, besides the pasture of the orchard; and unless the season should be extremely unfavourable, the produce will be found not only adequate to that purpose, but also to maintain the calf for some time, till it can be sold to advantage. It is indeed extremely material, under the proposed system, to make as much profit of the calves as possible, as the money thus raised will be a resource, enabling the cottager to replace his cow when a new one must be purchased.

"For the winter provision of the cow, which is the most material, because the summer food can be more easily procured, there is the produce,

"1. Of about three roods of tares made into hay.

"2. Of three roods of straw, deducting what may be necessary for litter; and if dry earth be put into the cow's hovel, and removed from time to time to the dunghill, little or no litter will be necessary.

"3. Of one rood of turnips.

"The whole will be sufficient for seven months in the year, namely, from the 1st November to the 1st June; and during the remaining five months, the pasture of the orchard, some of the winter tares, and the produce of three roods of clover and dry-grass, will not only suffice, but will furnish a surplus for the calf, if it is kept for any length of time, and some clover for the pigs. The inferior barley, potatoes, &c., will of course be given to the pigs and poultry.

"*Value of the Produce.*—The land thus managed will certainly produce, by means of the extra industry of the family, and at a small expense, a most important addition to the income which the cottager may derive from his ordinary labour. For instance—

	Per Annum.		
1. The orchard, after the trees become fruitful, will probably yield	L.1	10	0
2. Three roods of turnips and potatoes,	4	0	0
3. Eighteen bushels of barley, at 4s.,	3	12	0
4. The cow and calf,	7	0	0
5. Hogs,	3	0	0
6. Poultry and eggs,	2	0	0
Total,	L.21	2	0

"Where wheat can be raised instead of barley, the profit would be still more considerable. Opinions will differ much regarding the value put on each article; but that is of little consequence, as the total cannot be accounted too high.

"*Time required for Cultivating the Land.*—The quantity of land intended to be cultivated will not materially interfere with the usual labour of the cottager. It will only require to be dug once, and is then fit to be cropped. It is proposed that only nine roods shall be annually cultivated (the remaining three roods being under clover and rye-grass), and nine roods may be dug in the space of about 558 hours, or at the rate of 62 hours per rood. This may be done at by-hours (more especially when the family of the cottager shall be somewhat advanced, and consequently more able to furnish assistance; but supposing that the digging, manuring, harvesting, &c., will require twenty entire days per annum, in addition to the by-hours, and allowing sixty days for Sundays and holidays, there will remain 285 days for the ordinary hand-labour of the cottager, which, at 1s. 6d. per day, would amount to £21, 7s. 6d.; the earnings of the wife and children may, at an average, be worth at least £4 per annum more. This is certainly a low calculation, considering how much may be got during the hay and corn harvests. But even at that moderate estimate, the total income of the family will be as follows:—

1. Produce of the farm,	L.21	2	0
2. Labour of the cottager,	21	7	0
3. Earnings of the family,	4	0	0
Total,	L.46	9	6

"*Rent and Balance of Income.*—The rents of cottages and of land vary so much in different parts of the kingdom, that it is difficult to ascertain an average. But if the cottage shall be stated at £3 per annum, the land at 25s. per acre, and the orchard at 10s., the whole will not exceed £7, 15s. The cottager will also be liable to the payment of some taxes, say to the amount of £1, 5s. more. Hence the total deductions would be about £9, leaving a balance in favour of the cottager of £37, 9s. 6d. Considering the cheap rate at which he is furnished with a quantity of potatoes, equal to several months' consumption, and with milk for his children, surely with that balance he can find no difficulty not only in maintaining himself and family in a style of comfort, but also in placing out his children properly, and laying up a small annual surplus, that will render any parish assistance, either in sickness or old age, unnecessary.

"*Advantages.*—The land possessed by the cottager would be completely cultivated, and rendered as productive as possible. The dung produced by the cow, pigs, &c., would be amply sufficient for the three roods under turnips and potatoes, which would afterwards produce—1. Tares; 2. Barley; and 3. Clover; with a mixture of rye-grass in regular succession, without any additional manure. The barley should yield at least 18 bushels, besides 3 bushels for seed; and if wheat is cultivated, in the same proportion. The milk, deducting what may be necessary for the calf and the cottager's family, might be sold in its original state, if there shall be a market for it; or converted into butter, for the purpose of supplying the neighbouring towns or villages. Such cottagers, also, might certainly send to market both eggs and poultry.

"It is hardly possible to suggest a measure more likely to promote the benefit of a numerous and valuable body of people. The system of keeping cows by cottagers, which has been found so advantageous in the grazing districts, may thus be extended over the whole kingdom; and indeed, if the above plan is found to answer, in place of four or five acres employed in feeding a single cow, it would be much better, even in the grazing counties, to restrict the land to a smaller quantity under a tillage mode of management.

"It is of infinite consequence to establish the practicability of this system, as the means of removing a most unfortunate obstacle to the improvement of the country. It is well known to be the only popular objection to the enclosure of our wastes and commons, that, while unenclosed, a number of cottagers are enabled to keep cows by the means of their common rights, and that their cows disappear when the commons are enclosed. But if so small a portion of land as 3¼ acres, when improved and properly cultivated, can enable a cottager to keep a cow to more advantage than with a right of common, which can hardly be doubted, as he is enabled to provide winter as well as summer food, there is an end to that obstacle to improvement. Indeed, if sufficient attention be paid to the principles above detailed, the situation of the cottager, instead of being deteriorated, would be materially bettered by the enclosure; and his rising family would be early accustomed to habits of industry, instead of idleness and vice.

"I shall conclude with asking, if any one can figure to himself a more delightful spectacle than to see an industrious cottager, his busy wife and healthy family, living in a comfortable house, rented by himself, cultivating his little territory with his own hands, and enjoying the profits arising from his own labour and industry? Or whether it is possible for a generous landholder to employ his property with more satisfaction, or in a manner more likely to promote not only his own but the public interest, than by endeavouring to increase the number of such cottagers, and encouraging, by every means in his power, the exertions of so meritorious and so important a class of the community."

To the article comprehending the above account, there is added an appendix containing a letter from Sir Henry Vavasour, describing the field-gardening on his estate We extract from it the following passages:—

"I have for some years encouraged my cottagers in Yorkshire in this mode of managing their small garths or gardens, which are in general from one to three acres. I have now an opportunity of stating the husbandry of a poor industrious cottager's garth. As the man can neither read nor write, these particulars have been transmitted to me from his own mouth; and as I saw his land almost every day during the last harvest, I can vouch that this account is not far from the truth.

Produce.	Value.			A.	R.	P.
240 Bushels of potatoes,	L.24	0	0	0	2	0
60 Ditto of carrots,	6	0	0	0	1	0
5 Quarters of oats, at 44s. per quarter,	11	0	0	0	3	20
4 Load of clover, part in hay, part cut green,	12	0	0	1	0	10
Turnips,	1	0	0	0	0	20
In garden-stuff for the family, namely, beans, peas, cabbages, leeks, &c.,	0	0	0	0	0	30
	L.54	0	0	3	0	0

Deduct rent,	L.9	0	0	including the house.
Seeds, &c.,	3	3	0	
Value of labour,	10	10	0	
	L.23	2	0	Produce before stated. L.54 0 0
				23 2 0
Profit,*				L.30 18 0 if sold at market, exclusive of butter.

"His stock was two cows and two pigs; one of his cows had a summer's gait for twenty weeks with his landlord. The land was partly ploughed and partly dug with the spade, cultivated (the ploughing excepted) by the man,

* These and the preceding calculations refer to prices a number of years ago.—ED.

his wife, and a girl about twelve years of age, in their *spare* hours from their daily *hired* work, seldom a whole day off, except in harvest: made the rent in butter, besides a little used in the family. The man relates that he thinks he clears, one year with another, from the three acres, about £30. The daily wages his family earns nearly keep them. It is very evident that this man clears, from his three acres, more than a farmer can possibly lay by from more than eighty acres of land in the common husbandry of the country—paying for horses, servants, &c.; and it must be obvious to every one how great the advantages must be to society in cultivating land in this manner. It would have taken more than half the quantity of his three acres in pasture for one cow at grass during half the year; whereas (except the summer's gait for one of his cows, as mentioned before) his stock of two cows and two pigs is kept and carried on the whole year. The family lives well; and a handsome sum has been yearly saved, to place out two sons, and supply them with clothes, washing, &c."

How to Keep a Cow and Pig upon an Acre of Land

A society was formed in London in 1833, called the Labourers' Friend Society, for the purpose of procuring allotments of small portions of land to the labouring poor, and whose operations, we believe, have been on the whole beneficial. The land, however, is let only from year to year, which, as a general principle, is pernicious; for no land will ever be properly cultivated when the holder of it is liable to be dispossessed at the end of every year. In cottage as well as large farming, the husbandman must be insured a continuance in his possession for at least ten or twelve years. Perhaps the above-mentioned society insures a renewal of the annual lease, provided a certain fixed rent is paid, which would be reasonable and beneficial to all parties.

The Labourers' Friend Society has published a cheap magazine of popular information on rural subjects, and from one of the numbers we extract the following advices, headed—How to Keep a Cow and Pig upon an Acre of Land.

"1. Never let the cow out of the cow-house. 2. Carry her food and water to her. 3. Do not keep one foot of land in pasture. 4. Dig your land instead of ploughing it. 5. Never throw away any thing that can be turned into manure. 6. Keep your land well weeded, and collect a large dunghill.

"A small cow, which is best for a cottager, will eat from seventy to eighty pounds of good moist food, of the following kinds, in a day:—Lucern or clover, and the leaves of yellow beet or mangel wurzel, from the beginning of spring to the end of autumn; and the roots of yellow beet or mangel wurzel, Swedish turnips, potatoes, and straw, from the end of autumn till the beginning of spring. If the cow is curried once a day, it will increase the quantity of milk.

"To procure the above-mentioned crops, you must have plenty of manure, which you will obtain by careful management. Rushes, potato-stalks, and weeds before they seed, should be industriously collected for the cow's litter.

"*Lucern* requires a good and deep soil. The ground for it should be well dug, two spits deep, and the manure deposited at one spit deep. It must be sown very early in the spring, in drills nine inches apart. The quantity of seed is one ounce and a quarter to the perch. It must be kept carefully free from weeds, and watered with the liquid manure from time to time; ashes also are a good manure for it. It sometimes admits of four cuttings in the summer, and, with attention to the foregoing rules, will continue productive for ten or twelve years. It will not do well upon shallow or boggy land, in which case red clover will be the substitute.

"*Swedish Turnips.*—Prepare the land as if for drilling potatoes; open the drills about twenty inches distant, the deeper the better; fill them with manure, cover them with four or five inches of earth, make the top smooth and level, then with a dibble make holes two inches in depth, and about twelve inches apart, and drop a seed into every hole. Keep them free from weeds. Three-quarters of a pound of seed will sow twenty perches. The time for sowing is May.

"*Mangel Wurzel*, or *Yellow Beet.*—The ground to be prepared in the same way as for Swedish turnips; from the 20th to the end of April is the best time for sowing; half a pound of seed will sow twenty perches. In August and September pull the leaves for the cow; these will last till you take up and store the roots, which should be done before the frost sets in.

"*Red Clover* (to be used only where lucern will not suit the soil) will afford a large quantity of green food as well as hay from ten square perches. It will last from two to three years on the same ground; one ounce and a quarter of seed is sufficient for a perch. The ground should be well and deeply dug, and made as fine as possible. The time of sowing is from February till April. The seed put in immediately after you have sown your oats half an inch deep in clayey soils, and one inch on loose soils; a coat of manure should be put on in spring and autumn. It may be cut two or three times in the season, and should not be given to the cow till it has been cut some hours, or she would be in danger of bursting.

"Some dry food should be given with the roots. The daily supply for a cow for the winter (about 180 days) may be as follows:—30 lbs. of mangel wurzel, or yellow beet—30 lbs. of Swedish turnips—14 lbs. of straw." The writer adds, with respect to the rotation of crops—"That, supposing the land of the peasant to consist of four roods, in the first year he devotes a rood for oats, a second rood to potatoes, a third to lucern, and a fourth to beet and Swedish turnips; in the second year he puts potatoes on the first rood, beet and turnips on the second, lucern on the third, and oats on the fourth; in the third year he puts beet and turnips on the first, oats on the second, lucern on the third, and potatoes on the fourth. By this means he effects a proper rotation of cropping, advantageous in keeping his land in heart. It will be easy for him to devote spare borders to the raising of onions and seeds."

Spade Husbandry in Belgium.

As a picture of rural affairs under a well-conducted system of spade husbandry, we present the following from the report of Mr. George Nichols respecting Belgium, laid before Parliament:—

"The extensive manufactures which at no very remote period flourished in Belgium, appear to have congregated a numerous population of artisans in and around the great towns. As the scene of manufacturing industry changed, this population was deprived of its means of handicraft employment, and was compelled to resort to the cultivation of the soil for subsistence. This seems to have been the chief, though possibly not the sole, origin of the system of the small farms which still prevails, and which are cultivated by the holder and his family, generally without other assistance. The farms in Belgium very rarely exceed one hundred acres. The number containing fifty acres is not great. Those of thirty and twenty acres are more numerous; but the number of holdings of from five to ten and twenty acres is very considerable, especially those of smaller extent, and to these I chiefly confined my inquiries.

The small farms of from five to ten acres, which abound in many parts of Belgium, closely resemble the small holdings in Ireland; but the small Irish cultivator exists in a state of miserable privation of the common comforts and conveniences of a civilized life, while the

Belgian peasant-farmer enjoys a large portion of those comforts. The houses of the small cultivators in Belgium are generally substantially built, and in good repair; they have commonly a sleeping-room in the attic, and closets for beds connected with the lower apartment, which is convenient in size; a small cellarage for the dairy, and store for the grain, as well as an oven, and an out-house for the potatoes, with a roomy cattle-stall, piggery, and poultry-loft. The house generally contains decent furniture; the bedding sufficient in quantity; and although the scrupulous cleanliness of the Dutch may not be everywhere observable, an air of comfort and propriety pervades the whole establishment. In the cow-house the cattle are supplied with straw for bedding; the dung and moisture are carefully collected in the tank; the ditches had been scoured to collect materials for manure; the dry leaves, potato-tops, &c., had been collected in a moist ditch to undergo the process of fermentation, and heaps of compost were in course of preparation. The premises were kept in a neat and compact order, and a scrupulous attention to a most rigid economy was everywhere apparent. The family were decently clad, none of them were ragged or slovenly, even when their dress consisted of the coarsest material. The men universally wear the blouse, and wooden shoes are in common use by both sexes. The diet consists, to a large extent, of rye bread and milk; the dinner being usually composed of a mess of potatoes and onions, with the occasional addition of some pounded ham or slices of bacon. The quantity of brown wheaten bread consumed did not appear to be considerable. I need not point out the striking contrast of the mode of living here described with the state of the same class of persons in Ireland; and it appears important to investigate the causes of this difference.

In the greater part of the flat country of Belgium the soil is light and sandy, and easily worked; but its productive powers are certainly inferior to the general soil of Ireland, and the climate does not appear to be superior. To the soil and climate, therefore, the Belgian does not owe his superiority in comfort and position over the Irish cultivator. The difference is rather to be found in the system of cultivation pursued by the small farmers of Belgium, and in the habits of economy and forethought of the people. The cultivation of the small farms in Belgium differs from the Irish—1st, In the quantity of stall-fed stock which is kept, and by which a supply of manure is regularly secured; 2d, In the strict attention paid to the collecting of manure, which is most skilfully managed; 3d, By the adoption of a system of rotation of five, six, or seven successive crops, even on the smallest farms, which is in striking contrast with the plan of cropping and fallowing the land prevalent in Ireland.

In the farms of six acres, we found no plough, horse, or cart; the only agricultural implement, besides the spade, fork, and wheelbarrow, which we observed, was a light wooden harrow, which might be dragged by the hand. The farmer had no assistance besides that of his wife and children, excepting sometimes in harvest, when we found he occasionally obtained the assistance of a neighbour, or hired a labourer at a franc per day. The whole of the land is dug with the spade, and trenched very deep, but as the soil is light, the labour of digging is not great. The stock on the small farms which we examined, consisted of a couple of cows, a calf or two, one or two pigs, sometimes a goat or two, and some poultry. The cows are altogether stall-fed on straw, turnips, clover, rye, vetches, carrots, potatoes, and a kind of soup made by boiling up potatoes, peas, beans, bran, cut hay, &c., into one mess, and which, being given warm, is said to be very wholesome, and to promote the secretion of milk. In some districts the grains of the breweries and distilleries are used for the cattle; and the failure of the Belgian distilleries has been reckoned a calamity to the agriculture of the country, on account of the loss of the supply of manure which was produced by the cattle fed in the stalls of these establishments.

The success of the Belgian farmer depends mainly upon the number of cattle which he can maintain by the produce of his land, the general lightness of the soil rendering the constant application of manure absolutely necessary to the production of the crop. The attention of the cultivator is always, therefore, especially directed to obtain a supply of manure. Some small farmers, with this view, agree with a sheep-dealer to find stall-room and straw for his sheep, to attend to them, and to furnish fodder at the market price, on condition of retaining the dung. The small farmer collects in his stable, in a fosse lined with bricks, the dung and moisture of his cattle. He buys sufficient lime to mingle with the scourings of his ditches, and with the decayed leaves, potato-tops, &c., which he is careful to collect, in order to enrich his compost, which is dug over two or three times in the course of the winter. No portion of the farm is allowed to lie fallow, but is divided into six or seven small plots, on each of which a system of rotation is adopted; and thus, with the aid of manure, the powers of the soil are maintained unexhausted, in a state of constant activity. The order of succession in the crops is various; but we observed on the six-acre farms which we visited, plots appropriated to potatoes, wheat, barley, clover (which had been sown with the preceding year's barley), flax, carrots, turnips, or parsnips, vetches, and rye, for immediate use as green food for cattle. The flax grown is heckled and spun by the farmer's wife, chiefly during the winter; and we were told that three weeks' labour at the loom towards the spring enabled them to weave into cloth all the thread thus prepared. The weavers are generally a distinct class from the small farmers, though the labourers chiefly supported by the loom commonly occupied about an acre of land, sometimes more, their labour upon the land alternating with their work at the loom. In some districts, we were informed, every gradation in the extent of occupancy, from a quarter or half an acre to the six-acre farm, is to be found; and in such cases more work is done in the loom by the smaller occupiers.

The labour of the field, the management of the cattle, the preparation of manure, the regulating the rotation of crops, and the necessity of carrying a certain portion of the produce to market, call for the constant exercise of industry, skill, and foresight, among the Belgian peasant-farmers; and to these qualities they add a rigid economy, habitual sobriety, and a contented spirit, which finds its chief gratification beneath the domestic roof, from which the father of the family rarely wanders in search of excitement abroad. It was most gratifying to observe the comfort displayed in the whole economy of the households of these small cultivators, and the respectability in which they lived. As far as I could learn, there was no tendency to the subdivision of the small holdings. I heard of none under five acres held by the class of peasant-farmers; and six, seven, or eight acres, is the most common size. The provident habits of these small farmers enables them to maintain a high standard of comfort, and is necessarily opposed to such subdivision. Their marriages are not contracted so early as in Ireland, and the consequent struggle for subsistence among their offspring does not exist. The proprietors of the soil retain the free and unrestricted disposal of their property, whether divided into smaller or larger holdings. The common rent of land is about 20s. an acre, and the usual rate of wages for a day labourer is a franc (or 10d.) a day.

A small occupier, whose farm we examined near Ghent, paid 225 francs per annum for about two bonniers, or six acres, of land, with a comfortable house, stabling, and other offices attached, all very good of their kind; this makes the rent (reckoning the franc at 10d.) equal to £9, 7s. 6d. sterling per annum; and if we allow £3, 7s. 6d. for the rent of the house, stabling, and other offices, there will be £6, or £1 per acre for the land, which accords with the information we obtained at Antwerp, Brussels, and other places, as to the rent of land in the flat country, the soil of which is generally of the same quality throughout. This farmer had a wife and five children, and appeared to live in much comfort. He owed little or nothing, he said; but he had no capital beyond that employed on his farm. We questioned him respecting his resources in case of sickness. He replied, that if he were ill, and if his illness were severe and of long duration, it would press heavily upon him, because it would interrupt the whole farm-work; and in order to provide for his family and to pay the doctor, he feared he should be obliged to sell part of his stock. If his wife and family were long ill, and he retained his strength, the doctor would give him credit, and he should be able to pay him by degrees in the course of a year or two. The thought of applying for assistance in any quarter appeared never to have entered his mind. We suggested that the Bureau de Bienfaisance, or charitable individuals, might afford him aid in such a difficulty; but, with evident marks of surprise at the suggestion, he replied cheerfully that he must take care of himself. If a sick club or benefit society were established among these people, so as to enable them by mutual assurance to provide for the casualty of sickness, the chief source of suffering to their families would be obviated, and there would be little left to wish for or amend in their social condition."

Comparative Value of Spade Husbandry.

It is, we believe, an indisputable fact, that a garden produces heavier crops, space for space, than a field under culture with the plough. "In regard to the difference of produce, an experiment was tried in the neighbourhood of Hamilton, expressly to ascertain that point. A field was taken, which had been cropped with beans the preceding year, and the previous year with oats. Two ridges were dug, and two ploughed alternately, and the whole was sown on the same day. A part both of the ploughed and dug was drilled with the garden-hoe. The whole was reaped the same day, and being thrashed out, the result was, that the dug land sown broadcast, was to the ploughed sown broadcast as fifty-five bushels to forty-two; while the dug and drilled was as twenty and a quarter bushels to twelve and a quarter upon the ploughed and drilled. The additional grain produced was not the only beneficial result gained by digging; for in this instance there was also a great deal of straw, and the land was much more free of weeds, and more easily cultivated next year."—*Sir John Sinclair's Code of Agriculture.*

Some soils, however, are unsuitable for spade husbandry; as, for instance, heavy wet lands liable to inundation; stony, gravelly, or shallow soils, more especially if incumbent on chalk. Manual labour is also inapplicable where the climate is precarious, and it is necessary to be expeditious in tilling the land, and in sowing and harrowing for a crop. On these accounts spade husbandry cannot be universally resorted to with advantage either to the culturist or the community. With respect to its economy, where it is available, there are two questions.

First, Whether the cottage farmer with his six acres can raise as much produce, and at as cheap a rate, as the capitalist can from any given six acres on his farm? If he cannot raise so much at so cheap a price, and cannot pay the same proportion of rent, cottage farming is decidedly injurious to the community; but if he can compete on all these points, there can be no solid objection against the practice. From the foregoing evidence of Sir John Sinclair, and from what is known respecting spade husbandry in Belgium and some other continental states, it is placed beyond a doubt that more produce is raised for human subsistence—space, soil, and climate being equal—by small farmers using only manual labour, than by large farmers with horses and ploughs; and it is certain that the produce is always more accessible to the public than that of large farmers, who, by means of their capital, which is very frequently not their own, but borrowed from banks, can hold themselves indifferent respecting sales, till, by a fortunate contingency, the prices rise and become highly remunerative.

Second, How far is spade husbandry available in the shape of paid labour to the capitalist farmer? We are unable to answer this question from our own experience, and therefore refer to a paper written by a competent authority on the subject. This is an essay by Mr. Archibald Scott of Southfield, near Haddington, who obtained a prize of £100, which the Rev. C. Gardiner, a clergyman of the church of England, had proposed to grant for the best plan of giving employment to the poor.

"I am quite convinced," proceeds Mr. Scott, "there is but one way of employing the surplus population of England and Ireland, and that is by a judicious introduction of spade husbandry.

"To show that I am not a mere theorist, but a practical man, I may mention that I rent a farm from the Earl of Wemyss in East Lothian, consisting of 530 Scottish acres; that I have cultivated land to a considerable extent with the spade for the last three years, and that the result has exceeded my most sanguine expectations. In 1831, I determined to ascertain the difference of the expense and produce between trenching land with the spade and summer fallowing with the plough in the usual way: I therefore trenched thirteen acres of my summer fallow-break in the months of June and July. I found the soil about fourteen inches deep, and I turned it completely over, thereby putting up a clean and fresh soil in the room of the foul and exhausted mould, which I was careful to put at the bottom of the trench: this operation I found cost about £4, 10s. per Scottish acre, paying my labourers with 1s. 6d. per day. The rest of the field, which consisted of nine acres, I wrought with the plough in the usual way, giving it six furrows, with the suitable harrowing. I manured the field in August; the trenched got eight cart-loads per acre, the ploughed land 16; the field was sown in the middle of September. The whole turned out a bulky crop as to straw, particularly the trenched portion, which was very much lodged. On threshing them out, I found them to stand as under:—

By trenched wheat per acre, 52 bushels at 6s. 9d.		£17 11 0
To two years' rent at £2, 10s. per acre	£5 0 0	
Expense of trenching - - -	4 10 0	
Seed, three bushels at 6s. 9d. - -	1 0 3	
Eight cart-loads of manure at 4s. - -	1 12 0	
Expense of cutting, threshing, and marketing - - - -	1 10 0	
Profit - - - - -	3 18 9	
		£17 11 0
By ploughed wheat per acre, 42 bushels at 6s. 9d.		£14 3 6
To two years' rent, at £2, 10s. per acre	£5 0 0	
Six furrows and harrowing at 10s. -	3 0 0	
Seed, three bushels at 6s. 9d. - -	1 0 3	
Sixteen cart-loads of manure, at 4s. -	3 4 0	
Expense of cutting, threshing, and marketing - - - -	1 10 0	
Profit - - - - -	0 9 3	
		£14 3 6

"I now saw, that though it might be difficult to trench over my fallow-break during the summer months, it was by no means making the most of the system, as the operation was not only more expensive, owing to the land being hard and dry during the summer, but that it was a useless waste of time to take a whole year to perform an operation that could be as well done in a few weeks, provided labourers could be had; and as in all agricultural operations losing time is losing money, as the rent must be paid whether the land is carrying a crop or not, so that in taking one year to fallow the land, and another to grow the crop, two years' rent must be charged against the crop, or at least there must be a rent charged against the rotation of crops for the year the land was fallow. As I felt satisfied that, by trenching with the spade, the land would derive all the advantages of a summer fallowing, and avoid all the disadvantages attending it, I determined on trenching thirty-four acres of my fallow-break immediately on the crop being removed from the ground, and had it sown with wheat by the middle of November, 1832. I may here remark, that I did not apply any manure, as I thought the former crop was injured by being too bulky. As it is now threshed out and disposed of, the crop per acre stands as follows:—

By average of 44 bushels per acre at 7s. - -		£15 8 0
To rent of land per acre - -	£2 10 0	
Expense of trenching - - -	4 0 0	
Seed - - - - -	1 1 0	
Cutting, threshing, and marketing -	1 10 0	
Profit - - -	6 7 0	
		£15 8 0

"The advantages of trenching over summer fallow are, in my opinion, very decided, as it is not only cheaper, but, as far as I can yet judge, much more effectual. I am so satisfied of this, not only from the experiments above noticed, but from the apparent condition of the land after it has carried the crop, that I have this autumn cultivated about a hundred acres with the spade, and the crops at present are very promising. When I first commenced, I was laughed at by my neighbours, but now when they see me persevering in what they considered a very chimerical project, they are suspending their judgment, and several of them have made considerable experiments this year. I should think there are at least 250 acres under crop cultivated in this way this season in East Lothian; in 1831, the year I commenced, there was not a single acre. I have therefore the satisfaction of knowing that I have been the means of causing £1000 to be spent this year among the labouring classes in my immediate neighbourhood; and I feel confident, that should the season turn out favourable for the wheat crop, and fair prices obtained, their employers will be handsomely remunerated for their outlay. I do not say that this system will succeed in every description of soil, as it must necessarily be of some depth to admit of the operation; but there are few districts where such soil will not be found in sufficient abundance to give ample employment to the surplus population of the neighbourhood.

"Now, this is going on in a county where agricultural labourers *are better employed* than almost any other in Great Britain. The system was not introduced, nor is it persevered in, for the purpose of giving employment to the poor, but entirely for the benefit of the employer. The East Lothian Agricultural Society are now offering premiums for the most satisfactory reports on the subject. I last year received a medal from the Highland Society of Scotland for introducing the system; and, what I value still more, I received a piece of plate from the labourers I employed, as a token of their gratitude. The system, I admit, is only in its infancy, but I have this year put it completely to the test; and should it succeed as well as it has done hitherto, it must take root and spread over the kingdom; and the landed interest in those districts of England where the poor-laws are so oppressive, and still more, the Irish proprietors, will do well to investigate the system, and have it introduced with the least possible delay, that what is now a burden on their estates may become a source of wealth, and what is now a curse may become a blessing.

"This system, if it succeed to my expectation, possesses all the requisites you require; it furnishes employment for the surplus population by substituting manual labour for that of horses—and certainly, if there is a lack of food for both, it is desirable that the one should give place to the other. It will make bread plenty, as the naked summer fallows of Great Britain will be covered with grain instead of lying waste for a season; it will render corn-laws unnecessary, as we will be then independent of foreign supplies; farmers will be enriched who are enterprising and industrious, and they only deserve to be so; it will raise rents by increasing the capabilities of the soil, enabling the farmer to cultivate wheat to double the present extent; it will raise up a home market for our manufactures, as the paupers, who are at present starving, or living a burden on the parish, will find employment, and thereby be enabled to procure the necessaries and comforts of life; it will check the poor-laws, as there will then be none but the aged and the helpless dependent on parochial aid."

Stronger testimony in favour of spade husbandry could not well be adduced, but we doubt its being generally practised with success in the ordinary routine of agriculture. It seems to be best suited for mere cottage farming, in which the labour is of little exchangeable value. Referring to this point, the Rev. Mr. Hickey (Martin Doyle), in his *Cyclopædia of Practical Husbandry*, observes—"On even an extensive scale of farming, we recommend spade husbandry in *potato or cabbage culture*, but not for general crops. However gratifying to the benevolence of an individual farmer it may be to employ a vast number of men to dig his land in preference to the usual course of plough and horse-labour, he must consider that there is a limit beyond which he cannot multiply his labourers without occasional inconvenience and perplexity to himself, and without *unceasing superintendence*. Should any of the numerous causes which may occasion a change of occupiers on a given farm, or a change of *system* occur, what is to become of the numerous families collected by an individual who has largely introduced the practice of manual labour, and confined his operations to that system alone? What is to become of an excessive population of agricultural labourers, if their services be no longer required by the successor of the spade husbandry farmer? If any one replies, 'Oh, let the system be generally introduced, and there can be no danger of their want of employment somewhere,' the answer is plain. 'If you substitute the spade for the plough to such an extent, you raise the price of labourers beyond what you can afford to pay, and you diminish the chances of success in your general farm operations, by giving up too much time to one department of labour. Time is money to a farmer; let him lose a week in a critical season, and the delay may be highly injurious to him in many respects. Promptitude and despatch are essential to his completion of farm labours at the proper times: without the aid which improved machinery affords him, it would be utterly impossible for him to get through his work in due course. Let him abandon the more rapidly working plough, and take the tedious spade, and he will soon heartily regret his exchange. After what we have premised on this subject, it is almost superfluous to repeat, that if these latter remarks possess any accuracy at all, they are merely true in their application to *large* farmers, and not intended by any means to affect the subject as it is connected with the cottier or small farmer, who has rarely any capital but his labour, and needs no other if he be suffered to use it freely and fairly.' What is the limit, then, to the capital of his labour? What sized farm should he have that will make it the most productive? Why, the exact amount, and no more, to which he can apply all his capital? Has he a family? he may then have more capital of labour to bestow by their assistance; consequently a larger allotment will be needed to employ all the capital of more extended labour. If he be single, then less, of course, will suffice."

The only point that remains to be settled is one connected with political economy. It is alleged by the leading political economists of England, that cottage farming (see article *Cottage System* in the *Encyclopædia Britannica*), while calculated to promote the growth of a population of paupers, is only distracting manual labour from its proper field of employment. But this allegation proceeds on an unproved assumption. If it could be shown that every able-bodied man could make five shillings a-day by working as a weaver, at a factory, or any other branch of labour, the assertion would in part be correct; but such is not the case. There are countries in which remunerative employment cannot be permanently had, and in such situations—to which society in England seems advancing—the choice is in a great measure between spade husbandry and starvation, not between spade husbandry and well-paid employment. Besides, the political economist entirely overlooks the fact, that the cottage-farmer derives immense advantages from the labour of his wife and children, not one of whom, most likely, would be able to earn a penny at any kind of labour in towns. It is by calling up these engines to assist him that he can outdo the large farmer with all his capital and machinery—a fact distinctly proved, at least as respects the keeping of cows and selling their produce; no joint-stock company of cow keepers being able to compete with the miscellaneous and unmarketable labour of an humble dairyman and his family. As to the allegation that cottage-farming would cause a deterioration in society, it is also founded on narrow views. In some parts of the canton of Vaud and elsewhere in Switzerland, where the farms are all small, and mostly wrought by their proprietors, there is no pauperism worthy of the name, no overplus population; and who would compare the orderliness of manners, the sobriety and thriftiness of the people, and the small amount of crime in that country, with the vice, intemperance, and poverty, for which England and Scotland, with all their large and splendid farms, are now becoming unhappily distinguished? It might be difficult to prove that large farms have been in any material degree the cause of the social evils now exciting so much attention; but it is clear that they have not prevented those evils. Without going so far as to say that cottage-farming would furnish a universal remedy, we think that, independently of its use in increasing the productive surface of the country, it would at least afford some relief, and add to that section of the population which is still in a healthful moral condition.

THE KITCHEN GARDEN.

There are various kinds of gardens—the Italian gardens, with their splendid terraces, vases, and statues; the old French gardens of Le Notre, of which we have a specimen at Versailles, with their long straight walks, clipt hedges, formal parterres, and fountains; English gardens, with their elegant blending of natural with artificial beauty; and so on. But it is none of these princely kinds of gardens which will engage our attention in the present and succeeding sheets. We propose to treat of the three departments which belong to the greater number of gardens of the middle and humbler classes; those, in short, which, designed on a moderate scale, are intended to afford the three staples of garden culture—vegetables for the kitchen, flowers to charm the eye, and the more easily attainable kinds of fruit. These various articles are for the greater part the production of one garden, a section or scattered part being set aside for each; but, for the sake of clearness, we shall confine ourselves in the present sheet chiefly to the economy and products of the kitchen garden.

LAYING OUT OF GARDENS.

A garden of the ordinary mixed description usually extends from the eighth of an acre to a whole acre; but the more common size in country places is about half an acre. Whatever be the dimensions, the garden ought to be enclosed with a wall from ten to twelve feet high, and, if possible, be surrounded by a strip of cultured land, which should be fenced with a hedge and shrubbery, so as to remove the appearance of stiffness from the walled enclosure, and serve for other useful purposes. Besides a wicket or small door for ordinary entrance and exit, there should be a gate that will admit a cart, to take away produce or bring in manure. A much more important circumstance than size or an external appearance is exposure. In a flat country, the garden must of course be level; but if there be a choice as to situation, select by all means a spot which lies with an easy slope—an angle, for instance, of fifteen degrees—towards the sun at his meridian. In the British islands, this will be facing the south. The next best exposure is towards the south-west, and the next is the west. Avoid a northern or eastern exposure. An exposure towards the morning and mid-day sun, even though at a very small inclination, is as good as being many degrees farther south: hoar-frost on the grass and plants will be melted within an hour after sunrise; whereas, if the garden lie in the smallest degree away from the sun, the hoar-frost will remain unchanged perhaps the whole day. Allow no house, wall, or trees, to interrupt the fair action of the morning sun on your garden; for the sun is the main agent in bringing all things to perfection, and if you be deprived of it, your operations will be blighted and retarded in every possible way. So important are the sun's rays, that, if your garden be small, rather have no wall on the south and west sides, but only a low fence, than submit to their exclusion. Some gardens are so disposed that they receive the sun in abundance in summer, but only partially the rest of the year. These gardens are imperfect. The garden should be visited all over by the sun daily, except, perhaps, in the heart of winter, when his rays are of comparatively little use. The exposure should also allow a free admission and currency of air; for this reason a garden is best away from a wood, and is most advantageously placed in an open sloping lawn, overlooked by, or near, the house of the proprietor.

The shape of a garden is of little consequence. It may be square, oblong, semi-circular, or irregular, according to taste or local circumstances. In the greater number of instances, an oblong, as represented in the adjoining figure, will be found most convenient. It is surrounded by a wall, in which is an entrance marked *e*. Within the wall is a border of several feet wide, and dotted round with flowers or flowering shrubs.

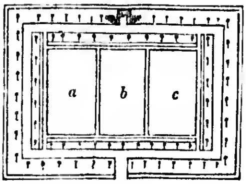


Fig. 1.

Next is a gravel walk; and within is another border containing fruit, bushes, or perhaps fruit trees on espaliers, and in the centre is the body of the garden laid out in three plots, marked *a*, *b*, and *c*. Between the plots and around them are paths of twelve or fourteen inches in width, not for ordinary walking, but for admission to the various plots or sections into which the ground may be divided. These paths are only flattened by the feet and by the spade, and are to be delved up annually in the course of digging.

At the opposite side of the garden from the door there may be supposed to be an arbour or summer-house, overhung with trailing plants and honeysuckle, and fitted up according to taste.

The regular walks in all moderately sized gardens should be not wider than three feet; any thing wider is a mere loss of ground. Much care is required to keep walks in order, for they are very liable to show crops of weeds and grass; but the best remedy is to bottom the walks well with broken cinders from a coal fire; this effectually prevents worms coming up, and also stops the growth of weeds. Over a smooth bed of cinders, put a layer of small gravel that will bind, or, failing this, a layer of brayed yellow ashes from a furnace, if they can be procured. Smooth all with the rake, and flatten with a roller. Many small flowering plants, such as daisies and thrift, are used for edgings to walks; but if not constantly attended to, they straggle over the borders. The most effectual and also the prettiest edging is dwarf box. It is easily set in an even row, grows regularly, requires little trouble in trimming—for it should not be always close shaved—and, summer and winter, is ever fresh and green.

No precise directions can be given respecting garden tools and apparatus; the following are the articles required in moderately sized gardens of a mixed kind:—Spades of three sizes, a trowel for lifting flowers, Dutch and common hoes, a broad iron rake, a rake with short teeth for the walks, a small rake for flower borders, a strong clasp-knife for pruning, a pair of strong pruning shears, an axe, a hand-saw, a hammer and nails (those made of zinc are best), a wheelbarrow, a wooden scuttle for carrying a little earth or manure, a roller, a pair of large compasses, a dibble and line, a watering-pot, and a ladder. Flower pots of different sizes, conical earthenware blanching pots, bell-hand glasses, and glazed frames of different sizes. These frames are among the most serviceable parts of a garden apparatus, and may be had either in one piece or with a movable top, as in fig. 2. A neat small kind, framed in zinc, useful for protecting early seedlings or flowers, may be had in London for 1s. 6d. each. Other utensils employed by gardeners, such as forcing pumps to wash wall trees, fumigating bellows, &c., need not be particularized.

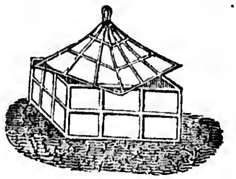


Fig. 2.

A person possessing only a small garden will shortly discover by experience what are the articles required in his operations. For gardens in which cucumbers and melons are to be grown, glazed frames and brick-built pits will be necessary. It is a great advantage for every garden to have a command of good fresh water for the purpose of irrigation, and also a small pond in which aquatic plants can be grown. If water is procured from a pump-well, it should be allowed to stand in the open air in a trough for at least a day, before being poured on the plants.

A garden is in all cases laid out according to the taste or fancy of the proprietor; but there are certain general rules which all follow. The wall is reserved for fruit trees. As fruit trees require much air and sun, the borders must not be clogged up with bushes, peas, or any other tall vegetables. The borders should contain only small articles which are delved up yearly; because the soil at the roots of the trees requires occasional renewal and loosening, and these operations cannot be done if the ground is encumbered with permanent plants. If a row of gooseberry or other small fruit bushes be placed on the borders, they should be near the outside, and not less than ten feet apart.

The body of the garden within the walks is laid out in larger or smaller plots, according to taste. These plots are generally oblong, and are subdivided into sections, rows, or beds for the different kinds of kitchen vegetables. In the corner of one plot are the cucumber and melon pits, partially secluded by bushes. In different corners are plots, and round the edgings are the flower parterres, disposed to meet the eye, and to be easily accessible from the walks. In some gardens, much of the ground is overshadowed by fruit trees. This is seriously detrimental to the growth of the plants beneath, exhausts the soil, and prevents the proper flowering and fructification of every vegetable within reach. Permit no tree to overshadow your ground; the only allowable places for trees are the walls and narrow espaliers running up one side of the central plots. When a garden possesses the addition of an outside strip, enclosed by a hedge, the exterior sides of the walls may be lined with fruit trees, and the ground laid out for potatoes and other common classes of vegetables; it will also afford the most proper site for compost dung-heaps and forcing pits.

SOIL—DIGGING—COMPOST.

The soil of a garden should be deep, rich, and easily penetrable. Whatever it may have been originally, the soil admits of vast improvement, and no trouble can be considered too great to bring it into a good condition. If shallow, trench it according to the plan mentioned in the previous sheet on Spade Husbandry, so as to loosen the subsoil, and gradually bring it into operation above. In many instances the soil is too stiff or clayey. Such a soil may not be unfit for plough husbandry, but is out of place in a garden. The method of loosening and meliorating a clayey soil is to give it a large volume of sand and vegetable manure, which may be delved in at the winter digging, and, at the spring digging, the new and old materials will be well mixed. In general, far too little attention is paid to giving sand as a restorative; such is absolutely necessary in all soils but those of a very sandy nature, because every crop actually carries away a certain proportion of the silica lodged in the soil. If the soil be already too sandy, it may be assisted by clay, mud from ditches, &c. Whatever be the nature of the soil, it should be thoroughly pulverized. Lumps thrown up by digging at the commencement of winter are meliorated by the frost, and have imbibed nutritious gases from the atmosphere. In spring all should be well delved, dashing every spadeful as it is turned down, and leaving no hard part impervious to the tender roots of the vegetables. A garden should not contain a single stone the size of a boy's marble. Every particle of soil should be capable of doing duty in feeding the plants. It will save much future trouble in lifting stones by the hand, if you would begin by putting every spadeful of mould through a sieve. Persons owning small gardens ought to pay particular attention to this. A working man having only a small patch for his amusement at leisure hours and holidays, could not do any thing more serviceable than to trench his ground bit by bit, and riddle every part of it as he proceeds.

No garden can be conducted with the least advantage without giving it a regular manuring. If you hunger a garden, it will hunger you in return. In connection with every rightly-managed garden, there must either be a compost heap, in which dung is preparing for use, or there must be some means of readily purchasing old manure when it is required. The manures employed are the same as in agriculture (see article on that subject), but being required for a more delicate purpose, they must in general be well rotted and ready to unite with the soil. A compost dung-heap is prepared by putting alternate layers of stable dung, or night soil, &c., with earth, weeds, and general offal of vegetation—turning the whole occasionally till the mass appears to be ready for use. A small quantity of this stuff will often be required to place at the roots of plants.

The practice of professional gardeners as respects composts, may be learned from the following brief notice in the "Encyclopædia of Gardening:"—"Composts for particular plants may be reduced to light sandy loam from old pastures; strong loam, approaching nearly to brick earth, from the same source; peat earth, from the surface of heaths or commons; bog earth, from bogs or morasses; vegetable earth, from decayed leaves, stalks, cow-dung, &c.; sand, either sea-sand, drift-sand, or powdered stone, so as to be free as possible from iron; lime rubbish; and lastly, common garden earth. There are no known plants that will not grow or thrive in one or other of these earths, alone, or mixed with some other earth, or with rotten dung, or leaves. Nursery-men, whose practice may be considered a safe criterion to judge from, have seldom more than three sorts of earth: loam, approaching to the qualities of brick earth; peat or bog earth, from heaths or morasses; and the common soil of their nursery. With these, and the addition of a little sand for striking plants, some sifted lime rubbish for succulents, and some well-rotted cow-dung for bulbs and some sort of trees, they contrive to grow thousands of different species in as great perfection (taking the difference between plants in pots and plants in the free soil and air) as in their native countries; and many, as the pine, vine, camellia, rose, &c., in a superior manner." The same author afterwards observes: "Peat earth, or heath earth, being generally procured in the state of turfs full of the roots and tops of heath, requires two or three years to rot; but after it has lain one year, it may be sifted, and what passes through a small sieve will be found fit for use. Some nursery-men use both these loams and peats as soon as procured, and find them answer perfectly for most plants; but for delicate flowers, and especially bulbs, and all florists' flowers, and for all composts into the composition of which manures enter, not less than one year ought to be allowed for decomposition, and what is technically called sweetening. The French gardeners allow for their rich orange-tree composts from three to six years."

Near large towns, where there is a constant demand for kitchen vegetables, market gardens are established for producing the required articles in variety and abundance. The finest market gardens in the world are near London, where the soil is deep, and any quantity of manure, in the form of night soil, from the metropolis, is easily obtainable. The plan on which these gardens are conducted might serve as a model for all kitchen gardeners in this country. It is thus briefly described in the article *Gardening* in the "Penny Cyclopædia:"—"The gardeners' year properly begins in autumn, when the land is dug, or rather trenched, and well manured. Various vegetables, which will be required in winter, are now sown, and especially those which are to produce plants to be set out in spring; spinach, onions, radishes, and winter salads are sown, and, when the weather is severe, are protected by a slight covering of straw or mats. In February, the cauliflowers, which have been raised in frames or under hand-glasses, are planted out. The cabbage plants are pricked out. The radishes, onions, and salads, go to market as soon as they are of sufficient size, and sugar-loaf cabbages succeed them. As the cauliflowers are taken off, they are succeeded by endive and celery, and the same is the case with the cabbages. Thus there is a constant succession of vegetables, without one moment's respite to the ground, which, in consequence of continual stirring and manuring, maintains its productive power. Deep trenching in some degree prevents that peculiar deterioration of the soil which would be the consequence of the frequent repetition of similar plants. This effect is most perceptible when the plants perfect their seed, which is seldom or never allowed to take place in market-gardens; but great attention is paid to the species of plants which succeed each other on the same spot. The principle which experience and theory unite in establishing, is that of avoiding the too frequent recurrence of plants which belong to the same natural families. The greater variety cultivated in gardens, in comparison with the common produce on a farm, enables this principle to be fully acted upon. Those gardeners who overlook this, and repeatedly sow or plant the same kind of vegetables in the same spots, are soon aware of their error by the diminution of the produce, both in quantity and quality, and by various diseases which attack the plants, however abundant may be the food supplied to them, or careful the tillage.

The principle on which the gardens are cultivated, is that of forcing vegetation by means of an abundant supply of dung, constant tillage, and occasional watering. The whole surface is converted into a species of hotbed; and crop succeeds crop with a rapidity which is truly astonishing. Those vegetables which arrive at a marketable state in the least time are always the most profitable, and those also for which there is a constant demand at all times of the year. With an abundant supply of manure, the market-gardeners have no fear of exhausting the soil; and dissimilar vegetables may grow together on the same ground.

The value of the produce in one year from an acre of garden-ground in the most favourable situation, as stated by Mr. Middleton, from the account which he received from a market-gardener, is almost incredible. It is as follows:—Radishes, £10; cauliflower, £60; cabbages, £30; celery (first crop), £50; (second crop), £40; endive, £30: making a total of £220 for the gross produce of an acre in twelve months. The expenses of cultivation are very great. In inferior situations, the produce is much less, but the expenses are also somewhat less.

When it is considered that there are nearly 2000 acres thus cultivated, the gross amount of produce must be very great."

The domestic gardener will now perceive, that, independently of a good soil, he must give his ground plenty of rich manure, and by so doing he need scarcely ever have any part of his surface unoccupied. To attain and keep up fertility is the grand principle of his operations; the delving may be awkward, the lines of beds uneven, the raking may not be neat, but all is of no importance in comparison with keeping the ground in good heart. He will likewise maintain a regular connective rotation, leaving no cropping to caprice at the time, or to a system of unintelligent routine.

GARDEN OPERATIONS—CULTIVATION.

Digging or *delving* with the spade is the principal means of garden culture. The spade usually employed is 10 inches deep in the blade or spit; but as delving is not direct downwards, but sloped, the depth to which the spade goes in digging is seldom more than nine inches, and often not more than eight inches. In commencing to dig a piece of ground, take out a spadeful all along one side, and carry it to the opposite side where you are to leave off. Now begin at one end of the trench just opened; thrust the spade with the foot into the ground, taking about five inches in breadth, lift it up, and turn it over into the open trench, the top undermost, and the fresh earth above. Do the same with the second spadeful, and so on with all the others to the end of the line. Take care to dig always a uniform depth and uniform breadth, so as to keep the line even, and the trench or furrow one width. If there be any weeds or loose offal on the surface, put them in the trench and cover them in. Break or pulverize the mould as you proceed, and keep the fresh surface level. When you have delved row after row to the last, the earth laid aside will fill in the concluding trench. Ordinary digging is performed best in dry weather; but digging to throw up lumps for winter melioration should, if possible, be performed when the soil is moist. In this kind of digging, do not touch the lumps with the spade after throwing them up.

Raking is usually performed after delving. Hold the handle of the rake at an angle of 45 degrees, and draw it lightly over the surface of the newly dug ground. The object is not to draw earth along, but to even or comb down the irregular surface, and bring away any loose refuse or stones. Like digging, it should be performed in dry weather.

Marking with the Line.—When there is any difficulty in delving in a straight line by the eye, mark off the ground with a cord, drawn from a reel stuck in the earth at one end to a dibble or pin at the other. This reel cord will be indispensable in marking off the edges of parterres, plots, &c. In such cases, having fixed the line, go along it with the spade, taking out a very small quantity of earth immediately beneath the cord. Then do the same with the opposite side and ends of the plot, and so its dimensions will be fairly marked. The gardener measures and marks off all his figures in the ground with his line and spade. With the lines he can draw a circle round a central pin, or make an oval from a union of two circles, or from semicircles, spirals, triangular spaces, or polygons. When he wishes to make a small path between rectangular plots, he sets his line accordingly, and walking along it, with a foot on each side, he tramples down the earth from one end to the other, and then he can even it and beat it down with his spade.

Hoeing.—With a common hoe, the earth is cut and drawn towards the operator. The object of hoeing is to draw the earth up the stalks of plants growing in a row, or to destroy weeds. In hoeing weeds, cut off the weed beneath the surface, and do not cover the stalk. If convenient, rake away all the loose stalks, and place them on the dung-heap. Weeds, such as dandelion and groundsill, which become winged when ripe, should be hoed and removed before seeding. As many such weeds which infest gardens are blown into them from adjacent road sides, it would not be misspent time to clear the neighbourhood of them periodically.

Animal annoyances.—All gardens are less or more exposed to the destructive inroads of wild animals. Hares and rabbits gnaw the bark off the stems or lower branches of trees, and also the buds in season. To prevent the encroachments of these quadrupeds, the garden ought to be properly fenced; but if they get in notwithstanding, the trees may be saved by smearing the lower parts with a mixture of cow-dung, soot, and water, reduced to the consistency of thin paint; a smearing of tar or grease will also answer the purpose. Moles, rats, and mice, may be caught in their appropriate traps; moles, also, may be got rid of by placing slices of leek, garlick, or onion, in a green state, within their holes, as they have a great antipathy to the odour of these vegetables.

Birds are sometimes an annoyance, particularly when new-sown peas or seeds may be easily scratched up. But though in some instances injurious, it is believed that, on the whole, their visits are beneficial; for they pick up large quantities of slugs, insects, larvæ, or caterpillars of different kinds. Wall-fruit may be preserved by nets, or by the more simple method of fixing horizontal lines of black worsted in front of the trees; the repeated ineffectual attempts to alight on the lines is said to scare the animals and cause them to desist. Lines of worsted threads, in which feathers are fastened, are employed in many cases to protect beds of seeds from birds; this preventative can be easily tried.

Insects are the grand pest of gardeners; their appearance is so mysterious, and their devastations so varied, that all schemes to extirpate them are often ineffectual. They are most destructive in their first condition of larvæ or caterpillars. In this state they should be removed by the hand from kitchen vegetables. To destroy the smaller kinds of larvæ, fumigation of tobacco smoke, by means of a fumigating bellows, is employed with advantage; and the plants are cleansed with a syringe and water. For the cleansing of fruit-trees from insects, we refer to our article on Fruit Gardening.

Slugs are another chief annoyance, especially in low-lying situations. A little salt destroys them, but, as in the case of caterpillars, the best plan is to clear them out at their first appearance by the hand or a pair of pincers. Worms in the ground are not considered injurious; in a properly trenched garden, however, they exist only in small numbers. Salt kills them.

Sowing.—The greater number of garden vegetables are reared from seeds, which are sown at certain seasons in the ground. Some seeds, such as peas, are sown in drills, the hand deliberately dropping them in a straight shallow trench. Other seeds, such as seeds of onions, leeks, cress, &c., are sown broadcast, which is a thin and equable scattering over a bed prepared for the purpose. Most seeds, peas included, require to be pressed down by treading or gentle rolling, and then covered up by the hoe or rake. All seeds should be sown and covered up in dry weather.

Planting.—Many vegetables require to be removed while young from the bed in which they were grown from seeds, and planted out in rows. A straight row is made with the line, which is gently treaded on each side. Commence now at one end of the trodden line, and in the central or untrod part pierce the earth with the dibble. Into the hole so made insert the root of the plant, and pierce the earth at its side, so as to press the mould round the root, leaving no vacant space below.

Watering.—In dry seasons, artificial irrigation is of great use for giving due liquid aliment to plants, and is indispensable to plants newly transplanted, in order to consolidate the roots. Watering, for whatever purpose, is most advantageously performed in the morning or evening. If done during the time the sun is shining, take care not to water the leaves of any plant, for the heat will raise the temperature of the liquid, and the leaves will be scalded. If the day be cloudy and cool, watering the tops of plants can do no harm. The watering, in any case, should resemble as nearly as possible a soft shower, and be performed with a rose watering-pot. The greater number of flowers are injured by watering, if the water touches them.

GARDEN VEGETABLES.

The vegetables usually grown in kitchen gardens are of various tribes or classes, which, for convenience, we shall arrange in certain intelligible groups, as follows:—1. The brassica, or cabbage kind of vegetables; 2. The pea and bean kind; 3. The root kinds, or those grown only for the sake of their roots; 4. The onion and leek kinds; 5. The salad kind; 6. The various kinds of sweet herbs; and, 7. miscellaneous kinds, including several of a delicate nature. This arrangement of groups, it will be understood, has no reference to botanical order, and has only been adopted in preference to the confusion of kinds in alphabetic lists.

The Brassica, or Cabbage Tribe.

This includes some of the most hardy, easiest cultivated, and useful of kitchen vegetables. The following are those which we would recommend to be cultivated: broccoli, Brussels sprouts, common cabbage, red cabbage, cauliflower, savoy cabbage, and Scotch kale.

Broccoli.—This is one of the best kinds of greens, and is valuable from coming at a season when not liable to be affected by caterpillars. There are various kinds of broccoli, but all may be arranged under two heads—those for spring use, and those for use from September to Christmas; the latter are termed "Cape" or autumn broccolies. The best varieties for spring use are Bowles's new sulphur, Moody's dwarf, Granger's cauliflower, and Portsmouth cream-colour.

One ounce of seed of broccoli is calculated to sow a bed four feet wide by ten long, broadcast on a prepared bed, but if sown in drills, rather less seed will be sufficient. Each kind should have a place allotted to itself. The soil should be a fresh sandy loam, not manured, and the season for sowing will be comprised between April and July. The Cape plants are finally set out in beds made rather rich with manure, at any time when they have leaves six or eight inches long; two feet distances, plant from plant, will be sufficient. Each plant is to be firmly secured in the soil; and if the weather be dry, every hole should be filled with water. This species will come in season in August, and continue to produce a supply throughout the autumn; in mild seasons, some heads may be cut even at the turn of the year.

The spring hardy varieties are treated by most persons in the same way as the Cape; that is, the plants, when they are six or eight inches high, are transplanted as they become ready, between the first week of July and that of September, into beds of richly manured loam, and set two feet apart, the largest sorts, as the Portsmouth, at thirty inches, and they are kept perfectly free from weeds. If the seasons be favourable, a successional supply of broccoli is thus obtained from the first week of March to the end of May. It is also customary to lay plants down in September, with the heads turned from the sun, applying earth on the south side over the stems, to protect them from snow and frost. We prefer to plant in six-inch deep trenches, properly manured, removing the plants to them when not less than a foot high, filling each hole with water, and repeating the watering for two or more successive evenings. This treatment, even in the driest seasons, will secure the plants; and as the winter approaches, by drawing the earth from the ridges on each side, and thus filling up the trenches, the stems will be protected, and the ground levelled and rendered light. We have practised this method during seven or eight winters, and have lost no opportunity to recommend it to others. Broccoli plants do better in trenches than any other members of this extensive family.

To save seed, it is only necessary to watch the progress of some very fine plant left late in the spring, to cut out all the weakly and crowding parts of the heads when expanded, and to secure the seed before it be quite ripe, or rather before the seed-vessels shed the seed. But as all these plants pass by crossing into other varieties, it is generally not desirable to attempt seed-growing.

Brussels Sprouts produce tall stems, three or four feet high, which support a head somewhat resembling an open savoy, of little value. This being cut off, the lateral buds down the stem protrude a succession of little green heads, like small savoys, delicate in flavour, very much admired, and yet but seldom seen, inasmuch as the true vegetable is not easily obtained. Our best authority is still that of Professor Van Mons of Brussels. We copy the following from the last edition of the *Domestic Gardener's Manual*, wherein the Brussels practice is noticed, and a few experimental remarks appended.

"The plants are raised from seed sown in March or April, of which an ounce may be requisite for a seed-bed of four feet by ten. Van Mons says (*Hort. Trans.* vol. iii.), 'The seed is sown in spring under a frame, to bring the plants forward; they are then transplanted into an open border with a good aspect. By thus beginning early, and sowing successively till late in the season, we contrive to supply ourselves in Belgium with this delicious vegetable fully ten months in the year; that is, from the end of July to the end of May. The plants need not be placed at more than eighteen inches each way, as the head does not spread wide, and the side leaves drop off.' With us (in England) the Brussels sprout is so hardy that it will stand twenty degrees of frost; and its head about Christmas is a tender and delicate species of greens. Being then cut, the plant will remain nearly torpid till the advancing sun causes it to start into new vegetation; then the spaces between the rows should have a little leaf-soil or good manure lightly forked in; and the young heads, all of which were quiescent, but visible in the winter, will speedily advance from the axils of the leaves, and yield a supply for many weeks, if they be properly pulled or cut in succession."

We cannot add much to the above, but may observe that, if any one can procure true seed, it will be advisable to try to ripen some, and to abandon seed-growing of every other kind of the brassica during that season, for fear of crossing it; also to try Van Mons' repeated sowings, for in truth a more delicate family vegetable cannot be cultivated.

Cabbage.—The cultivated varieties of the common or white hearting cabbage are very numerous; and as all can intermingle, so no one who aims at raising seed can be confident of what he shall produce. The best varieties in ordinary use are—1. Small and large York; 2. London variety of York; 3. Sugar-loaf; 4. Knight's Downton; 5. Battersea; 6. Vanack. The cabbage is a biennial plant; it runs a two years' course, bears seed, and dies. Therefore, to obtain hearted cabbages throughout the year, two or more sowings must be made; one in the spring, the other in summer. Spring-sowing can be effected at once, or it may be divided into two or three operations; because, from the third week of March to the first week of May, the seed can be successfully sown for the supply of summer and winter. Yet by attentive management, one sowing may be made to produce all that a large family can require; we restrict our directions to that simple operation.

Prepare a bed of good sound loam in an open exposure, and let it be very slightly manured, for cabbage seedlings benefit much by strong contrasts, and ought not to be made to run up while tender. Dig the ground for four rows, nine inches asunder, and from fifteen to twenty feet long. Break the earth finely, and leave it to settle for three or four days; then place boards to tread on, while a first drill, one inch deep, is struck by the line; make the bottom of this and every other drill even and a little solid, either by pressing a long pole into it, or by patting it with the back of a wooden-headed rake. Sow the seeds rather thickly, because it is better to thin out an abundance of plants than to lose the major part of a few by insects. When sown, cover the drill with fine earth, proceed to make and sow other drills, till the bed be finished, and then either tread the surface over with the feet placed nearly close together, or pat the surface with the spade, and then finish it off smooth with the back of a rake. Always avoid to tread ground into holes, and therefore recede from the work backward; prefer to use the feet in light sandy soil, but rarely with stiff and binding ground. In a very dry season, seeds will not easily vegetate; therefore, in such cases, strike the drills, and water effectually along them for three successive evenings, covering the plot with mats throughout the day. In the third evening make the drills even, sow, cover with earth, sprinkle again, and lay on the mats by day, till the plants be visible, then dust them once with the finest road sand while the dew is on, and in the evening with air-slaked lime.

These directions need not be repeated. We never saw a set of cabbage, turnip, or celery plants, so dusted with road sand that was much infested with the turnip beetle; and as to slugs, lime, or lime with coal-soot, will prevent their ravages or destroy the vermin.

When the plants begin to produce their true leaves, thin them out, first to an inch asunder, and again to two inches; they will thus gain strength rapidly; and when they have three or four good leaves four inches long, they will be fit to go out, some into nursery beds, and others to the plots where they are to remain. Those set in the former, six inches asunder, will require stocky roots, and be prepared for successional beds. The size of the plants will indicate the season during any of the summer months. Those planted permanently will require the ground to be made rich with manure, and the transition from poor to rich earth will make them grow rapidly. The smaller Yorks, &c., should stand twelve or fifteen inches apart, the large varieties twenty to thirty inches. Set each plant as deep as the base of the lower leaves, and observe the directions given under Broccoli, p. 356. These seed and nursery beds will supply the table from May to November, and in fine seasons even later.

Cabbage Coleworts—a favourite vegetable in London, known by the name of *spring greens*—are raised by sowing the seed of the hardier middle-sized cabbages from the end of June to the middle of July, to be transplanted in August and September in rows twelve or fifteen inches asunder, the plants nine inches from one another; they form pretty little heads—not properly cabbages—at a period when the old stock is exhausted, and the spring cabbage is not come in. They fail in very severe winters.

The main summer crops are raised from seeds sown between the 25th of July and the 10th of August; the last week in the former month comprises the most favourable period. The directions previously given will apply in every respect to the treatment of the plants; we need only remark, that it is advisable to plant the young cabbages first in nursery beds of simple loam, wherein they will be more secure during the frosts than they would be in rich beds; but being transferred to the latter at the end of February or early in March, they will make rapid progress, and, according to the season, produce hearted cabbages in April, May, and June. All the departments must be kept clean, and free from litter or weeds. Seed can easily be raised, but the result is always doubtful.

Red Cabbage is only used for pickling; it is raised by a two years' course—that is, by sowing in August, and transplanting as directed above; but this variety requires a little more space. The heads form in the ensuing summer, and are in fine condition in October. If sown in spring, little-hearted cabbages can be obtained, which may supply a loss, or serve as a substitute for the others.

Cauliflower.—This plant, which is grown only for its rich white head, requires in the open air a warm and moist climate, or it must be grown under glass. In Holland, it grows to great perfection, and, like many of our garden vegetables, is most likely imported from that country. One of the chief difficulties attending its open-air culture is its destruction by caterpillars, and therefore great care is in many respects necessary to bring crops forward. Under glass, the plants are rendered very expensive.

Spring sowing, for a first crop, may be made in March, over a temperate hot-bed. The seedlings are to be pricked out when the leaves are an inch broad; and from this nursery bed they are moved to the garden bed in May, to stand more than two feet asunder, the ground being made extremely rich. The plants, after they begin to grow, are occasionally watered with liquid manure collected from the drainage of dunghills. A second spring-sowing is made in the open border in May, to obtain plants from September to November, by a similar mode of treatment. The last sowing occurs in the middle of August. The plants, when about four or five weeks old, are to be thinned out to two or three inches apart, the best to go into nursery beds of rich earth, three or four inches asunder. Here they must grow till November, when the strongest are to be set out in rows, to be preserved under bell or hand-glasses. Dig a bed of rich ground in an open situation, and make it still richer with manure; set three or four plants together, five inches apart, in patches, each patch a yard asunder; give water, and cover close with a hand-glass till the plants begin to grow; then tilt the glasses on the sunny side with a brick; and thus continue to give air on mild days during the winter, and on some occasions take the glasses quite off, but replace them and cover close every night.

In the spring thin the plants to two under each glass, making good any deficiencies with some of the best plants thus taken up, and plant the surplus in a warm spot of ground two feet apart. Keep the glasses on the other plants, raising them more and more, occasionally exposing them to mild rains till about the beginning of May (unless in the event of intense frost, such as we have experienced within a few years), when the glasses may be finally removed. Cauliflowers will thus be produced in succession from the end of May throughout June.

Other plants should, in November, be placed in frames four inches apart, in a bed of rich dry loam, over a very slight hot-bed: give water, close the lights, and be guided as respects the admission of air by the directions for the hand-glass division. The lights should be covered with mats and boards during severe frosty nights. In February, March, and April, the plants are removed in succession to beds richly prepared; and the cauliflowers will come into perfection during July and August. It is customary to form the earth immediately around the stems into the shape of basins, to contain water or the liquid manure: it is a useful practice, and this, with hoeings between the rows, will comprise the general treatment.

The Savoy, or Savoy Cabbage, is very hardy, and the most useful of winter cabbages. Its culture is very easy, and admits of four sowings. There are two approved varieties, the *hardy small green*, and the large *yellow;* the former is generally preferred. Begin to sow in February, sow a second time in March; a third, and this is for the main crop, in April, about the middle of each month. Let the situation be open, the soil a good natural loam, if possible, and laid out in a bed three or four feet wide, digged and made fine. Scatter the seeds evenly, and rake them. Repeat, for the fourth time, in August. The plants of this last sowing will attain a large size by the following August and September, if planted out in April. As the plants of all the sowings, after thinning, become four or five inches high, they are transplanted between crops standing widely apart, as in the single-row system of asparagus, or as succession on potato-land. Moist weather should be chosen, and the savoys should stand two feet apart. Keep the ground clean, stir it occasionally, and draw a little toward the stems on each side, always, however, leaving a sort of furrow three or four inches wide, to receive the rain, and convey it to the roots. Seed can be sown in the second year, but it may be rendered spurious.

Scotch Kale and German Kale are the hardiest among our winter greens. They are raised by sowing the seeds either in beds or single drills late in February or early in March; to be first thinned out to three inches apart, and finally transplanted to beds or rows, wherein the plants are to stand thirty inches asunder. The plants may go out in succession, from June to the middle of July. The heads are cut first, and subsequently side-shoots arise, which produce excellent winter greens, till early cabbages come in. The plant runs up to flower and seed during the succeeding summer.

Instead of growing kale, cabbage, or any other of these plants from seed, it will save much trouble to purchase young plants by the hundred from a nursery of such vegetables.

The Pea and Bean (or Leguminous) Kinds.

The Pea.—There are various sorts of this nutritious little vegetable, but it is only those of a fine kind which are cultivated in gardens, and called *garden-peas*, that we require to notice. When fresh, they are a bright green, and when dry for seed, most are a buff yellow. Peas are a summer delicacy, and the chief art is to produce them in the open air, by the middle of May, and to keep up a succession of crops till other vegetables supersede them. Skilful gardeners do not consider it a difficult process to effect an early crop, as the plant is very hardy, and sustains violent transitions without much danger. Peas, therefore, may be accelerated in frames and vineries during February, and being transplanted into rows fronting a south and east wall, will continue to advance progressively though the weather be cold. They can also be sown (provided there be no frost) in the open ground at any time. The chief varieties for the earliest and latest crop are the *early Warwick*, *bishop's dwarf*, *Charlton*, *frame*, and some other peculiar to localities. The varieties for the main summer crops are the *blue Prussian*, the *imperial*, *Knight's dwarf* and *tall marrowfats*, and the *cimetar*.

The soil most affected by this vegetable is a free, light, but rich loam, abounding with vegetable matter, but not manured with recent dung. The situation for crops from June to August should be exposed and open. The times of sowing are very various. Some obtain an excellent yield from seed sown early in November in long drills; and if the winter be open, success is nearly certain. At whatever season persons commence, a better general rule cannot be adopted than to sow for a successional crop as soon as the peas of the preceding sowing are fairly above the surface. The plants, when three inches high, should have earth drawn against their stems on both sides, after which the soil may be superficially opened by passing the hoe lightly through it, and thin brunchy sticks, of a height suitable to the habit of the variety, ought to be thrust into the ground, converging a little, so as to meet at top, and interlace each other. Shallow soils over chalk are soon over-cropped by peas, and refuse to bring a healthy plant; and in all kinds of ground, the frequent repetition of pea-sowing is to be deprecated. The land also must be purified by a rotation of cabbage and potatoes.

Sticks for peas are indispensable in keeping them from trailing on the ground; and therefore every person who wishes to grow this vegetable in his garden, should take care to preserve the sticks from one season to another, as long as they are serviceable. Any kind of branchy twigs will answer the purpose. When all the pods are taken, remove the haum or pea-stalks to the compost dung-heap.

Dwarf-Beans are planted in rows, and the seeds are generally sown at different periods between the 1st of May and the middle of July. The situation should be open, not crowded by other vegetable crops, or under trees—the soil a free-working loam, moderately manured. The drills should not be nearer to each other than thirty inches, and not more than two inches deep. In these the beans are to be dropped at regular distances, not exceeding three or four inches. Make the ground firm at bottom, but let the covering earth be light, and only slightly raked, not trodden or made hard. The one leading principle of successful growth is to bring the plants up as soon as possible, and this is effected by selecting warm weather, and opening the drill early in the day, that its base and the loose soil about it may be rendered hot by exposure to the hottest sun for two or three hours. A cold, wet, cloddy condition of the land causes decay.

The Kidney Bean comprises two species of plants, which, though of one family, are of very different habits. Both, however, are natives of the east, and are very impatient of cold; hence the necessity of deferring the sowings till the weather be nearly settled in the spring, and the ground warmed to the depth of several inches. The two species are, first, the dwarf with its numerous varieties, all bearing the title of *French Beans;* and second, the climber, commonly termed *Scarlet beans*, or runners, although there are varieties with white and variegated blossoms: one of the latter, *the painted lady*, is very prolific. There are few of the many varieties of the dwarf which can surpass the buff or dun-coloured bean—it is free of growth, and fertile, either when forced in pots, or planted in the open ground. The black speckled dwarf is also an excellent bearer; the white-seeded is the true *haricot* of the French; in Kent it is called *caravansera*.

Runner-Beans are planted with similar precautions, or, if sown early in pots and boxes, will transplant very well. When the plants attain the height of three or four inches, they should have a little earth drawn about the stem, and be sticked; that is, somewhat tall branchy sticks should be placed on each side, converging towards each other at the top; these props ought to be eight feet high, and when the plants reach their summits, they should be nipped off and kept stopped, to cause them to produce fruit-bearing laterals. "Gather beans and have beans," that is, never leave any pods to ripen; if redundant, let them be given away, or go to the pig-stye, for a maturing pod arrests the fertility of the plant by tasking all its powers. Keep all the crops clean, and the surface of the ground about them rather open.

The Garden Bean is known to every one, and it has been in use from time immemorial, as appears by the allusion made to it by ancient classical authors. Though a native of the east, it is in all its cultivated varieties very hardy; these varieties are numerous: some of the more approved are, the early *mazagan* for the first crops, which may be sown from October to February; early *long-pod*; an excellent fertile bean for general use, not highly flavoured; *broad Windsor*, the best of all beans for flavour, but not a prolific bearer, a hybrid between the two last, combining the fertility of the one with much of the high flavour of the other.

Beans prefer a sound and rather firm loam, retentive of moisture. They suffer much in a very dry season and soil, particularly if attacked by the black blight (*aphis*), which covers the tops, preys upon the fluids of the plant, and as we have seen in the summer of 1840, almost entirely destroys whole fields in a very short time. *Topping*, when the insects are first seen, appears to be the only remedy. The seeds should always be sown in rows, and one pint is considered enough for eighty feet. The beans ought to be sown in one long row, three inches deep and four inches apart, returning the soil and treading along the course of the row; after which the rake should be employed to level the surface. Beans transplant extremely well, and therefore may be sown thickly in autumn, covering the plants with hoops and mats, or with a garden frame and lights.

When the plants rise in the rows, or begin to grow after being transplanted, loosen the earth by pushing the Dutch hoe along the surface, and draw three inches of it to each side of the stems; or rather shovel up two or three inches of the earth, and lay it flat a foot wide on each side of the row of beans, shelving rather towards the stems than from them, for then the rains would find their way directly to the roots. The seasons of sowing are autumn for the mazagan, January and February for long-pods, and from March to June for the Windsor. Sow succession crops one after the other, according to the demand, as soon as the plants of the preceding sowing shall be quite above ground. To cross the variety, sow Windsor and long-pods alternately in the row, and save the beans, introducing in future sowings an occasional Windsor bean, till the desired rich flavour be obtained.

As the beans ripen and turn black, draw them up, and place them to dry in an airy situation, guarding the pods from mice, which sometimes take every bean, and thus, as we have found, deprive the gardener of a choice variety, which he had been at considerable pains to procure.

Esculent or Root Vegetables.

The vegetables grown for the sake of their roots are of two kinds—1. Those in which the roots are round or lumpy, including the Jerusalem artichoke, the potato, and the turnip; and 2. Those which are tap or taper rooted, including the carrot, the beet-root, the radish, and the horse-radish. Strictly speaking, the tubers of potatoes, &c., are not *roots*, but merely parts of the vegetable below the ground, the real roots being small fibres which shoot out from the tubers, and bring nourishment to the plant. All require depth of soil to penetrate, and also looseness and breadth of soil to allow of expansion.

Jerusalem Artichoke.—This is a root which may be said to combine, in point of flavour, the turnip with the potato. Its name is an absurdity, for the plant has no resemblance to an artichoke; and the word *Jerusalem* is a corruption of the Italian name *Girassol*. The plant is a native of Brazil, and botanically belongs to the same family as the sunflower, but it rarely produces flowers in the British islands. The tubers, which alone are eaten, are produced abundantly under the surface close to the base of the main stem. The plant is set like the potato, by either whole roots or cuts with one or more eyes to each. The pieces or cuts should be prepared at the time of planting, and set by depositing in shallow trenches two feet apart, and one foot asunder in the row; and being covered with earth, nothing more will be required but to keep the ground clean by the hoe. The season for planting is in the first dry weather of March; and half a peck of tubers, according to Abercrombie, will plant a row 120 feet long. A good mellow loam is the proper soil, and the spot for planting should be apart from the vegetable garden, otherwise this prolific plant may intrude and become a complete nuisance. Being set in March, the plant is perfected about October or November; the crop is ready for use when the stems are quite dry. Dig only when wanted, if that be convenient; but if there be a danger of frost, as will most likely be the case, lift the crop, and store away for winter use in moist sand or any kind of light soil through which the frost cannot penetrate.

Potato.—Like the Jerusalem artichoke and some other plants, the potato is a naturalized exotic in English gardens from the wilds of America, and has been greatly improved by culture within the last hundred years. There are now many varieties, individually distinguished by colour and flavour; and as some are better than others, it is very important that proper sorts should alone be cultivated. There are two distinct kinds—*early* and *late*. Early potatoes are a premature and transient kind; they soon come to perfection, and cannot be stored for future use. On this account no cottager should have any thing to do with early potatoes, which are never grown but as a luxury, and after all they are in general poor waxy stuff. The true potato is the late kind, which will store for winter and spring use. Of this there are hundreds of sorts, every district apparently having one which is best adapted to its soil and climate. The sorts to be preferred are those possessing the quality of mealiness, and which will not degenerate or fail in cropping. The kinds we recommend, as far as they may be found suitable as to climate, &c., are kidney-shaped, or long and flattish; red roughs, a round reddish-coloured potato; and those white kinds which are smooth skinned. Of early potatoes, the ash-leaved kidney is among the best for open-garden culture.

The potato may be cultivated either from seed procured from the apple on the stalk, or from the tuber itself. If from the seed, the first crops of tubers are only a little larger than peas, and several seasons are required to bring the plant to an edible size. The common method of cultivation is by pieces or cuts, each having at least one well-defined eye; cuts with two eyes are generally preferred. These are set in trenches, the ground being in good heart with previous manuring, or good old manure placed along with the sets. The season for planting is late in April. Dig and plant sets, fresh cut as the work proceeds, placing the sets from nine to twelve inches apart, and the rows being about twenty inches asunder. Heap six inches of soil loosely over the sets, and when the shoots have risen sufficiently above ground, keep earthing them up with a hoe. When the stalks begin to decay in October, the crop is ready for lifting. (For further information on potato culture, see Agriculture.)

The Turnip.—Of this useful vegetable there are many varieties, but three only are grown in gardens: these are the *early Dutch*, which is white; the *yellow Dutch*; and the *Swede*, also a yellow kind. The white is the most delicate while young, but the yellow Swede is preferable as a keeping or late turnip. The yellow Dutch has also an excellent flavour. Turnips are cultivated from seeds in drills one foot apart, and thinned when they come into leaf, to afford room for their expansion. For the two Dutch varieties, the best soil is sandy, enriched with bone-dust or good old stable dung. One ounce of seed will go over a great space—Aber crumble says as much as 200 square feet of surface. Small sowings should be made in succession from March till July, and then the main crop for winter should be sown. To avert the encroachments of the turnip beetle, scatter road-dust over the leaves before the dew is off them in the morning. This, when timely applied, will never be found to fail. Swede turnips should be sown in April and May. Deeply hoe the ridges after thinning, and keep the surface clear of weeds.

THE CARROT.—The favourite varieties are the *early horn*, the *Altringham*, and the *long orange* or *Surrey*. All require a deep light soil. The early horn is sown in February for the spring crop, and in July for a late crop; the two other kinds are sown in March, April, and May. All are sown broadcast in beds. The seed may be saved by planting a few of the best carrots to stand the winter; seed will not retain its growing principle above a year. Carrots may be stored like potatoes in winter.

THE PARSNIP is a taper-rooted vegetable resembling the carrot in shape, and in England is a favourite vegetable with salt fish. The seed is sown in drills a foot asunder. The period of sowing is comprised between the last week of February and the first week of May. On thinning out, let the remaining plants be nine inches apart in the row.

THE RADISH.—There are two distinct kinds of radish, which comprise all the numerous varieties which are occasionally cultivated. According to Lindley's catalogue, these are—

The *taper-rooted spring radish*, of which the varieties are—1. the long white; 2. purple or salad radish; 3. salmon or rose-coloured, 4. scarlet; 5. white Russian radish.

The *round turnip-rooted spring radish.*—6. Crimson turnip-rooted; 7. yearly white; 8. purple turnip; 9. white turnip; 10. yellow turnip.

Winter radish.—11. Black Spanish; 12. brown oblong; 13. large purple; 14. round brown; 15. white Spanish, a large bulb, which in good soil grows to the size of a small stubble turnip.

Numbers 2 and 3 are the best of the spindle-rooted radishes; numbers 6 and 7 of the early turnip-rooted. The winter black radishes are rarely seen in gardens; but the large white (15) is very mild, if the soil and season be favourable, and its texture is tender.

Sown in February and March, the spring radishes come into use in April and May; if required earlier, they must be protected by frames or mats. The market-gardeners obtain them early by gentle forcing, covering the beds every severe night. The sowings of all the early varieties may be repeated monthly till August. The winter radishes are sown in July and August, and come into use from September till the spring. A rich and light soil suits the radish, with occasional copious supplies of water; and rapidity of growth is required, otherwise the roots will not be tender, nor will the flavour be mild.

HORSE-RADISH is a vegetable which in certain soils is of extremely difficult culture, in others of uncontrollably luxuriant growth: it is a most pernicious weed where it intrudes, because of the multitude of vital germs with which its root-stock abounds, and by which it is rendered a sort of vegetable polypus, every inch of it being capable of developing a growing bud.

Such being the difficulty of artificial propagation, it may be questioned whether much trouble is not expended uselessly to effect that which nature produces by the most simple means. However, horse-radish can be procured by trenching two feet deep a plot of free loam, removing all stones as the work proceeds. One trench being well cleared, a layer of manure two inches thick should be laid at the bottom (for none must be mixed with the soil), and upon that three inches of the fine loam. Some fine straight roots being in readiness, they are to be cut into two-inch lengths and piece after piece pressed into the soil eight inches asunder, in a row, to the whole length of the trench, and exactly in the middle. The soil is then to be dug out another two feet space, turning it into the open trench, clearing away the stones and other rough substances. Thus alternately trenching and planting, a bed will be formed of any extent that may be required. The work should be performed either in October and November, or in February; and the dryest weather of the season should be selected.

Abercrombie, one of the best practical writers on gardening, made the following judicious remarks, which will, if duly considered, throw light upon those habits of the plant which have led to the deep method of culture just described. "The root," he says, "being durable, forms itself into a thick knotty stool at a certain depth, sending up several erect, straight, root-shoots, in length proportionate to the depth of the stool or main root, which, if planted fifteen or eighteen inches below the surface, the shoots or sticks of horse-radish will rise to that length. They will rise in May, increasing all summer till October, when in rich ground they will be sometimes large enough to dig up for use, being an inch thick, if not, they must have another year's growth, taking them up clean to the bottom by cutting them off close to the old stool, which remaining, sends up a fresh supply annually."

These habits indicate two important facts. First, that the crown or stool must enjoy all the benefit of the manure, to enable it to send up a straight stem, and to nourish that stem by its own power; therefore no manure must be placed in the upper soil, since it might excite lateral growth. Second, it points out the method of taking up the roots, which should always be that of trenching, beginning at one end of the bed and clearing away the soil to the full depth of the original trench Thus a row can be taken without disturbing the crowns, by cutting off the sticks or upright shoots close to the head of each stool or stock, and what is surplus of each digging can be preserved in sand till more be required.

BEET-ROOT or RED BEET.—This is one of the most valuable of the spindle-rooted vegetables; it has heretofore been wasted by most persons, who, overlooking the really useful purposes to which a root so salubrious can be applied, have considered it as little more than a garnish to salads. Beet-roots should be boiled or baked till they become perfectly tender, when they may be eaten warm as a dinner vegetable. When cold, they should be cut into slices, and covered with vinegar. The plant is a biennial, that is, it grows, and perfects its roots in one season; in the following spring it sends up its flower-stalk, ripens its seeds, and dies. Seed, therefore, can thus be procured; but it is better to purchase or exchange than to grow it. Of the two varieties of red beet, the smaller deep-purple variety is greatly preferable to the larger, which approaches to and is little better than mangel-wurzel. We select two varieties. 1. The short-rooted deep purple beet, for its root. 2. The *beta cycla*, or silver beet, the leaves of which only are used in lieu of spinach.

To grow the red beet well, the ground ought to be light and pulverizable, otherwise the spindle-root will be diverted if it meet with obstacles, and become forked and distorted. Trench the plot to the depth of eighteen inches, removing large stones, roots, and hard clods of earth; lay a stratum of manure at the bottom of the trench, in order to attract the root downward; then return the fine earth. Let the work be completed before frost set in, and mark out the beds according to the number of rows required. At the middle or latter end of March, the seeds are to be sown. These are contained in a curious seed-vessel of rude shape, and cannot conveniently be separated from it. In sowing, stretch the line, and draw an even drill about an inch or an inch and a half deep, and drop the seed-vessels at even distances, two or three inches asunder; for although these spaces as much too small for final growth, it is in all cases wise to be liberal of seed, because insects and other enemies destroy many plants, and thus a season may be lost. Cover with light fine earth, and either tread or beat the covering earth with the spade till it lie firm on the seeds. If the plants rise equally, thin them gradually, till they stand from nine to twelve inches apart every way, or even eighteen inches for the large rooted variety. Beet will transplant, but the operation dwarfs the plants; and at best it is attended with some risk. Keep the rows or beds entirely free from weeds by hand-weeding or flat-hoeing. Some roots will be ready in September, and thence throughout winter. In using them, or prior to storing up during winter, cut off the straggling leaves, being careful not to wound the roots; they keep well in dry and well-washed sand, but become tainted if wet straw or decomposable vegetable substances are present.

To collect seed, either reserve two or three of the best roots in the spot where they grow, or transplant them in autumn to a convenient situation. The flower-stems will be produced in the following spring, and should be secured by stakes till the seeds ripen. Then cut down the stalks, and dry them on a cloth under an airy shed; separate the seed-vessels, and preserve them in paper bags in a dry and cool situation; the seeds will retain vegetative power for several years.

Remark applicable to Beet, Carrot, and *Parsnip.*—In stiff clayey or cloddy land these spindle-root vegetables succeed very indifferently, carrot especially; therefore, to avoid repetition, it is thought right to observe that at the time of sowing (the land having been previously trenched, and left exposed to frost in ridges), the soil is to be levelled, and holes made along the course of a garden line with a strong pointed crowbar about four inches asunder and twelve inches deep. Fill them with very light sandy earth sifted, and make a little cavity in the centres, into which drop four or five seeds; cover them with the same light earth, and beat the surface level with the flat of the spade; the roots so treated will tap downward, and be preserved as in a sort of sheath by the binding earth around them. Thus carrots, which always fail in certain soils, as we have often observed, may be produced of handsome figure and good quality, and beet-root may be grown without a fork in it—a circumstance of considerable importance with a root which is so liable to be injured by the loss of its purple juice whenever it is wounded by the knife.

The Alliaceous or Onion Kinds of Vegetables.

This savoury class of kitchen vegetables comprises the onion, leek, garlick, and shallot, the two former being by far the most important. All are natives of eastern countries, but they grow to great perfection, as respects pungency of flavour, in the British islands.

The Onion.—For a crop of onions the soil should be rich, light, and deep, and well exposed to the sun. Before sowing, work and enrich the bed to the depth of eighteen inches, and then beat it flat and firm with a spade. Sow the seeds at any time of March, thus—scratch drills by the line just so deep as to be clearly discernible, and sprinkle the seeds along them about three or four in an inch. Sift fine sandy earth over the seeds, and pat the surface even. As the onions advance, thin them out according to the variety, allowing alternately an intervening space fully equal to the breadth of the onion between bulb and bulb. In September twist the necks, take up the crop when the leaves become yellow, and expose the onions to sun and air under a shed till they be externally quite dry. Many sow onions broadcast in beds, in which case they likewise require thinning.

A summer supply of onions, at a time when the previous stock is exhausted, and the growing autumn crop has not come into season, must be desirable, and it is easily obtained. Prepare the ground early in February; select a number of those small bulbs that are always found in every bed of the larger kinds, which are not above an inch broad. The bed being ready about the end of the first week, mark out squares on the surface by means of cross-strings, but do not move the ground. At each intersection of the lines, press in an onion, the root downward, to one-third of its depth, so that the bulb remain firm and erect. Thus, when completed, the bed will exhibit the onions in squares five or six inches asunder. The onion forms its bulb in the first year of its growth, and the flower and seed in the second year. These small onions will therefore naturally attempt to produce a flower head, which, as soon as it is fairly visible, is to be pinched off. Another attempt will be made, and that also must be frustrated. The natural course of the vital-fructifying sap being thus interrupted, will be diverted to the bulb, and gradually, almost imperceptibly, two, three, or four onions of medium size will be produced and grow freely. These are to be taken, as soon as they are ripe (which, if the summer be fine and sunny, with occasional showers, will be in July,) and dried in the air as before directed.

The Leek is another of the garlic family, and if properly treated in a favourable soil and situation, grows to a very large size. It is a plant which is much improved by proper transplantation, but yet can be grown very well in its seed-bed; the London leek is the best. Sow the seeds in a shallow drill at the close of February or early in March, and cover them with half an inch of fine soil; as the plants grow, keep the surface clear of weeds by hand-picking and passing the Dutch hoe lightly on each side of the leeks. Presuming that they are thinned out at first to stand three inches asunder, half of the plants will remain, and the other half will be removed to another situation. Thus the plants in the seed-bed will stand six inches asunder, and will be greatly assisted if the ground be opened on each side of them at the distance of nine inches, and manured spit deep. A crop of fine middle-sized leeks will be obtained in the succeeding autumn.

To transplant leeks, prepare a bed at the end of June to contain either two or four rows nine inches asunder, and manure the soil richly to the depth of a foot or fifteen inches. Let the bed settle during a week or more, and in July make holes along the intended lines six inches deep and as far apart. Collect a number of the strongest leeks, trim off the straggling roots, and all the suckers or offsets. Drop a small handful of powdery manure or reduced year-old cow-dung into each hole, place in it a leek, and holding it by one hand, fill the hole with water. The object is to fix the leek as in a case, to which it can adapt itself, and will fully occupy, becoming, under propitious circumstances, a plant of large size and of most excellent quality.

Garlic, one of the most pungent species of *allium*, is increased by dividing the bulbs into cloves or small bulbs, and planting them in good sandy loam, at any period between the middle of February and the end of April. Draw drills two inches deep and ten inches apart, then press the root-end of each clove firmly into the earth, till it stand erect; let the distance between each be six inches, and fill up the drills with fine sand. Keep the ground free from weeds, and when the leaves turn yellow, take up the bulbs with a trowel or hand-fork, and keep them in a dry room. *Rocambole*, a mild species of garlic, may be cultivated in the same manner.

The Shallot is a native of Palestine; its culture is precisely the same as that of garlic, therefore both may be grown to great advantage by adopting the plan suggested by the late Mr. Knight, described in vol. ii. of the *Transactions of the London Horticultural Society.* Let a rich soil be placed beneath the roots, and raise the mould on each side to support them till they become firmly rooted. This is then removed by a hoe, and by pouring water from the rose of a watering-pot, till the bulbs stand wholly out of the ground. Thus they become mere surface bulbs, supported entirely by the fibrous roots, which pass deeply beneath into the rich soil. The growth of these plants, Mr. Knight adds, so closely resembled that of the onion, as not readily to be distinguished from it till the irregularity of form become conspicuous. "The form of the bulbs, however, remained permanently different from all I had ever seen of the same species, being much more broad and less long; and the crop was so much better in quality, as well as more abundant, that I can confidently recommend the mode of culture to every gardener."

Chives, one of the smallest of the garlic tribe, is a hardy and useful vegetable, far superior to young immature onions. The plant grows in tufts somewhat like small rushes in appearance, but of a colour resembling the yellow green of young onions or scallions; it never bulbs. A crop is readily increased by dividing the roots in April or early in May.

SALADS.

Salads are those watery plants whose long fresh leaves are eaten at table raw, or only dressed with zests and condiments without the preparation of cooking. The principal vegetable of this kind is

The Lettuce, of which there are several varieties, but all may be classed under two heads—the upright or cos lettuce, and the open or cabbage lettuce. Of the upright, the green and white cos, and of the open, the inner cabbage and grand admirable, are the best. In spring culture, sow every month in very shallow drills of fresh-digged ground, in good heart, made extremely rich with rotten manure. Strike the drills a foot asunder, and as the plants rise, thin them to stand in regular order, first to two inches, then, for table use as small salad, to six inches, and for the larger sorts, finally to one foot. Never transplant during spring and summer, as the plants, by removal, sustain a check which urges them to fly up to seed. Spring and summer lettuces are sown from February to July. In September, two small sowings should be made of the hardy sorts, to come in use during the late winter and spring; but it would be safer to make use of a large three-light frame. Some lettuces heart freely; those which do not should be assisted by passing a flat string of matting round them from the middle upwards. This bandage must not remain many days, otherwise the lettuce will run to seed, and become bitter.

In autumn culture, sow in August, in drills pretty close together, for the express purpose of transplantation in September or October; they will not then run up. When the plants are three inches high, thin out half of them, and transplant some into warm quarters, and others under a frame; protect by coverings of hoop and mats those in the open ground; and if they bear the winter, thin the plants early in the spring to six inches apart. The plants in the frame will rarely fail if the earth be free from slugs.

To save seed, transplant some of the finest lettuces when about half grown; they will produce a flower stalk, and when the down of the seeds becomes visible, cut off the upper portion of the stalk, and dry it in a warm and airy room: thus save all the seed as it ripens in succession for it is very valuable.

Endive is a salad of a pleasant bitter taste, and some authorities say it has been imported from China. There are three principal sorts in ordinary cultivation, the *green-curled*, *white-curled*, and *Batavian*, with undivided flat leaves. The seeds are sown at different periods between the beginning of June and the second week of August, as required for the autumnal, winter, and spring crops. When the plants are three or four inches high, they may be removed to beds of moderately enriched loam, to stand a foot apart. But transplantation is not essential, for very fine plants are produced in the seed beds. When they are nearly full grown, they must be prepared for the table by blanching, as otherwise they would be too bitter for use.

Blanching may be effected by several methods; the most simple is that of passing a string of soft bass matting round the centre of each plant, so as to exclude the light from the heart; but as hard frost is very injurious, some plants ought to be removed to a bed of dryish earth or sand under an airy shed; or a garden frame partially covered might be placed over a certain number of those already tied up. A good kind of pot for blanching is one of French invention, made of earthenware, and perforated with holes; a representation of it is given in fig. 3. Many persons blanch only by throwing straw loosely over the plants, but this makes a litter not very pleasing in a garden. The curved endives would blanch in a short time without tying within a darkened frame or pot, and be thus less liable to decay; for it is known that the plants suffer from being tied. The Batavian endive, however, requires a bandage at all times, otherwise its harsh green leaves will be useless, and the central heart, which alone is eatable, will never be rendered tender and white. Some persons blanch in a simple way by laying a tile over the open heart of the plant.

Fig. 3.

Corn-salad—Lamb's Lettuce, a native of Britain, formerly used much more than it now is, and cultivated in gardens as an agreeable but rather insipid salad. A quarter of an ounce of seed was estimated by Abercrombie as sufficient to sow a bed 4 feet by 5 broadcast. The first sowing is effected in August, the second in September, for winter use. Thin out the plants when an inch high, to stand at three times that distance asunder. For summer salading sow once a month, beginning in March. Cut the plants for use as soon as they are large enough; this the taste will determine; but they should be taken very young, otherwise they become rank in hot weather.

Cress, or Garden Cress.—In alluding to the culture of this common salad, we will include *mustard*, because they naturally are companions, and are always mentioned together, though they are of two very different families. In cultivating mustard and cress, it is essential only to remark, that the latter should be sown three or four days in advance of the former, because cress is more tardy than mustard. Both are very accommodating herbs, inasmuch as they will grow upon wetted flannel in a saucer placed in any apartment as well as on the floor of a green-house. On ship-board, thus, under cover, they can be obtained throughout the winter; and in the gardens, from March to November, by successional sowings made once every fortnight. Sow either broadcast over the surface of a fresh digged bed, raking, and patting in the seeds by the flat of the spade, or in shallow drills half an inch deep, covering the seeds with a little fine soil. Sow thickly, and if the young plants rise, as they are apt to do, with a covering or cake of earth over them, remove it by means of a light heath-wisk. Salad should be taken before the true rough leaves be fully developed.

Water-Cress, a valuable antiscorbutic, and wholesome as a fresh alterative to the inhabitants of cities, is grown to most advantage by the edge of running streams. If a small rivulet can be introduced into the garden, nothing can be more easy than to plant the roots in spring, and when they have once seeded, there will be speedily a mass of water-cress, which it requires only trouble to pull. The moisture is required principally in summer. The soils best calculated to bring the plants forward are loams inclining to gravel. The London markets are now supplied with immense quantities as "fine spring water-cresses," from the moist lands of Essex and neighbouring counties.

Celery is a native of Britain, found in ditches and marshes near the sea. The odour of the wild plant is very rank and disagreeable, and its juice is acrid and dangerous. By cultivation, this dangerous weed has been brought to the condition of that highly esteemed vegetable which is called sweet celery. Of this there are three varieties: 1. The common upright hollow white celery; 2. The purple-stalked; 3. The giant white and red. Of the last (for which Manchester is particularly celebrated) there is a new sub-variety, extremely tender and delicate in flavour, the plants growing in favourable soils, and, under skilful management, to an enormous size, but in ordinary cases not larger than the common white, yet always possessing a superiority in texture and flavour. Half an ounce of seed is deemed sufficient to sow a bed 4½ feet wide, and 10 feet long, comprising, therefore, 45 square feet of surface; and it may be sown in a frame, with gentle heat, at the end of February, for the first crop, and thence to the end of May, on a warm sheltered border for succession. All the seedling plants should be pricked out into intermediate beds of soft rich earth (the first sowings over a gentle hot-bed), to bring plants in June and July.

The roots of celery become bushy, and its leaf-stalk firm and stout; it likes moisture, and the soil to be rich with decomposed vegetable matter. Self-sown seed, that which falls from a seeding plant, if it light on rich earth, as that of a newly-dressed asparagus bed, in October, will bring noble plants in the spring, fit to go at once into trenches. Such plants may be thus shortly described: they are about six or eight inches long, with numerous stout leaves, and a massive collection of short fibrous roots. If these be produced by autumn-sown seed, nothing more is required; but the spring sowings will always furnish weak and lax plants, that, when grown three inches high, must be removed to a nursery bed over manure to strengthen and become stocky. Few persons can obtain these plants till June, unless grown constantly under glass.

To trench for celery, prepare the trenches by previously manuring the whole plot in the method recommended for asparagus, and after the ground has settled, dig a trench or two for the first plants at a moderate spade's depth, depositing the earth on a ridge to the right and left of the trench. Clear the bottom, lay on it three inches of leafy manure, and re-dig the ground to incorporate it with the manure. Then [illegible] a number of the strongest and most regular plants, trim off loose straggling fibres and all the side suckers, but do not touch a true leaf: set the plants four or five inches, and the large sorts six inches asunder, and fill the holes with water; shade during sunshine for three days, and give water every evening, unless there be copious showers. The size of the plants will indicate the season of transplanting.

As to future attention, water the plants frequently in the evenings till they begin to grow; and when they become three inches higher, stretch a line along each edge of the trench, and cut down by the spade as much soil as will suffice to earth the stems to that height; break it fine, and grasping each plant firmly in the left hand, insinuate the soft soil around it; then place a little finely-reduced manure along the channel of the trench on each side, remote from the stems; this will nourish the fibres, without coming into contact with the leaves; water poured once or twice along the course of this manure will promote its action. Repeat the earthings as often as the plants advance three inches, and manure the extreme edges where the spade has made a groove, till at length the trenches become level with the surface of the ground. Then dig out soil, and add it, sloping ridgewise till the plants are "landed" up fifteen, eighteen, or more inches above the surface level. Celery may be preserved from frost by two or more sloping boards placed as a pent-house about the leaves

SWEET HERBS.

These we shall class under two heads—namely, those that are purely fragrant, and those which are used for culinary purposes.

Rosemary and Lavender.—These are hardy under-shrubs, natives of the south of Europe. They yield powerful essential oils, when distilled with water, that of lavender being employed, as are also the dried flowers, in the preparation of the spirit usually but erroneously called *lavender water*. Bees are extremely partial to the flowers of rosemary.

Both these shrubs are propagated with great facility by slips of the young side shoots, trimmed of the strip of ragged bark, and merely dibbled into the soil. They will grow almost anywhere, and in any aspect, but the flowers possess the highest degree of fragrance when the plants grow in a dry, sandy, or gravelly earth. Spring or September is most favourable to the propagation by slips.

Thyme and Lemon Thyme are used in seasonings; the latter is one of the most fragrant herbs of the garden; both are raised from seeds sown early in spring, or by opening the earth around the stems, spreading the reclining shoots like layers upon it, and spreading some fresh sandy mould over them. Roots are soon formed, and thus a supply of young plants is obtained. It appears essential to renew thyme, and to place it (lemon thyme particularly) in a new soil, otherwise the plant dwindles and perishes.

Sage, red and green, is propagated in the same way as lavender.

Marjoram.—There are three sorts of this herb—*pot marjoram*, *sweet* or *knotted marjoram*, and *winter marjoram*, all hardy or sub-hardy perennial and biennial small shrubs, natives of the south of Europe, which grow readily in a dry light soil, but require change of situation. The first and third sorts may be propagated by division, in the manner of thyme, but the sweet marjoram should be raised from seeds sown in April every year, the plants to be thinned out to the distance of six inches.

Savory.—Winter and summer savory; the former is propagated either by slips and cuttings, by separating the lower shoots, or rooted offsets, in spring; the latter is an annual, sown in April, and becoming fit for gathering in the summer and autumn.

Mint.—Garden and spearmint, and peppermint, are not properly sweet herbs; the latter, indeed, is only used medicinally, the essential oil possessing extremely pungent qualities, which render it one of the best diffusible stimulants we possess. Spear, or garden mint, is used in the kitchen for a variety of purposes familiarly known. All the species, including *pennyroyal*, another medicinal mint, are cultivated by division of the roots in spring. Mint delights in moisture; and when growing in a soil which it affects, extends with great rapidity. Care, however, is required to give it a new situation when the plant becomes weak, and its leaves appear of a pale and yellowish hue.

To dry and preserve these herbs, select the shoots just as the flowers [illegible] and show colour, but before they expand; suspend them in an airy situation, under cover, not exposed to the sun.

MISCELLANEOUS VEGETABLES.

Artichoke.—This vegetable is esteemed by many, yet is found in few gardens; it is a native of the south of Europe, and was brought to England nearly three hundred years ago. Two varieties of it are cultivated in the best gardens—the conical oval-headed, and the round-headed, with dark purplish heads, the scales turned in at top. The plant has fibrous, rather fleshy roots, large deeply-cut leaves, whitish with down, and it produces an upright stem, bearing at the summit an oval or roundish flower-head, not unlike a thistle. Artichokes can be raised from seed, but much more speedily by offset-suckers, which are produced freely by the parent plant. Select a spot of open ground; any soil will do, but a free light loam is to be preferred. Dig out a trench two feet wide, and of the same depth, if the good soil extend so low; if not (and this remark will apply to every future allusion to trenching), remove all the good soil, whatever its depth, to a space beyond the boundary of the farthest intended trench, and dig and turn the inferior bottom soil, incorporating with it three or four inches of good half-decayed stable manure. Then mark out another two-foot trench, and throw into the first eight or nine inches of the surface-soil of the second trench; add another similar layer of dung, and work it and the earth thoroughly together. Again, throw in the remainder of the good soil of trench 2, and add a third layer of manure, which mix also with the soil. Thus trench 1 will be completed, and by repeating the work till the earth dug out of 1 be deposited in the last intended trench, all will be manured and laboured alike; and a piece of rich ground will be prepared that may be expected to keep in heart during many years. These directions will apply to all enriched trenching, therefore we shall not repeat them. The work ought to be performed before the frosts of winter set in; and if the land be constitutionally heavy, it will be prudent to set it up in ridges.

Suckers are generally ready at some period of April; and gardeners are willing enough to part with them. Having procured the desired number, level the ground, dig a portion of it again, and reduce the surface to the finest condition possible; then, after trimming off decayed leaves and damaged roots, plant the suckers in a row, two feet asunder. It is usual to form a complete bed of three or more ranks, the rows to be five feet apart —and we have prepared ground, as above, for such a bed—but, in truth, artichokes and all other permanent vegetables ought to be set in single rows ten feet apart, because the ground between the rows can be cropped with other annual vegetables, which will benefit the artichoke, not only by the rich manure applied at the first, and other successional croppings, but by abstracting from the soil whatever it may exude from their roots of an excrementitious nature, and which, of necessity, must be injurious to the individual itself, though nutritious as manure to a vegetable of a different habit and character. The garden, in all its crops, permanent or temporary, ought to be made a laboratory of corrective rotations, wherein one crop shall attract and consume that which another deposits. A dozen good artichokes will be sufficient for a moderate family; but as some suckers may fail, it will be prudent to set the plants one foot asunder, securing the roots firmly in the soil, and giving a copious watering at the time of planting; the supernumeraries can be removed when all are safe.

The subsequent culture is as follows:—Hoe occasionally to destroy weeds, and keep the surface open. A crop cannot be anticipated during the first year; and if little heads be pushed up, it will be wise to remove them as soon as seen. When the plants become torpid and yellow in autumn, a few of the outside leaves are to be scaled off by the hand; the ground should then be marked by the line on each side at eighteen inches distance from the plants; and being cut straight by driving the spade to its full depth along the line, the earth is to be dug up, broken fine, and laid on the surface of the eighteen inches left on each side of the plants, bringing it carefully against them, so as not to fall into their hearts, but yet to protect them effectually near the tops of the leaves; the operation is called *landing up*. This done, fill the trenches with littery straw, dung, or fern; and in the event of hard frost, bring more litter close to the plants and lay it over the *landing* earth, for artichokes are rather tender, and may be destroyed during severe winters. This practice is to be observed every year, with the additional precaution to cut the flower-stems close down.

Spring-dressing consists in removing suckers after levelling the earth, and digging in a little of the short manure that is left on the ground after clearing away the straw, &c., and making the soil neat. One or two of the strongest suckers may be left on the stock.

Asparagus.—This is justly esteemed one of the choicest vegetables of the garden, and indeed it possesses every quality to recommend it—flavour for the palate, hardihood of constitution, facility of culture, and it brings profit to the grower. It is a native of the British isles, but in its wild state bears little resemblance to the plant in a state of cultivation. Perfectly hardy, so much so as to resist a frost below zero, as was that of January, 1838, it nevertheless benefits by protection and generous tillage: this it will now be our object to prove, while explaining the method by which it is cultivated. In forming new plantations, it is customary to purchase two years' old plants, because they are safely removed at that age, and will come into bearing in two years more; April is the best season for planting; but having ourselves produced beds from *seeds*, we prefer that method of propagation. Let the ground be prepared before frost sets in by deep trenching and rich manuring; but by all means adopt the practice recommended by Grayson, who produced what he styled *giant asparagus* about the year 1830. We give his own concise directions in the following quotation:—"If your ground be stiff and unpleasant to work, get some milder earth to mix with it, and a very large cart-load of rotten dung to about every ten square feet; trench it two spit deep, and loosen the bottom; let the dung and earth be well mixed together. When your land is fit for planting, draw your drills six inches deep and sixteen inches from the first row to the second; that will form a bed; and ten inches between each plant in the row. Do not raise your beds till they have been planted one year; then put on about four inches of mould out of the alleys, and cut till the 10th of May. If you keep them well manured, they will last twenty years; but *never cut later than the 4th of June*. Let them be eight feet in the clear from bed to bed, so that you may crop between, and lose no land."

Here we find the sum of all that constitutes asparagus planting; but, after all, persons must be content with such plants as the constitution of their ground will produce; for this very sort, which in the rich water-deposited grounds (alluvial) about the Thames, produced shoots an inch in diameter, would and did dwindle in the loams of ordinary gardens to less than half that size. Nevertheless, if the beds be narrow, thoroughly manured at first, remote from each other; if, also, about February of the first year after planting, a trench eighteen inches deep, and a foot wide, be formed on each side of the narrow bed, and twelve inches distant from the plants, and be half filled with the best rotten dung, incorporated with an equal quantity of the earth dug out, a most excellent asparagus will be obtained, speedily, and the quality will not deteriorate. This enrichment may be occasionally renewed, but these auxiliary trenches are to be made at an increased distance each time, so as to avoid cutting and mutilating the roots, which extend very rapidly. As this vegetable will no doubt be sold by the cottager, too much pains cannot be bestowed in order to obtain an early supply of the very finest quality.

The seed of asparagus may be purchased, but it is yielded abundantly by every good bed, and should be gathered before it falls off, and kept in the berry till spring

We will presume the object to be double—first to raise bearing beds, and second, to raise a stock of young plants for forcing. In the former case, the ground is to be in readiness for narrow beds, eight feet asunder; in the latter, wide beds, like those directed for artichokes, should be made. Towards the latter end of March, rub out the seed, and place the line along the course of the bed; strike two drills with the hoe at the distances directed by Grayson, two inches deep: or in the broad beds, make similar drills nine inches asunder; and in both scatter the seeds pretty thickly, we will say half an inch apart; cover with fine earth, and pat it to an even surface with the spade. Watch the coming up of the plants, and be prepared to dust them with air-slacked lime, if slugs threaten them. When they shall have fairly formed rows of young seedlings six inches high, thin out the *narrow beds* first to four inches apart, and again to nine inches. The *seed rows* for forcing, thin first to three, and afterwards to five inches, and then leave both to grow, observing to use the Dutch or thrust hoe repeatedly, to keep down weeds.

In future treatment, suffer the stems to become yellow, then cut them down at two inches above the soil; clear the surface with hoe and rake, and lay on the beds eight inches of decayed leaves. Such manure is the nearest approach to that substance which it is now fashionable to call *humus;* this word is the Latin for *the ground,* and the meaning of it, if it have any, is this: all good ground contains substances which the living principle of the plant converts to sap; *earths pure* cannot be so converted, but *manure,* or decayed vegetable and animal remains, when mixed up with earth, can. After a time, ground so prepared contains what is called *humus,* and leaves or dung from an old dunghill is in a condition to be soon converted to food; therefore we say it approaches pretty nearly to the state of humus. This surface-manuring, which will generally take place about the end of October, will tend greatly to protect the young plants, and impart a stimulating principle to the ground; so that in early spring the plants will be strongly excited, and rise through the remaining manure in perfect safety. The trench manuring also, before alluded to, will come in aid of the top-dressing. We have cut excellent "grass" within three full years of the sowing, and our two large beds now existing, were prepared from seed sown in 1831. These annual enrichments, be it observed, might be persisted in with every bed that is used for cutting; but for the beds devoted to raising plants for forcing, it will suffice to make the ground thoroughly rich at the time of trenching; because the plants, when three or four years old, will be removed to the forcing department; yet a coating of half-decayed leaves or manure, after the stalks are cleared off, will not be lost, as the stronger the plants, the more remunerative will be the produce.

When once asparagus is in full bearing, if the cuttings be judiciously made, that is, by taking only the strong shoots, always leaving one or two of medium strength to each crown, and duly applying manure, a bed may keep in high condition for twenty years. But it must not be forgotten that, if every shoot be taken off a crown, to the end of a long season, that root will be destroyed. To prevent the crowns from being too deeply buried, in consequence of the autumnal dressings, it is customary to fork the beds late in March, digging them carefully, or rather loosening the surface with a fork of three prongs, and raking the rough earth into the alleys; this operation also gives freedom to the plant by opening the top soil.

With respect to forcing, it is very easy, with narrow distant beds, to bring the plants somewhat more forward in the spring, by digging trenches eighteen inches wide or wider, and above a foot deep, and filling them with warm stable dung, blended with a third part of forest-tree leaves, raising the dung to six inches above the surface level The gentle warmth communicated will stimulate vegetation, and it would be assisted by covering the beds with hoops and mats, or with boards set up ridgeways, in the event of sharp frosty nights. Successional forcing beds are prepared as soon as the cutting of the earlier begins to decline, or even when it is at its height.

The Cucumber.—This juicy vegetable is tender, and requires a fine climate and extremely rich soil. It is usually grown over a heap of old horse-dung, on a spot of ground open to the south, and large enough to permit a two or three-light frame to rest upon it. Dig out the soil a foot in depth, and lay it on one side or around the trench. If this soil be a light friable loam, incorporate it, a month before it is to be used, with one third part of leaf or vegetable earth and old decayed dung, and again dig this mixed earth two or three times. But if the soil produced from four or five year-old couch grass roots, harrowed from a field of sound loam, can be procured, it is the best aliment for the cucumber. The soil should be ready in April, and the work of planting begun in the first week of May, by filling the excavation with stable manure to the height of six inches above the surface-level of the unmoved earth, and placing on it the frame and lights. In a week the manure will have settled, and is then to be covered with a six-inch layer of the couch mould or other soil, and a hill of dryish earth raised a few inches higher under each light, in which eight or ten seeds of any approved variety may be sown. If preferred, the seeds may be prepared by previous sowing in pots in a slight hot-bed, and the plants so raised can be transferred to the hills. But as the plan now recommended is not one of forcing, it is safer to begin on the spot, by sowing seed, and covering the bed with the lights, and those with mats or boards every night. As the plants rise, observe them carefully, and pick out the central buds when the true leaves have become strong. Persons differ much in opinion at this stage concerning the practice of stopping the shoots. M. Phael, gardener to Lord Liverpool, at Addiscombe, Surrey, pointed out the true theory and results of stopping, as may be perceived by the following abbreviated extract from his work on the cucumber. He first directs to stop (nip back) the young seedlings at their second joint, then—"When the plants shoot forth after a second stopping above the second joint of the latterals, produced by the first, they seldom miss to show fruit at every joint and also a tendril, and between this tendril and the showing fruit, there may be clearly seen the rudiments of another shoot. This shoot is then in embryo but if developed it becomes a fruitful lateral. And when the leading shoot has extended itself fairly past the showing fruit, then with the finger and thumb pinch it and the tendril off just before the showing fruit, being careful that, in pinching off the tendril and the shoot, the showing fruit be not injured. This stopping of the leading shoot stops the juices of the plant, and enables the next shoot—the rudiment above mentioned—to push vigorously, and the fruit thereby also receives benefit."

The remarks will avail equally with the melon-plant as with the cucumber; and when the few remarks which follow on forcing shall be considered, nothing farther need be said of the cultivation of melons.

Whether cucumber and melon plants have been raised separately in pots, or from seed sown in the frame, they ought to be progressing early in June, and should be stopped occasionally, till fruit begin to show itself. The soil must never be *wet* but always retained in a free and rather moist condition, water being kept in the frame for the express purpose. No water ought to be poured against the stems—it should be applied to the soil round the slope of the hills only. Air ought to be admitted in all warm days, by tilting the back of the lights till three o'clock, but after that hour the frame should be kept closed. When fruit is visible, stopping, according to M. Phael's direction, should be persevered in, and its fertilising effects will soon be apparent. Cover with mats, and boards over them, at sunset. Every decayed leaf and weak shoot should be removed as soon as perceived.

In order to raise and fruit cucumbers or melons before midsummer, *forcing* must be employed. The hot beds of the best regulated gardens are conducted without masses of manure under the roots; heat is excited by an atmosphere of warm air; thus injury from internal rank vapour is avoided, and manure is economized. By this method cucumbers and melons can be produced during the spring and summer months with certainty and precision. In the cultivation of both these plants, equability of heat is important; and nothing would be more likely to secure this, and also to ward off sudden accession of cold, than to case the frame with an inner lining of thin boards, leaving a space of an inch or two between them, to be filled with some imperfectly conducting substance, such as powdered charcoal or very dry deal saw-dust, taking care to secure it from the ingress of water. The expense would be trifling, and the security afforded very great.

Celeriac, or turnip-rooted celery, is raised and nursed the same as celery; but in planting out, the ground is dug and enriched, not trenched, and the plants are set by the dibble or garden trowel along the course of shallow drills drawn by the hoe, six inches apart, watering them freely. As the growth advances, bring earth to the plants, by which the knobby roots will be bleached, and made delicate and tender. When these are the size of small turnips, they are fit for the table. Celeriac is never eaten raw; it is boiled, and served up with melted butter. The seeds of both the species ripen freely in the summer of the second year, and many fine plants are obtained from self-sown seeds, which may serve as excellent substitutes should the spring-sowings fail.

Mushrooms.—We have great hesitation in saying any thing of the artificial growth of this species of vegetable, both on account of the difficulty which unprofessional gardeners labour under respecting the right sorts, and the complex methods which require to be employed for bringing forward crops. The greater number of mushrooms brought to market are of natural growth on old rich pastures; and it would appear that, without providing a similar kind of soil full of decaying matter, the plants cannot be raised. The method of procedure is very peculiar. The mushrooms are not sown in the form of seeds, for they have no observable seeds, but by spawn, or portions of their substance, mingled in the prepared soil. Mr. Rogers, in his work, *The Vegetable Cultivator*, to which we would refer for much useful information on kitchen gardening, describes the process of mushroom culture which he says is that approved of by the Horticultural Society. We extract a few passages for the sake of general information.

"In June or July take any quantity of fresh horse-droppings (the more dry and high fed the better), mixed with short litter, one third of cow's dung, and a good portion of mould of a loamy nature; cement them well together, and mash the whole into a thin compost, and spread it on the floor of an open shed, to remain till it becomes firm enough to be formed into flat square bricks; which done, set them on an edge, and frequently turn them till half dry; then with a dibble make two or three holes in each brick, and insert in each hole a piece of good old spawn, about the size of a common walnut. The bricks should then be left till they are dry. This being completed, level the surface of a piece of ground, under cover, three feet wide, and of sufficient length to receive the bricks, on which lay a bottom of dry horse-dung, six inches thick; then form a pile, by placing the bricks in rows one upon another, with the spawn side uppermost, till the pile is three feet high; next cover it with a small portion of warm horse-dung, sufficient in quantity to diffuse a gentle glow of heat through the whole. When the spawn has spread itself through every part of the bricks, the process is ended, and the brick may then be laid up in a dry place for use.

Mushroom spawn made according to this direction, will preserve its vegetative power many years, if well dried before it is laid up; but if moist, it will grow and exhaust itself. The next subject to be treated of is the preparation of the dung for the bed; and for this purpose none answers so well as that of the horse, when taken fresh from the stable; the more droppings in it the better.

About Michaelmas is the general season for making mushroom beds (though this may be done all the year round). A quantity of the dung mentioned should be collected, and thrown together in a heap, to ferment and acquire heat; and as this heat generally proves too violent at first, it should, previously to making the bed, be reduced to a proper temperature by frequently turning it in the course of a fortnight or three weeks; which time it will most likely require for all the parts to get into an even state of fermentation. During the above time, should it be showery weather, the heat will require some sort of temporary protection, by covering it with litter or such like, as too much wet would soon deaden its fermenting quality. The like caution should be attended to in making the bed, and after finishing it. As soon as it is observed that the fiery heat and rank steam of the dung are gone off, a dry and sheltered spot of ground should be chosen on which to make the bed. The place being determined on, a space should be marked out five feet broad, and the length (running north and south) should be according to the quantity of mushrooms likely to be required. If for a moderate family, a bed twelve or fourteen feet long will be found (if it takes well) to produce a good supply of mushrooms for some months, provided proper attention be paid to the covering.

On the space marked for making the bed a trench should be thrown out, about six inches deep; the mould may be laid regularly at the side, and if good, it will do for earthing the bed hereafter; otherwise, if brought from a distance, that of a more loamy than a sandy nature will be best. Either in the trench, or if upon the surface, there should be laid about four inches of good dung, not too short, for forming the bottom of the bed; then lay on the prepared dung a few inches thick regularly over the surface, beating it as regularly down with the fork; continue thus, gradually drawing in the sides to the height of five feet, until it narrows to the top like the ridge of a house. In that state it may remain for ten days or a fortnight, during which time the heat should be examined towards the middle of the bed, by thrusting some small sharp sticks down in three or four places; and when found of a gentle heat (not hot), the bed may be spawned; for which purpose the spawn bricks should be broken regularly into pieces about an inch and a half or two inches square, beginning within six inches of the bottom of the bed, and in lines about eight inches apart; the same distance will also do for the pieces of spawn, which, in a dung ridge, are best put in by one hand, raising the dung up a few inches, whilst with the other the spawn can be laid in and covered at the same time. After spawning the bed, if it is found to be in that regular state of heat before mentioned, it may be earthed. After the surface is levelled with the back of the spade, there should be laid on two inches of mould—that out of the trench, if dry and good, will do; otherwise, if to be brought, and a choice made, that of a kindly loam is to be preferred. After having been laid on, it is to be beaten closely together, and when the whole is finished, the bed must be covered about a foot thick with good oat-straw, over which should be laid mats, for the double purpose of keeping the bed dry and of securing the covering from being blown off. In the course of two or three days the bed should be examined, and if it is considered that the heat is likely to increase, the covering must be diminished for a few days, which is better than taking it entirely off

In about a month or five weeks (but frequently within the former time, if the bed is in a high state of cultivation) mushrooms will most likely make their appearance, and in the course of eight-and-forty hours afterwards they will have grown to a sufficient size for use; in which case the author recommends that, instead of cutting them off close to the ground, they be drawn out with a gentle twist, filling up the cavity with a little fine mould, gently pressed in level with the bed."

As mushrooms may be said to cost no more than a little trouble, manure, and space for growth, at what an inconsiderable cost might not this excellent vegetable be abundantly procured! No product of the garden has hitherto been less attended to, and few afford so high a relish, either in their substantial form or as ketchup.

Nasturtium, or Indian cress, is a native of South America, but is not tender: it is used occasionally (that is, the green seed-vessels are) as a pickle. These, when they ripen, separate, and drop on the ground, where they remain torpid till the spring. Thus the plant sows itself, and so do most of the garden ornamental varieties. It therefore requires no minute directions; and any one who once possesses a plant, can multiply it by sowing seed in any way or place which may suit his taste.

Parsley.—Several species and varieties of parsley are in cultivation; these are the plain and curled-leaved, and the common and the broad-leaved, or Hamburg parsley. Preference ought to be given to the curled-leaved parsley. This vegetable is one of the most easily cultivated, and it will long keep the ground with little trouble. It is sown in drills in any spare patches of border, and arrives at maturity the next season. When it has attained this state, sprigs may be taken from it when required. When it becomes rank, it may be rooted out, and fresh parsley sown.

Rhubarb.—This is a large vegetable, grown for the sake of its firm leaf stalks. The leaves are very broad and spreading, to catch moisture, and shelter the ground around the main [illegible] from the exhausting heat of the sun. When on[illegible]d, it requires no trouble, but keeps growing [illegible] plant runs up to seed. To give additional size to the stems, cut off the seed stalk. Suckers taken from known and approved plants succeed well, but the plant can easily be raised from seed. Each plant requires considerable space. In taking away the stalks for use, do not cut them, but wrench them from the main stock, so as to take them out by the socket. The earliest sorts in repute are *Buck's scarlet*, and the *new Tobolsk*, or yellow stalked. *Radford's scarlet Goliath* is later, but remains in season till August; it surpasses for delicacy, fullness of flavour, and extreme productiveness, all its competitors. Rhubarb may be forced by very simple means. A common method is to cover the plant in the early part of the year with a box, to which air is admitted, and covered with a little stable-manure. This blanches, as well as brings forward the stalks; but that is an advantage, as it renders the vegetable more tender and delicate in flavour. Some bring forward the plants in pots in darkened forcing-houses, and, for this purpose, plants two years old are most suitable. Watering copiously is necessary in the early stages of growth, whether in the open air or under boxes. As rhubarb forms a valuable vegetable for tarts in spring, before gooseberries are ready, it would not be misspent time or trouble for a cottager to attempt forcing by the simple means above recommended.

Sea-Kale.—This is a perennial vegetable, deriving its name from being found growing in a wild state on the sandy downs which border the southern coasts of England. The method of garden culture is as follows:—Beds or spaces for single rows should be trenched and prepared as for asparagus; and at any dry period of March, when the surface earth will work freely, one or more drills should be drawn by the line, two inches deep, and the seeds scattered along the drill; or, the line being strained tight, five or six seeds should be inserted in rings two inches deep, made at the distance of two feet apart. The seeds are then covered with earth, and when the plants become strong, they are to be thinned of supernumeraries, leaving one or two of the strongest remaining eighteen inches or two feet asunder every way. If the plants be weak, it will be prudent to retain double the number. During the first season, nothing more will be required than to keep the bed or row free of weeds. In the following spring, if the plants stand nearer to each other than eighteen inches, the surplus number should be carefully raised, and transferred to another prepared space, planting the crowns of the roots two inches below the surface. Eighteen inches to two feet, according to the strength of the plants, may be the regular distances at which they are to remain. The first bed, if pots be placed over the crowns, will yield a moderate supply of blanched kale during April or May of the second spring.

Sea-kale may be forced at various periods, commencing with November, by inverting large pots over the plants, and covering those with warm dung, or dung and leaves, to excite and maintain a heat in the pot and soil of about 55 degrees. Sea-kale, like other plants, subjected to heat, can be, as it were, educated and made to conform to induced habits. Thus, at first, it seems to remain long torpid, even though the heat be considerable; but after a second season, provided the gardener be himself regular, the plants will yield to the stimulant almost to a day, though it be comparatively mild; hence sea-kale is at command from December to March by heat, and then the succession can be maintained during April and part of May by the cold beds or rows. As soon as the kale is cut from one or more roots, a sharp spade should be thrust through it, so as to cut the plant level with the surface.

Spinach is an annual, of which there are many varieties. The following are the principal kinds:—1. The round-leaved, smooth-seeded, which is sown chiefly for spring and summer crops. 2. The triangular-leaved, prickly-seeded, or winter spinach—it is sown in August, stands the winter, and continues in full bearing during spring and till midsummer. 3. The New Zealand spinach, a plant very different from the true spinach, and now neglected. 4. The white beet spinach, cultivated only for the leaves. The round-leaved should be sown about the end of January, and again in February and March, for successive spring and summer crops. The triangular-leaved is to be sown at the end of July or first week of August, and the leaves come into use at the beginning of winter; the plants require thinning and hoeing. The outer leaves only are to be taken during winter and spring, the inner leaves forming in their turn an ample succession. The seed or flower stalks will become apparent in the early part of the summer, and some of the best plants, male and female (for spinach produces both separately), should be left to perfect the seeds.

Vegetable Marrow is a species of gourd (*cucurbita*) cultivated extensively of late years. It was brought originally from Persia, and was particularly noticed by Mr. Sabine, in the *Horticultural Transactions*, vol. ii., where he described the best culinary variety as bearing a "fruit of uniform pale-yellow or light-sulphur colour, when full grown, about nine inches in length, four inches in diameter, of an elliptic shape, the surface being rendered slightly uneven by irregular longitudinal ribs, the terminations of which uniting, form a projecting apex at the end of the fruit, which is very unusual in this tribe." There are other varieties which produce fruit that weighs twenty or thirty pounds, oblong in figure, and quite green during growth; this is coarse in flavour, and in no respect equal to the small cream-coloured variety.

Sow in pots of any light soil early in April, treating the plants exactly as cucumbers under glass. About the middle of May, transfer them to a bed of rich earth over a trench filled with warm stable dung. Protect the plants by a hand-glass or frame, which, if the shoots are to run on the ground, should be raised by four or more bricks, giving air freely. When danger of frost ceases, remove the light or frame.

We have seen the best plants nailed and secured to a wall, as trees usually are. They bear profusely in summer and autumn, and are not subject to be injured by damp. The seeds are sown on the spot at the end of May, and one strong plant remains, being stopped once or twice at the tips of the advancing shoots, of which six are enough for each plant. It would be wise to place a large spare light or two sloping in front till midsummer, and again early in September. Glass diminishes the direct solar power to the extent of from 8 to 12 degrees, but it wards off the primary attack of frost, which is fatal at once to these plants. If it be desirable to save seed, preserve the fruit first formed on a plant reserved for the purpose.

HORTICULTURAL MONTHLY CALENDAR.

Having in almost every instance mentioned the seasons for sowing, planting, transplanting, and otherwise attending to the culture of vegetables in the kitchen-garden, it would only be waste of room to repeat directions, as is usually done, in connection with the different months. It is hoped, therefore, that the following general references to the months will be sufficient:—

January.—Trench and delve up all open grounds, if the weather permit; and in warm exposures, sow articles that are to be brought forward early. *February.*—Continue turning up the ground designed for early crops; sowing may go on a little more briskly. *March.*—This is a particularly busy month, being, from its open and drying character, favourable for all works of preparation. Peas, beans, asparagus, onions, carrots, &c., are sown; and various articles are transplanted from frames. *April.*—A continuance of preparing, sowing, and planting; hoeing, thinning, and clearing out of weeds, require also to be attended to.

May.—The main crops are now to be sown, early peas earthed up and staked, and young plants transplanted. The garden is now supposed to have assumed its perfect summer garb, with all things advancing in their early and mid-stages of growth. *June.*—Sow kidney beans, runners, &c.; water growing plants, if required; hoe potatoes, cabbages, and peas; and thin out beds. *July.*—Sow broccoli for the last time; also turnips, lettuces, &c.; and prepare all the unoccupied plots of ground for autumn and winter crops.

August.—Commence now to sow for the crops of next year, such as onions, early cabbages, and parsley; also winter spinach. Earth celery: hoe and thin turnips; cut down stems of gathered artichokes, and generally clear out all stumps and stalks of used plants, for their continuance exhausts the ground to no proper purpose. *September.*—The kitchen gardener has now got his principal labours in cropping over, and his chief work is continuing to sow for winter and spring successions; he also digs potatoes that seem ready, and takes care to cut down and clear off weeds.

October.—The garden having been prepared for spring vegetables, sow what was left over last month, including celery, asparagus, also early peas and beans. The cabbages and savoys require to be earthed up as high as the leaves. Remove carrots and other roots, which store away for winter use. *November.*—If temperate and open, a little sowing may be continued in sheltered borders; but frost usually sets in early in the month, and puts a stop to cropping operations. *December.*—During the latter end of November, and the open period of this month, the chief operations are digging, manuring, or trenching vacant ground, and attending to the preparation of composts. In frost, the labour exerted on the plants need only be protective; and the gardener usually occupies much of this period in pruning his trees, and attending to the more delicate plants in frames and sheltered borders.

We have now presented a sketch of the principal vegetables grown in the kitchen gardens of England, with the modes of general treatment, and the seasons suitable for their culture. It may be necessary to add the observation, that kitchen gardening, except among skilled professional men, is still in a backward condition in all parts of the British islands; and that, except in and about London, the people generally either do not know what fine vegetables are, or very seldom see them. Much has been done by horticultural societies to promote a better knowledge on the subject, and taste is evidently improving as respects all the products of the garden; nevertheless, the bulk of the people are still far behind their continental neighbours both in the cultivation and preparation of culinary vegetables. In order to produce a sensible improvement in kitchen gardening, we should require to impart a knowledge of what vegetables can be made to perform by proper cookery—what relish can be given to a plain diet, at scarcely a farthing of more expense, merely by adding a few sprigs or slices of some highly flavoured plants. In the article COOKERY, we have attempted to throw out a few useful hints on the best means of preparing vegetables, and would here add the recommendation to all persons in an humble condition of life, that, if circumstances at all permit, they should endeavour to rent and cultivate a small garden, for the purpose of rearing at leisure hours a supply of kitchen vegetables, as well as a choice of flowers, and at least small fruit. The directions afforded in the preceding pages (and in the two sheets which follow) have been drawn up in a great measure for the use of this class of people, and those in a somewhat higher sphere; and though these directions may not apply in any individual instance, they will, it is hoped, lead the mind to the true principles on which garden-culture is to be conducted; and by thought, diligence, and experience, each person will in a short time attain that amount of skill which will bring his operations to a successful issue.

THE FLOWER GARDEN.

Flowers are the ornament of vegetable existence, and have in all ages been cultivated by persons of leisure and taste, for the pleasure which they yield to the eye and the fancy. While generally healthful and exhilarating from being pursued in the open air, flower-culture is justly reckoned to be a pure and harmless recreation, which, by leading to the tranquil contemplation of natural beauty, and diverting the mind from gross worldly occupations, has a positively moral and therefore highly beneficial tendency. It has also the advantage of being alike open to the pursuit of high and low, the peasant and the peer, the over-toiled man of business and the industrious artisan. It may be followed with equal enjoyment by individuals of both sexes, and, as is well known, on every imaginable scale, from that of a single flower-pot or ornamental border, to the princely greenhouse and exquisitely varied parterre.

The natural grace, simplicity, and attractive colouring of flowers, have afforded endless themes to moralists and poets, and volumes have been penned to show how many associations of feeling, simple and sublime, these beauteous objects are calculated to excite. As our desire is to improve the feelings as well as to instruct the understanding, we hope to escape blame for pausing an instant over this agreeable view of the value of flower-culture, and would refer, for one of the most glowing eulogies on the subject, to the elegant work of Miss Sarah Stickney—the *Poetry of Life*. According to the well-expressed sentiments of this lady, few natural objects are more poetical, or more calculated to refine the taste than flowers. "From the majestic sun-flower, towering above her sisters of the garden, and faithfully turning to welcome the god of day, to the little humble and well-known weed that is said to close its crimson eye before impending showers, there is scarcely one flower which may not from its loveliness, its perfume, its natural situation, or its classical association, be considered highly poetical.

"As the welcome messenger of spring, the snowdrop claims our first regard, and countless are the lays in which the praises of this little modest flower are sung. The contrast it presents of green and white (ever the most pleasing of contrasts to the human eye), may be one reason why mankind agree in their admiration of its simple beauties; but a far more powerful reason is the delightful association by which it is connected with the idea of returning spring. Perhaps we have thought long of the melting of the snow that impeded our noonday walk. But it vanishes at last; and there, beneath its white coverlid, lies the delicate snowdrop, so pure and pale, so true an emblem of hope, and trust, and confidence, that it might teach a lesson to the desponding, and show the useless and inactive how valuable are the stirrings of that energy that can work out its purpose in secret and under oppression, and be ready in the fulness of time to make that purpose manifest and complete. The snowdrop teaches also another lesson. It marks out the progress of time. We cannot behold it without feeling that another spring has come, and immediately our thoughts recur to the events which have occurred since last its fairy bells were expanded.

"It is of little consequence what flower comes next under consideration. A few specimens will serve the purpose of proving that these lovely productions of nature are, in their general associations, highly poetical. The primrose is one upon which we dwell with pleasure proportioned to our taste for rural scenery, and the estimate we have previously formed of the advantages of a peaceful and secluded life. In connection with this flower, imagination pictures a thatched cottage standing on the slope of the hill, and a little woody dell, whose green banks are spangled all over with yellow stars, while a troop of rosy children are gamboling on the same bank, gathering the flowers, as we used to gather them our selves, before the toils and struggles of mortal conflict had worn us down to what we are now, and thus presenting to the mind the combined ideas of natural enjoyment, innocence, and rural peace—the more vivid, because we can remember the time when something like this was mingled with the cup of which we drank—the more touching, because we doubt whether, if such pure drops were still there, they would not to our taste have lost their sweetness.

"The violet, while it pleases by its modest, retiring beauty, possesses the additional charm of the most exquisite of all perfumes, which, inhaled with the pure and invigorating breezes of spring, always brings back in remembrance a lively conception of that delightful season. Thus, in the language of poetry, 'the violet-scented gale' is synonymous with those accumulated and sweetly-blended gratifications which we derive from odours, flowers, and balmy breezes; and, above all, from the contemplation of renovated nature, once more bursting forth into beauty and perfection.

The jasmine, also, with its dark-green leaves and little silver stars, saluting us with its delicious scent through the open casement, and impregnating the whole atmosphere of the garden with its sweetness, has been sung and celebrated by so many poets, that our associations are with their numbers rather than with any intrinsic quality in the flower itself. Indeed, whatever may have first established the rank of flowers in the poetical world, they have become to us like notes of music, passed on from lyre to lyre; and whenever a chord is thrilled with the harmony of song, these lovely images present themselves, neither impaired in their beauty nor exhausted of their sweetness, for having been the medium of poetic feeling ever since the world began.

"It is impossible to expend a moment's thought upon the lily, without recurring to that memorable passage in the sacred volume—'Consider the lilies of the field how they grow. They toil not, neither do they spin; and yet I say unto you, that Solomon in all his glory was not arrayed like one of these.' From the little common flower called heart's ease, we turn to that well-known passage of Shakspeare, where the fairy king so beautifully describes the 'little western flower.' And the forget-me-not has a thousand associations tender and touching, but, unfortunately, like many other sweet things, rude hands have almost robbed it of its charm. Who can behold the pale narcissus, standing by the silent brook, its stately form reflected in the glassy mirror, without losing himself in that most fanciful of all poetical conceptions, in which the graceful youth is described as gazing upon his own beauty, until he becomes lost in admiration, and finally enamoured of himself; while hopeless Echo sighs herself away into a sound, for the love which, having centred in such an object, was neither to be bought by her caresses nor won by her despair?

"Through gardens, fields, forests, and even over rugged mountains, we might wander on in this fanciful quest after remote ideas of pleasurable sensation connected with present beauty and enjoyment; nor would our search be fruitless, so long as the bosom of the earth afforded a receptacle for the germinating seed—so long as the gentle gales of summer continued to waft them from the parent stem, or so long as the welcome sun looked forth upon the ever-blooming garden of nature.

"One instance more, and we have done. The 'lady rose,' as poets have designated this queen of beauty, claims the latest though not the least consideration in speaking of the poetry of flowers. In the poetic world, the first honours have been awarded to the rose, for what reason it is not easy to define, unless from its exquisite combination of perfume, form, and colour, which has entitled this sovereign of flowers in one country to be mated with the nightingale; in another, to be chosen, with the distinction of red and white, as the badge of two honourable and royal houses. It would be difficult to trace the supremacy of the rose to its origin; but mankind have so generally agreed in paying homage to her charms, that our associations in the present day are chiefly with the poetic strains in which they are celebrated. After all the pains that have been taken to procure, transplant, and propagate the rose, there is one kind perpetually blooming around us through the summer months, without the aid or interference of man, which seems to defy his art to introduce a rival to its own unparalleled beauty—the common wild rose. Blooming in the sterile waste, this lovely flower is seen unfolding its fair leaves where there is no beauty to reflect its own, and thus calling back the heart of the weary traveller to thoughts of peace and joy—reminding him that the wilderness of human life, though rugged and barren to the discontented beholder, has also its sweet flowers, not the less welcome for being unlooked for, nor the less lovely for being cherished by a hand unseen."

To these elegantly expressed sentiments, nothing need be added by the writer of these pages.

LAYING OUT OF FLOWER GARDENS.

Flowers are cultivated in the borders and parterres of gardens of a mixed kind along with kitchen vegetables and fruits; and this may be said to be the general plan in those grounds of limited space belonging to persons of moderate means, and limited in the extent of their possessions. Many, however, cultivate flowers in gardens exclusively appropriated to them, and also in the isolated clumps which decorate ornamental lawns. In whichever way, the method of culture is clearly the same; and therefore it is unnecessary for us to enter into particulars with reference to all the sizes and kinds of gardens in which flowers may be grown.

The directions given in the previous sheet on the laying out, shelter, and exposure of kitchen gardens, apply also to flower gardens. The soil should be rich, dry, soft, and partially improved with decomposed peat and leaf mould; the exposure should be towards the sun; a free air should be allowed to play over the ground; and means should be at hand for procuring a plentiful supply of pure soft water for irrigation. Every flower garden, also, should possess a small store of fine washed sand as a restorative, and for scattering beneath the finer kinds of flowers when in bloom, as a protection from creeping vermin. Besides the utensils usually employed, the flower gardener should have a pair of small scissors to clip off decayed leaves, and some stripes of mat for tying up certain drooping plants.

The greatest difference of taste prevails on the subject of disposing the various parts of a flower-pot or garden. Straight-lined borders, ovals, circles, and fancy figures, have each their admirers; and we should advise every one to adopt that form which will be most effective in striking the eye. If the garden is seen from a parlour window, as is often the case, the plan most agreeable is to lay out the foreground as a patch of well-shaven green, which is fresh both winter and summer; on its further side there may be a semicircular border; then a walk; and next parterres of such form and size as will suit the extent of the ground. If the ground contain kitchen vegetables, they should be out of sight of the windows of the dwelling-house, or at least not brought ostentatiously forward. "It is more difficult," says the author of the *Florist's Manual*, "than may at first appear, to plan, even upon a small scale, such a piece of ground nor, perhaps, would any but an experienced and scientific eye be aware of the difficulties to be encountered in the disposal of a few shaped borders interspersed with turf. The nicety consists in arranging the different parts so as to form a connected glow of colour; to effect which, it will be necessary to place the borders in such a manner that, when viewed from the windows of the house, or from the principal entrance into the garden, one border shall not intercept the beauties of another—nor, in avoiding that error, produce one still greater, that of vacancies betwixt the borders, forming small avenues, by which the whole is separated into broken parts, and the general effect lost. Another point to be attended to is the just proportion of green turf, which, without nice observation, will be too much or too little for the colour with which it is blended; and, lastly, the breadth of the flower-borders should not be greater than what will place the roots within the reach of the gardener's arm without the necessity of treading upon the soil, the mark of footsteps being a deformity wherever it appears among flowers."

Whether all the flowers of a class—such, for instance, as violets, hyacinths, &c.—should be cultivated together, or interspersed and mingled with others, is another matter for taste to decide. The preferable plan seems to be to form a choice variety in borders and other spots, but also to cultivate a quantity of certain sorts in compartments by themselves. Neill judiciously observes, on the choice of flowers for borders—"The plants are arranged in mingled flower-borders, partly according to their size and partly according to their colour. The tallest are planted in the back part, those of middling size occupy the centre, and those of humble growth are placed in front. The beauty of a flower border, when in bloom, depends very much on the tasteful disposition of the plants in regard to colour. By intermingling plants which grow in succession, the beauty of the border may be prolonged for some weeks. In a botanic garden, the same plant cannot be repeated in the same border; but in the common flower garden, a plant, if deemed ornamental, may be often repeated with the best effect; nothing can be finer, for example, than to see many plants of double scarlet lychnis, double sweet-william, or double purple jacobea."

The Dutch, who are among the best flower gardeners in the world, have lately begun to copy the English in ornamenting turf lawns with plots of various kinds of flowers; but in all their large and regular gardens, they still dispose each kind of flowers by themselves. "We ridicule this plan," says Hogg in his Treatise on Flowers, "because it exhibits too great a sameness and formality like a nosegay that is composed of one sort of flowers only, however sweet and beautiful they may be, they lose the power to please, because they want variety. It must undoubtedly be acknowledged, that a parterre, no matter in what form—whether circular or square, elliptical or oblong—where all the shrubs, plants, and flowers in it, like the flowers in a tastefully arranged bouquet, are variously disposed in neat and regulated order, is a delightful spectacle, and worthy of general imitation. Yet still, in some particular cases, I am disposed to copy the Dutchman; and I would have my bed of hyacinths distinct, my anemones, my ranunculuses, my pinks, my carnations distinct, and even my beds of hollyhocks, double blue violets, and dwarf larkspurs distinct, to say nothing of different sorts of roses. Independently of the less trouble you have in cultivating them when kept separate, you have beauty in masses, and you have likewise their fragrance and perfume so concentrated, that they are not lost in air, but powerfully inhaled when you approach them." Leaving this question to be settled according to taste and other circumstances, we have only to recommend that no flower or herb of any kind should be sown or planted in figures resembling familiar objects. Some persons, for example, will be seen sowing annuals or planting crocuses in the figure of a letter of the alphabet, a spoon, a ship, a house, &c.—a practice so essentially vulgar that it cannot be too loudly condemned.

An error not uncommon in deciding which flowers shall be planted, is to select numbers merely for their rarity or novelty, without reference to what will be their appearance when in bloom, and which generally leads to disappointment. Unless for botanical illustration, make a choice of flowers on two principles—those which will be beautiful when in bloom, although common, and those which will bloom at the particular seasons required, to ensure a succession of variegated beauty from spring to autumn. The true amateur gardener takes a pride in improving even the commonest flowers—urging them by careful culture to the highest state of perfection as to size and brilliancy of colouring of which they are susceptible in our climate.

GENERAL CHARACTER AND TREATMENT OF FLOWERS.

All flowering plants belong to the division *Phænogamia* in the vegetable kingdom; but it is only those in which the flower is conspicuous, beautiful, or odorous, that are the objects of garden culture. The part of the plant which constitutes the flower, bloom, or blossom, is the *corolla;* it consists of several divisions or leafy parts, called *petals.* The corolla encloses the *stamens* and *pistils,* or organs of reproduction (see VEGETABLE PHYSIOLOGY); and to bring these to perfection, so as to effect the development of the seeds, is the prime object of vegetable growth. When the seeds are perfected, or in the way of being so, the corolla languishes and dies. The design of the flower gardener is less to produce size and strength in his plants, than to cause them effectually to bloom; he wishes a fine corolla. It is proper, then, to mention, that whatever tends to give excessive vigour to the stems will prevent the formation of flower-buds and the same result will follow from stunting or starving the plant. To induce flowering, the plant must be fully exposed to sun and air; at a lower temperature than 50 degrees the blooms cannot be expected to open; but from that to 65 degrees, the sap will ascend, and the buds, if duly provided with moisture and fresh air, will be rapidly developed. When freely exposed to seasonal influences, flowering plants appear withered and nearly gone in winter; they begin to shoot up in spring; come to perfection in their bloom in summer; and languish and yield their seeds in autumn. But if treated properly in the artificial climate of a greenhouse, they will be found disregarding seasonal influences, and perhaps blooming in winter or spring.

It has been remarked, that when plants have been slightly checked by frost or dry cold air, they sooner come into bloom. "This," says Mr. Rennie, in his *Alphabet of Gardening,* "arises evidently from the pulp being concentrated instead of being expended in the production of new leaves and branches, while perhaps part of the effect may be owing to increased excitability. On this principle the early potato, which does not flower freely, may be made to do so by removing the tubers; and, on the other hand, the tubers are increased in the late sorts by picking off the flower. The greater the quantity, then, of good healthy pulp which can be prepared by the leaves, the more really vigorous and healthy will the plant become; and as flowering and fruiting exhaust a great quantity of this pulp, and, of course, tend to weaken the general system of the plant, it follows that the artificial prevention of flowering must preserve in the plant the digested pulp which would have gone to nourish the flower and the fruit. Thus, by pruning off the luxuriant shoots of melons, &c., the pulp induces the shoots to spring into flowers and fruit. Upon this principle is founded the practice of treating bulbs so as to cause them to bloom vigorously, by cutting off the flowering stem as soon as it appears, in some cases, and in others so as to have the blossoms evolved when placed in water, taking care to encourage the growth of the leaves by rich soil and free exposure to air and sunshine. In this way the greatest quantity of strong pulp is stored up in the bulbs, and luxuriant blossoms are produced the succeeding season. The practice, consequently, of some unskilful gardeners, of trimming off the leaves of snowdrops, crocuses, and tulips, after the blooming is over, for the purpose of rendering a border or a bed neat, is very bad; and it is not much better to tie up the leaves, as is also preposterously done, for in this way they cannot be duly exposed to the air and the light. The same principle will apply to all other flowering plants. When a flowering branch or stem has been produced, and has begun to show the flower buds, it must be considered that it can only blow finely in proportion to the quantity of healthy pulp, either previously in the branch, or from time to time prepared by the leaves of that branch. Consequently, if there are two or more flowers on the branch, each will require its due proportion of food; but if one or more of these be artificially removed, all the spare pulp will go to feed the one, two, or more blossoms which may remain. On this is founded the practice of thinning out the flower-buds from the bunches of auriculas, polyanthuses, chrysanthemums, and other plants, in order to increase the size and beauty of those which are left to expand. It is in consequence of the same principles that free exposure to air is indispensable for producing fine flowers, inasmuch as they depend for nourishment on the pulp, which without these cannot be formed. The vivid colours and pleasant odour of flowers depend on the same causes—for in the shade these are both feeble."

Flowering plants are usually divided into the following kinds:—*Annuals;* plants which require to be sown annually, as they live and bloom only one season. *Biennials;* which do not blossom till the second season after sowing, remain a certain time in perfection, and then die; they are produced by seed, but some of the finest double varieties are continued by cuttings. *Perennials* are plants which continue to grow and blossom annually *Indigenous plants;* those which are natives of this country, and may have been perfected by culture from a wild state. *Exotics;* plants of foreign origin, which have been introduced into this country. The greater number of our fine flowers and fruits are exotics. Many of these have been acclimated, or accustomed to our climate, and rendered hardy by a course of culture; but others require to exist in green-houses and hot-houses, or under glass frames, for at least a part of the year. It would appear that each region of the globe possesses plants as distinctive in their features as the different races of men. On this subject Mr. Loudon remarks—"The native countries of plants may often be discovered by their features, in the same manner as the national distinctions which are observable in the looks and colour of mankind, and which are effected chiefly by climate. Asiatic plants are remarkable for their superior beauty; African plants for their thick and succulent leaves, as in the case of the *Cacti*; and the American plants for the length and smoothness of their leaves, and for a singularity in the shape of the flower and fruit. The flowers of European plants are but rarely beautiful. Plants indigenous to polar and mountainous regions are generally low, with small compressed leaves, but with flowers large in proportion. Plants indigenous to New Holland (or Australia) are distinguishable for small and dry leaves, that have often a shrivelled appearance. In Arabia they are low and dwarfish; in the Archipelago they are generally shrubby, and furnished with prickles; while in the Canary Islands, many plants, which in other countries are merely herbs, assume the part of shrubs and trees."

The different kinds of flowering plants are either *herbaceous* (green herbs) or *shrubby*, the stems of the latter consisting of small woody fibres. A *deciduous* tree or shrub is one which casts its leaves every winter and is recovered in spring. An *evergreen* is a shrub which retains its leaves during winter, but casts them in spring as the new buds come out. A *fibrous-rooted* plant is one whose roots send out small fibres; polyanthuses are examples of this class. A *tuberous-rooted* plant is one whose root forms small tubers or lumps; dahlias, ranunculuses, and anemones are examples among flowers, and the potato among kitchen vegetables.

The prevailing colours of flowers are yellow, orange, white, pink, scarlet, red, blue, purple, and many are variegated or composed of different tints. Proper culture, with pure air and sunshine, increase the brilliancy of the tints, and give massiveness to the corollas. Plants of a kindred species may, likewise, be improved by hybridizing or crossing, the general principle of which is the artificial application of the pollen of one plant to another. By this means, some of the most beautiful flowers have been originated. Change of soil and climate, however, are the great means of improvement. As long as it is confined to its native habitation, the corolla of the plant and all its other appurtenances are meagre and generally unattractive; but when nourished in a cultivated soil, and all its wants supplied, the whole plant strengthens and expands, and the corolla flashes on the eye in all its brilliancy of colour. The changes effected on the daisy, the rose, and the violet, will here occur to remembrance as striking instances of metamorphoses by culture and change of habitation. Speaking of the laws by which a change of colour is produced, Dr. Lindley, in his *Introduction to Botany*, observes—"A blue flower will change to white or red, but not to bright yellow; a bright yellow flower will become white or red, but never blue. Thus the hyacinth, of which the primitive colour is blue, produces abundance of white and red varieties, but nothing that can be compared to bright yellow; the yellow hyacinths, as they are called, being a sort of pale yellow-ochre colour, verging to green. Again, the ranunculus, which is originally of an intense yellow, sports into scarlet, red, purple, and almost any colour but blue. White flowers, which have a tendency to produce red, will never sport to blue, although they will to yellow; the rose for example, and the chrysanthemums. It is probable that white flowers, with a tendency to produce blue, will not vary to yellow; but of this I have no instance at hand."

Improvement in the brilliancy or change of colour, is not effected without a certain loss in the odorous properties of the plant. It is remarked, that cultivation naturally renders the odour less intense, and sometimes altogether destroys it. Thus the pleasant odour of the wild violet is not to be found in the heart's-ease.

Propagation.

Flowering plants are propagated in various ways—by sowing seeds at the proper seasons, by dividing the roots, by suckers, layers, pipings, cuttings, and bud-grafting.

Dividing the Root.—This is one of the most simple methods of propagation. The root of the growing plant is partially uncovered, and one or more portions are removed; the root is then covered up, and the removed parts transplanted in soft earth prepared to receive them. Nine-tenths of herbaceous perennials are treated in this way.

Suckers.—These are young plants thrown up from the roots of the main plant, round which they cluster. They may be removed by taking up along with them a part of the root. They should be removed in spring, after the plant has begun growing, and immediately planted out. If any flower-buds be developed on them, take them off, so as to give strength to the plant.

Layers.—Some plants, as, for instance, strawberries send out layers or runners along the ground; these have joints, if we may call them such, at certain points; and where any joint strikes the earth, it takes root, and becomes the centre of a new plant. Thus a running plant will speedily cover, as with a network, a large space of ground. Nothing is more easy than to propagate by causing the layers of some plants to take root. In the case of the carnation and similar plants, fix a stem at one of its joints to the ground, with a hooked stick or peg, covering it slightly with mould, and giving it a little moisture. Roots will, in general, strike out in a few weeks; and at the end of the season the plant is ready for being cut from its parent, and transplanted. Where layering is tedious or difficult, propagation by division of the root or cuttings is preferable.

Pipings.—Propagation by piping is an expeditious mode of raising young plants. The following is the method prescribed in a small and useful work, entitled *Every Lady her own Flower Gardener*:—"Take off the upper and young part of each shoot, close below a joint, with a sharp knife, and cut each off at the third joint, or little knob; and then cut the top leaves down pretty short, and take off the lower and discoloured ones. When you have piped in this way as many as you require, let them stand a week in a tumbler of water, which greatly facilitates their doing well. Indeed, I never failed in any pipings, slips, or cuttings, which I allowed to soak and swell in water previous to planting. When you plant the pipings, let the ground be newly dug, and raked very fine; dibble no hole, but gently thrust each piping half way down into the soft earth round each, to fix it in the bed. Water them often, if the weather is dry, but moderately, just to keep them moist; and shade them from the hot sun in the day. If pipings are covered with a hand-glass, they root earlier by three weeks than those which are exposed. Laying, piping, and slipping, are done in June and July. The plants will be well rooted and fit to plant out in October." Slips are shoots wrenched off at a joint, instead of being cut, and are treated in the same manner as pipings.

Cuttings.—A cutting is a strong shoot of last year's growth, cut from the parent stem or branch, and set in the ground. The cutting should be about six inches long, and cut off slantingly and smoothly. The soil in which the cutting is inserted requires to be dry or not too moist. Roses and honeysuckles are among the class of plants propagated by cuttings. The operation should be performed in January or February, so that the cuttings may root and vegetate in the opening of spring; but several months are required to bring the cuttings to a state fit for transplanting. Some cuttings of flower-stalks may be set as late as May and June.

Budding.—This is the method of propagation chiefly used in connection with fruit-trees; but as it is likewise applicable to rose-bushes, it may here be described. Budding is a species of grafting, and consists in inserting the fresh-cut extremity of a small twig or bud beneath the bark of another plant. A leaf bud, easily known by its tapering point, should be alone selected, and not a bud on which a flower is developed. The leaf on the selected bud is to be taken off, for if it remained it would exhaust the sap, and the bud would in all likelihood wither and die. Along with the bud, a small slip of bark is to be taken; and if this bark separate freely, it is a test of there being pulp enough to form a union. The slip of bark is to be inserted beneath the bark of the other plant, in a slit made for the purpose, and the whole tied with a strip of mat to keep out the air.

The annexed cut represents the various parts in bud-

b a c

ding. *a* is the bud cut out, with a shield of bark attached to it; *b* the stem, with a slit in the bark to receive the shield attached to the bud; *c* the bud inserted and the leaf cut away.

Shrubby plants are also propagated by *in-arching*: but a notice of this, and also of ordinary *grafting*, will be more appropriately given in Information on Trees.

SELECT FLOWERS FOR THE GARDEN.

Flowering plants are now so numerous, both as respects species and varieties, that a bare list of them would more than fill the present sheet; all, therefore, that can reasonably be expected from us is a few hints as to those which are most approved, and cultivated chiefly in the open air. A person with little experience should stock his garden only by degrees—a small number of different sorts every year, according to fancy, and what he finds to be the capabilities of the soil and exposure. In commencing to make a choice for a moderately sized garden, or for still smaller plots of ground and borders, we should also recommend the plan of cultivating a mixed variety of different colours and different heights; those which are smallest being in front or nearest the eye, and the other rows rising in height and massiveness as they recede. With as few as four colours, four sizes, and six different periods of coming into bloom, a mingled border may be established with ninety-six sorts, which will present a pleasing assemblage to the eye.

Annuals.

Some annuals are called *hardy*, and others *half-hardy*. The hardy kinds will grow and blossom in open borders, without artificial heat or protection; those which are more tender will also grow in the open air, but are improved by being brought forward under hand-glasses. Of the delicate class of annuals which must be constantly kept under glass frames, it is not our purpose to speak. The greater number of annuals may be sown at the end of March or beginning of April. The soil should be fine, and have a warm exposure; and, on being sown, cover the seeds with only about a half an inch of mould; peas and lupines should be an inch below the surface. If the weather be dry, irrigate with pure soft water occasionally. Take care that the seed you sow is fresh and good; the way to test its quality is to throw it into a glass of water; if it be worthless, it will swim; if good it will sink to the bottom.

Among the vast number of annuals that offer themselves to the choice of the gardener, the following, each having varieties as to colour, may be mentioned as taking the lead in the *half hardy kinds*:—African marigold, French marigold, China aster, marvel of Peru, chrysanthemum, sweet sultan, Indian pink, love apple, gourds, bottle gourd, convolvulus, yellow balsam or touch-me-not, amaranthus, ten-week gilliflower, white ten-week stock, cannacorus, and Chinese hollyhock. *Hardy kinds*:—Adonis-flower, candytuft, larkspur, lupines, sunflower, lavatera, poppy, major convolvulus, nasturtium, Tangier pea, sweet pea, winged pea, Lobel's catchfly, dwarf lychnis, Venus's looking-glass, Virginian stock, heart's-ease, snapdragon, mignonette, xeranthemum, purple jacobæa, Clarkias.

If annuals are required on a more extended scale, the best plan is to leave the selection to a respectable nurseryman. Such a person will at least present a copious list to make your choice from, and mention the size or height to which the plants will respectively grow. Mr. Loudon in his *Encyclopædia of Gardening*, quotes a list by Mr. Swindon, a Brentford nurseryman, consisting of nearly ninety hardy annuals, distinguished in ranges according to heights. From this we make the following extract—for the sake of clearness, leaving out the Latin names:—

"*First range—from* 8 *to* 12 *or* 14 *inches high.*

Cape marigold: purple and white. Large caterpillar; yellow, and singular pod. Venus's looking-glass: light purple. Ram's Horns; yellow: the pod is its beauty. Round snails; yellow, and singular pod. Dwarf variegated lychnis; crimson and white. Heart's ease; purple and yellow. Half-moons, or moon-trefoil; white, and singular pod. Blue meadow lychnis; sky-blue. Dwarf Virgin's stock; purple. Small hedgehogs; yellow, and singular pod. Woodroof; light-blue. Red hawkweed; pale red. Large hedgehogs; yellow, and singular pod.

Second range—from 12 *to* 18 *or* 20 *inches high.*

Oak of Jerusalem; yellowish, with fragrant smell. Small white candytuft: clear white. Long-horned devil in a bush; yellow, and singular pod. Convolvulus minor; bright blue, with yellow eye. Large purple candytuft; light purple. White Lobel's catchfly; reddish white. Annual snapdragon; purple and yellow. Scarlet or wing peas; dark and light red. Large white candytuft; clear white. Stripped convolvulus minor; blue and white. Red Lobel's catchfly; bright red. Dwarf nasturtium: deep orange. Broad Spanish nigella, with brown seed; deep blue. Red flos Adonis; dark red.

Third range—from 20 *to* 24 *or* 28 *inches high.*

Spanish nigella, with black seed; light blue. Spanish hawkweed; pale yellow and purple eye. Blue Moldavian balm; deep blue, and fine scent. Annual rest-harrow; pale red. Double Roman nigella; white mixed with blue. Small running nasturtium; dark orange. Nettle marjoram; yellowish, no smell but to the over-curious. Rocket larkspur; pink and white. Sweet-scented lupines; bright yellow. White Moldavian balm; fair white, and fragrant smell. Dutch lupines; fine blue. Annual hare's-ear; pale yellow. Purple jacobæa; purplish-red and yellow eye. Dutch ranunculus marigold; sulphur-colour. Red-topped clary; pale red, and pink leaves.

Fourth range—from 2 *to* 2½ *or* 3 *feet high.*

Belvidere: yellowish—a handsome plant. Small variegated corn-poppy; various, red and white, &c. Double upright larkspur; blue, blush, &c. Cyanus minor; blue, crimson, &c. Thorn apple; white, and singular pod. Prince's feather; dark crimson. Crown-larkspur; pale pink, spotted, &c. Honey scabius; pale blue, and globular pod. Portugal lychnis; pale red. Small blue lupines; bright blue. Love lies a-bleeding; bright red. Ranunculus-marigold; deep orange. Honeywort; dark purple, and singular shape. Strawberry spinach; bright red fruit.

Fifth range—from 3 *to* 4 *feet high.*

Venetian small-flowered mallow; purplish-white. Double crimson jagged-leaf poppy; dark crimson. Tall narrow-leaf wall-flower; bright yellow. Arach; deep crimson. Double stripped carnation poppy; red and white. Blue sweet trefoil; lead-colour. Red lavatera; light changeable red. Branching larkspur; blue and white, &c. Tall white lupines; clear white. Double black carnation poppy; rose-colour. Small Peruvian nasturtium; dark orange. Lord Anson's peas, fine blue. White lavatera; snow white. Dwarf double and quilled yellow sunflower; deep yellow. Bladder ketmia; pale sulphur and purple eye, with singular pod.

Sixth range—from 5 to 7 or 10 feet high.

Tall double yellow sunflower, with black-seed; deep yellow. Painted lady sweet-scented peas; pale red and white. Arach; sulphur-coloured. Purple sweet-scented peas; dark and light purple. Tall Indian persicaria; bright crimson. Painted lady crown peas; black and white. Convolvulus major; fine purple. White crown peas; clear white. Large Indian nasturtium; dark and light orange. Tall double brimstone sunflower; sulphur-coloured. White sweet-scented peas; clear white. Plain Tangier peas; fine crimson. Tall oriental mallow; purple. Painted lady Tangier peas; pale red and white. Scarlet beans; fine scarlet. Curled leaf upright mallow; white tinged with purple."

Whether tender or hardy, all annuals should be carefully trimmed and kept from straggling. Some will require thinning. Preserve the strongest blossoms for seed; and remove withered blooms to add vigour to those which remain.

Biennials and Perennials.

The difference between biennials and perennials is in many instances very ill defined. A biennial is said to be a plant which, when sown, does not bloom till the following spring, and dies out in the course of autumn. This is true as respects some biennials, but it is equally certain that many will survive and bloom year after year, the same as perennials. For instance, carnations are called biennials, although it is notorious that these plants will grow and multiply by roots in the same spot, year after year, with only ordinary culture. Another circumstance requires notice. No treatise on gardening that we have seen sufficiently recognises the power which biennials and other plants possess of continuing themselves by dropping their own seeds on the spot where they grow; by which means, in point of fact, many biennials, and annuals also, possess much of the virtue of perennials. In all treatises, far too much stress is laid on the necessity of artificial propagation. In most instances, biennial and perennial flowering plants simply die off from the top to the bottom of the stems at the beginning of winter, and the roots remain dormant in the ground till revived by the warmth of the ensuing spring. Except, therefore, as respects thinning, and propagating by a division of roots, and transplanting occasionally for the sake of change of soil, the unprofessional gardener has little or nothing to do in the way of multiplying the number of his plants, or artifically keeping up the species during winter. Of course, we here refer to gardening operations in the British islands, where the winters are generally so temperate that every kind of root is safe in the ground, excepting those of a tuberous nature, such as potatoes, dahlias, ranunculuses, &c., which the frost would reach and destroy. The case is very different in the Netherlands, North and Central France, and several other continental countries, where bulbs would perish if left in the ground in winter, and where even hardy evergreens require protection. The laurel, for example, remains unscathed in the open air at Edinburgh during winter, while at Brussels, five degrees farther south, it must be sheltered.

Among biennial plants suitable for ordinary flower gardens, are included the following, each having several varieties:—Canterbury bells, carnations, French honeysuckle, globe thistle, hollyhocks, scabius, sweet-william, rose campion, wallflower, lavatera arborea, purple digitalis, and stock gilliflowers. Some of these are very beautiful flowers, and none more so than carnations.

Carnations.—The carnation is an elegantly formed flower, with a slender stem and blossom at top, each blossom consisting of a convolution of petals like the rose. As a number of stems grow up together, the show of brilliant heads is considerable. Of the carnation, Hogg observes—"Of all the flowers which adorn the garden, whether they charm the eye by their beauty, or regale the sense of smell by their fragrance, the carnation may be justly said to hold the first rank. The stateliness of its growth, the brilliancy and diversity of its colours, and the sweetness of its perfume, never fail to attract our regard and admiration. The tulip, though styled the queen of the garden, cannot boast of more admirers; they may, with propriety, be considered the two masterpieces of nature; and though rival beauties, may be said to share the sovereignty of the garden equally between them; yet it must be admitted that the carnation, independent of its fragrance, has this advantage over its rival, that it continues longer in bloom, and that, when planted in pots, it can be removed to decorate the green-house, the conservatory, or the drawing-room."

There are many varieties of the carnation, but all are arranged in three classes—flakes, bizarres, and piquettees. Flake-carnations possess but two colours, with large stripes through the petals. Bizarres are variegated in colour, with irregular stripes and spots. Piquettees have a white ground spotted with purple or some other colour, and are serrated on the edges; they are the most common. According to amateurs, the finest carnations should have a flower at least three inches in diameter, with the edges of the petals waving or smooth, not serrated. The petals must fill the calyx, but not to bursting; if a calyx burst, the flower has been imperfectly cultivated. "The calyx," says Hogg, "should be at least one inch in length, terminating with broad points sufficiently strong to hold the narrow bases of the petals in a close and circular body. Whatever colours the flowers may be possessed of, they should be perfectly distinct, and disposed in long regular stripes, broadest at the edge of the lamina, and gradually becoming narrower as they approach the claw of the petal. Each petal should have a due proportion of white, one half or nearly so, which should be perfectly clear, and free from spots. Bizarres, or such as contain two colours upon a white ground, are esteemed rather preferable to flakes, which have but one, especially when their colours are remarkably rich and very regularly distributed. Scarlet, purple, and pink, are the three colours most predominant in the carnation. When the pink flake is very high in colour, it is distinguished by the appellation of rose flake."

The following, which we copy from an agreeable horticultural treatise, "The Manse-Garden," are the plainest directions we have seen respecting the culture of carnations:—"The best soil for carnations is good loam, enriched with well-rotted stable-dung, and quickened with a little sand. The quantity of manure can only be determined by the previous strength of the ground; if made too rich, the flowers will lose their fine colours; if left too poor, they will want vigour. No recent manure should ever come near a fine plant. Let the ground be prepared before winter with dung, and a rough furrow laid up to the frost. In April give a fresh digging, and plant in rows three feet by two. This width is to make room for layers, without which a fine blow of carnations cannot be maintained above one year. As the plants shoot up, they must be tied to neat green rods; and in order to have a fine blow, superfluous flower-buds must be pinched off, leaving only three or four to each stem. The young shoots near the ground, which do not run to flower, are denominated grass; and from these the layers are selected. The operation is somewhat nice, but when rightly done, is always successful, and good flowers are thus preserved and multiplied from year to year. Towards the end of July, stir up the ground about the plants, and mix with the soil a little old well-wrought compost. Have at hand a sharp penknife, a trowel, and a number of small pegs with an angle at the head: pieces of fern will do, or wood of no more strength than to bear pushing into the ground. Scoop out the earth in the form of a basin around each plant; select the strongest grassy shoots for layers, and remove such as are in the way; crop the top leaves an inch from the heart, and pinch off all the rest, taking care not to peel the stem. Begin an incision on the under side of the shoot, a little below the second joint from the top, and cut upwards till the joint is slit in the middle. Set the pointed extremity made by the slit into the bottom of the excavation, and there fix it with the peg; place the head of the shoot erect, fill in the earth, and make it firm, and finish the work with a good watering. The young plants will be ready for removal by the end of autumn, when they may be set in flower-pots if the soil is too damp, and apt to cause rotting in winter; but if sufficiently dry, the layers may remain till spring, and it will be of use before winter to earth them up, sloping and beating the mould about them so as to throw off the rain. Although the propagation of this plant by pipings (as the grass shoots taken off and stuck in the ground are called) is by no means so sure as the above method, yet of a number some will take root; and as pipings are more easily procured than plants, the experiment may be made. If carried to some distance, steep the slips in water till they swell to their proper size; trim them as above directed, and set them firm into old elastic compost; water plentifully, and set over them a handglass, first throwing water on the glass, and then earth to darken it, and let it not be stirred for some days, it being found that a deficiency both of light and air promotes the striking of slips—probably on this principle, that the sick, having no appetite, must avoid the exertion which requires food as well as that which food requires." We may add, that carnations require room to expand and blow; and when fully grown, the stalks should be tied with a strip of bass to a small stake sunk into the ground at their side.

Hollyhocks.—The hollyhock is a splendid flowering plant, and exceeds all others in tallness. With good soil, shelter, and proper exposure, it will attain a height of twelve or fourteen feet, and generally reaches seven or eight. It is a substantial herbaceous plant, with a thick stem, along which, to the top, are the broad showy blossoms; and from this attractive appearance it is very suitable to ornament fronts of cottages, edgings to shrubberies, or the centre of clumps in lawns. The colours are very various, as pink, dark purple, yellow, &c., the double sorts being the richest and most esteemed. The seeds of hollyhocks are sown in May; and in September or October the young plants are transplanted into the ground where they are intended to blossom. Although classed as biennials, the plants will spring and bloom for a number of years.

Wallflower.—There are several sorts of this fragrant plant, those flowers which are dark and most massive being most highly esteemed. Every cottage-garden should have two or three wallflowers, as their perfume is very pleasing, and their culture no way troublesome. "To insure," says the author of the "Manse-Garden," "a succession of the best breed (and the method applies to the double flowering, which yields no seed, and cannot otherwise be preserved), about the beginning of July, pinch off a hundred slips or young shoots of five or six inches in length, taken only from the finest stocks; crop the leaves, and strip the rest of the stem bare; dibble the slips, so prepared, into a bed newly dug, and shaded by trees or a north wall. Sprinkle them with water, and shade any part to which the sun has access. Not one will go back, and in this way a bountiful profusion of one of the sweetest flowers, and the best of its kind, may be had from year to year."

From what are usually called biennials, we turn to the copious list of *perennials*, which may very properly be sectioned into those with bulbous roots, tuberous roots, and fibrous roots—the latter by far the most numerous, and including plants of a herbaceous and shrubby nature; to these may be added climbing and aquatic plants.

Bulbous-Rooted Flowers.—In this class are included the hyacinth, narcissus, iris, lily, tulip, snowdrop, and crocus, with their kindred varieties.

The *Hyacinth* has a tapering bulb, shoots up long green leaves, and in the centre is a stalk on which the bloom, in the form of bells, grows all round, causing it to droop or bend. There are several varieties, differing in colour, as blue, red, and white, but the blue is the most common. The hyacinth is a favourite of the Dutch, by whom it has, like the tulip, been brought to great perfection. The best kinds have double flowers with brilliant colours. A sandy soil and saline atmosphere, with a warm exposure, are favourable in developing these properties. In the British islands, they will endure the winter in the ground, and are among the earliest blossoming plants of spring. In Holland, the bulbs are lifted and carefully stored during winter.

Of the *Narcissus* there are many varieties, which include daffodils, white narcissus, jonquils, and polyanthus narcissi. The chief difference is in colour and size of petals. Most have a lightish-yellow flower, with a deeper yellow cup. A fine narcissus has tall and firm leaves, and from the centre springs the round tube-like stalk, on the top of which is the bright yellow bloom, with petals spreading out like rays from a star. Some send up two flower-stalks, and the criterion of excellence is massiveness and distinctness of colour in the corolla. Of the polyanthus species there are at least a hundred sorts, sulphur-coloured, single and double, white, &c. Like hyacinths, the bulbs remain in the ground during winter.

Of the *Iris* there are also various kinds, some low and others tall, but always beautiful from the delicacy of colour. The Persian iris is low, with delicate blue and violet blossoms. The Chalcedonian iris is more tall, distinguished by the great size and magnificence of its flower, which is a purple-blue striped with white. The English iris is of still greater height, and has flowers of double the size of the former. None requires much sun.

The *Lily* is a plant equally tall with the larger iris. There are many species, with different colours—white, orange, and carmine. The orange, speckled with dark dots, is the more common. This plant will grow and bloom with little sun, or under the shade of trees. The effect of the orange blossom is pleasing among green plants which require to be set off by a contrast.

The *Tulip* is the pride of the garden, or at least stands pre-eminent in general estimation. Like most other bulbs, it is a native of the Levant, and was brought to its perfection in Holland, where tulip-fancying was at one period a mania, and the bulb is still a large article of trade. The finest tulip-gardens are at Haarlem, which has a warm and saline climate, with a soil light and rich. Round the roots and over the beds sand is freely scattered, so that the tulips seem as if growing from a sandy beach. In planting in this country, follow the same practice. Before planting, take off the brown outer rind. Plant in October or early in November, so that the plant will blossom in April. In forming a bed of tulips, the bulbs should be set at a distance of seven inches apart, and in straight rows, taking care to mix the different colours. To raise from seed, or to improve the varieties by crossing, are works of time, and not to be thought of in ordinary circumstances. Bulbs can be obtained from nurserymen at a price ranging from five shillings a dozen to five guineas a bulb. Half-a-crown each is a common price for tolerable bulbs; but, of course, all depends on taste. The following is Hogg's criterion of a fine variegated late tulip:—"The stem should be strong, elastic, and erect, and about thirty inches above the surface of the bed. The flower should be large, and composed of six petals: these should proceed a little horizontally at first, and then turn upwards, forming almost a perfect cup, with a round bottom, rather widest at the top. The three exterior petals should be rather larger than the three interior ones, and broader at their base; all the petals should have perfectly entire edges, free from notch or serrature; the top of each should be broad and well rounded; the ground colour of the flower, at the bottom of the cup, should be clear white or yellow, and the various rich-coloured stripes, which are the principal ornament of a fine tulip, should be regular, bold, and distinct on the margin, and terminate in fine broken points, elegantly feathered or pencilled. The centre of each leaf, or petal, should contain one or more bold blotches or stripes, intermixed with small portions of the original or breeder colour, abruptly broken into many irregular obtuse points. Some florists are of the opinion that the central stripes or blotches do not contribute to the beauty and elegance of the tulip, unless confined to a narrow stripe exactly down the centre, and that they should be perfectly free from any remains of the original or breeder colour. It is certain that such appear very beautiful and delicate, especially when they have a regular narrow feathering at the edge; but the greatest connoisseurs in this flower unanimously agree that it denotes superior merit when the tulip abounds with rich colouring, distributed in a distinct and regular manner throughout the flower, except in the bottom of the cup, which, it cannot be disputed, should be a clear bright white or yellow, free from stain or tinge, in order to constitute a perfect flower."

In order to have tulips in any thing like perfection, they require a vast deal of care. As strong sunshine injures them, they must either be placed in some shady situation, or covered with a slight awning from the sun's rays. They must, also, on no account be allowed to go to seed, for in that case the bulb is exhausted and done. To prevent this catastrophe, they should be watched when they approach perfection, and the head and stalk cut off. A usual signal for cutting is when they cease closing at sunset, or when the edges of the petals exhibit the slightest appearance of withering. They should be cut rather too early than too late. After cutting, admit the sun to the stems; and when these wither, which may be in June or July, lift the bulbs and lay them aside in a dry, airy situation; there let them remain till the period for planting, which is the end of October or beginning of November. If the bulbs require to be sent to a distance, twist each separately into a piece of paper; in this state, and kept dry, they will remain dormant, yet fresh and ready for planting, for years.

The *Crocus* and the *Snowdrop* are two small bulbous plants, so well known for their hardy growth that little need be said of them. Crocuses are very various in colour—blue, yellow, white, and so forth; and the principal thing to attend to in planting is mixing these colours in a pleasing variety. When the bloom withers, remove it, but do not cut away the numerous small green leaves. Crocuses, like all other bulbous roots, require occasional transplanting: this may be done in October.

Tuberous-Rooted Flowers.—In this class the *Dahlia* (named from Dahl, a Swedish botanist), both from its beauty and size, deserves the first place. It is a native of the temperate plains of South America, and requires a dry and airy situation for its growth. The tubers at the root resemble long potatoes, and as they spread to some distance, the plant should have a free space of from two to three feet all round. The stems, at and near the top of which are the rose-like blossoms, rise to a height of four feet, and require to be supported by stakes. A new plant may be procured by separating a part of the root, to which a stem is attached. Frost at once blights the green stalks; and when these seem utterly withered and dried, carefully lift the tubers and place them in a dry situation for the winter. In May they must be sprung on old manure under a glass frame, and then planted out and occasionally watered. Dahlias are now found of almost every colour—the Acme, a white variety edged with crimson; Amanda, rosy lilac; Ariel, white and lilac; Augusta, purple; Countess of Liverpool, scarlet; Enchantress, creamy edged cherry; Lord Althorp, dark puce; Yellow Perfection; Peerless White; and so on.

Ranunculus.—This is a stock beauty in all gardens, and it has some hundreds of varieties. The tubers are small, and require to be treated like those of the dahlia. The blossom resembles a compact small rose, of a flattish form. The soil in which the plants are placed requires to be fine and in good heart. In planting ranunculuses and dahlias, the colours should be arranged so as to produce an agreeable variety.

The *Marvel of Peru* is a very fine tap-rooted plant, rising to a height of two or three feet, and bearing beautiful transient flowers, differing in colour, as pink, white, and yellow, according to varieties. There is a succession of blossoms daily, the old ones dropping off and a new set advancing. In its native climate, the blossoms do not open till after the heat of the day is over, about four o'clock; the plant is therefore viewed as a kind of time-measurer, and is called the *West India four o'clock.*

Fibrous-Rooted Flowers.—The genera, species, and varieties of flowering plants with fibrous roots include the greater part of vegetable productions. A few of those most prized are all we need notice. Take, first, the humble *Daisy*, which has been cultivated up from the wild *gowan* or daisy, the "wee modest crimson-tipped flower," and is now found in two principal varieties, the mottled crimson and white, and the pure crimson. This plant is the hardiest of the herbaceous tribe, keeps longest in bloom of any, and may be propagated to any extent by separation of roots.

Pinks are another universal favourite; they may be viewed as an inferior kind of carnation, and are divided by florists into the three classes—damask, cobs, and pheasant's eye. The criterion of a fine pink is clear white petals, laced with crimson purple, and finely serrated on the edges. The branches of stalks require tying to stakes; and they should be cultivated, so as, if possible, to avoid bursting the calyx.

The *Primrose* family includes several pretty flowering plants—all, as is believed, sprung and cultivated up from the wild primrose (*primula vulgaris*) and cowslip. There is no great beauty in the primrose as a garden plant, but it is useful as an early spring flower, and succeeds the crocus in giving colour to the borders. The highest cultivated of the race is the *Polyanthus*, which sends up stems loaded at top with a bunch of peduncles, brown, red, and yellow. The colour most admired is that shaded with a light and dark rich crimson, resembling velvet, relieved by a bright golden hue. The *Auricula* (*primula auricula*) is a larger plant, but varying in colour, and more delicate in many respects. It flourishes best in rich soil from old turf and rotted cow-dung. The chief colours are red, pink, crimson, white, blue, apple-green, and mulberry. On the petals there is a fine meal, which is injured and marked by drops of rain or artificial irrigation; and therefore flower-fanciers take care to shelter the plants with a glass frame, and allow no drops from the watering-pot to touch them. When treated with attention, a bed of auriculas may be rendered very beautiful to the eye.

The *Anemone*, when double, is a pretty flower, with a number of flattish petals forming a cup, in the centre of which is a great number of long small petals clustering over each other. The *Lobelia*, in its different varieties, is a fine tall showy flower; that which is most common is the cardinal flower, with splendid scarlet blossoms. The *Lychnis* is another pretty scarlet flower, but small in size. The *Sweet-William* is deserving a place in every garden; it may be had of various colours, and ing from deep crimson to light pink. The *Campanula*, or pyramidal bell-flower, in its different varieties, blue and white, is a graceful flower, with pendant bells, which should also be found in all tastefully laid out borders. It may be kept long in flower, by cutting off the blooms as soon as they begin to wither. The large herbaceous *Peony*, with its brilliant and deep crimson disk, is another choice flower; it requires little care beyond supporting with stakes.

The *Violet* family, which now embraces what are termed *heart's-ease* and *pansies*, is a cultivation from the original wild violet (*viola odorata* and *viola tricolor*). By the French, the cultivated violet or heart's-ease is called *pensée* (thought), and hence our name *pansy*. No flower in the garden has lately engaged so much attention as the heart's-ease; and by means of culture and hybridizing, it has attained a most extraordinary degree of perfection as respects size and richness of colour. As many may look to us for some distinct information on this beautiful flower, we cannot do better than offer the following intelligible directions on the subject from a work of merit, Harrison's *Floricultural Cabinet*:—"The most approved method of propagation is by taking off young slips in the autumn, which is the best time, as then the ground and weather are most suitable for the formation of young rootlets, on account of its dampness and dullness. About the first week in October a bed is prepared of light but rich soil, raised a little above the path, in order to drain off all superfluous moisture. The cuttings are then made ready, by stripping them of their under leaves, and cutting close below the bottom joint, from which the roots must spring; for if this is not done, the cutting will decay to that joint, which frequently destroys the whole. After the bed is prepared, the cuttings are arranged according to their varieties, each sort being marked by a tally stick, numbered or named according to the pleasure of the owner. The cuttings will be found to be well rooted in about six weeks, when they may be planted out for blooming in the spring, or potted to keep over winter in a frame.

"The soil in which the pansy is found to flourish best is a compost of cow-dung one-half, fresh loam one-quarter part, leaf mould one-eighth part, and coarse sand one-eighth; but peat soil should on no account be intermixed, as it burns up the pansy completely. These ingredients should be well mingled together, and purified from worms and slugs by having lime-water frequently thrown over the heap, and in a short time it will be fit for use. The situation best adapted for the heart's-ease is one which is sheltered from the mid-day sun, but which receives a little in the morning, as then it is not so powerful as to injure the colours.

"Transplanting may be performed at any season, but in doing so an error is prevalent. We see the plants taken up with a ball of earth around them, and planted again with it. Now, as every thing deteriorates the soil in which it grows, and as the pansy entirely pierces every particle of earth its roots can reach, therefore that which we take up with it must be entirely exhausted, and when planted again can receive very little food from its new situation, as its roots do not by nature straggle far from the stem. To prevent this starvation, it would be much better to wash away all the soil from the roots, and plant it again with its roots unconfined; then it would be able to seek food for itself abundantly, and thereby produce much larger flowers.

"The following list contains some of the best varieties in cultivation:—Argo, Augusta, Anne Eliza, British Queen, Colonel Dundas, Captivation, Dandie Dinmont, Eclipse, Feronia, Haidee, Henrietta, Imogine, Jewess, Livia, Laura, Magnet, Miss Jane, Miss Towers, Paul Pry, Peter Dick, Platonia, Penelope, Queen of the Whites, Reliance superb, Triumph, Victoria superba, Wycomb Abbey, Westminister Abbey, Windsor Castle, White Perfection, Liberal, Acme of Perfection, Ringleader, Revenge, Victory Miss May, Glory of North Durham, Beauty of the Wear." To this we may add the Fair Maid of Perth, and Lord John Russell.

Shrubbery Garden Plants.—Among these the *Rose* unquestionably deserves the first place, having from time immemorial been a favourite in every garden. There are some hundreds of species and varieties of roses, among which are included China roses, hardy climbing roses, moss roses, select double Scotch roses, red and white roses. The China rose is delicate, with few petals in the flower, and yields a succession of blossoms monthly through a great part of the year; it is hardy, and is green and flourishing in winter. Among red roses the moss rose is the most beautiful, and next it may rank the cabbage rose; but both are excelled in fragrance by the leaves of the *Sweet Briar*, a rose shrub, which, for the sake of its delicious odour and hardy green leaves—a thing of moment in making up a bouquet—should have a place in every garden. All kinds of rose-bushes are exhaustive of the soil, and should be frequently manured, if not transplanted to fresh mould. In order to keep them in bloom, cut off all blossoms which seem about to wither. The branches require careful pruning. For adorning the walls of summer-houses, cottages, &c., the *Honeysuckle* excels, and should, both for its beauty and fragrance, by all means have a place in every garden, however humble. The honeysuckle is a *twining* plant, and has a tendency to climb in a spiral direction from right to left, which requires to be accommodated. The *Hop*, which is sometimes grown in gardens, and allowed to climb on tall poles, twines in an opposite direction, or left to right, or with the sun, and this peculiar tendency, also, must not be frustrated, but assisted by strings of bass. In point of massiveness of green surface, the honeysuckle is surpassed by the *Jasmine*, a tall running shrub, growing up in numerous branches, which, being well covered with small narrow leaves, is very suitable for leading up verandahs or concealing pieces of wall. It does not adhere, and requires nailing; when carefully treated, its massive green and elegantly drooping small branches have a pleasing effect. *Ivy*, the most pertinacious of climbing plants, will grow almost anywhere, and only requires pruning, to keep it within bounds, every winter or spring.

Among the various tall bushy shrubs most appropriate as an ornamental background in gardens, are the different species of Laurustinas, Azaleas, Rhododendrons, and Lilacs. The *Laurustina* yields a plenteous crop of small variegated blossoms. The *Arbutus* is likewise a beautiful shrub, but more suitable as an embellishment in lawns; it has small whitish bell-shaped flowers, and yields a strawberry-like fruit in warm exposures. Perhaps all out-of-door exotic shrubs should yield the palm of beauty to the *Ribes sanguineum*, a plant profusely adorned with small red blossoms which appear in spring. It resembles the currant, and matures its berries in our climate.

Evergreens.—This is a class of shrubby plants, more suitable for the ornamental front-plots of dwelling-houses, or for approaches and lawns, than for gardens; because, although the green of the leaves is pleasing in winter when other vegetation is dead, these plants are very exhaustive of the soil; often prevent the sun from getting to the borders; and keep the ground in a litter with fallen leaves at a time when trimness is expected. Many species of evergreens are now cultivated in gentlemen's grounds; but those which are most generally esteemed for ornamental plots or other limited situations, are the various tribes of laurels, alaternus, arborvitæ, holly, juniper, and box. With proper care, any of these may be lifted and transplanted into situations more agreeable to the eye, either at the beginning of September or May, when young shoots are preparing to burst forth. The plan is to dig all round them, at a distance equal to the compass of the branches, sinking the trench to a point beneath the sole of the plant; then lift them bodily with the whole mass or ball of earth round the roots. A pit must be prepared for the reception of the ball, and when placed in its new situation, fill in the rest of the pit with fine earth, laying the rootlets straight, and packing in all neatly to the surface. A copious stream of water must now be poured from a watering-pot upon the newly placed mould, round the stem; this carries the particles of earth to the rootlets, surrounding each with its proper nourishment and giving solidity to the plant. If likely to be exposed to winds, the plant should be supported in some manner.

Concluding remarks on the Garden.

The preceding are the principal flowering plants annual and perennial, herbaceous and shrubby, usually grown in open gardens in England and Scotland; and, if we have failed to do so, we wish now to impress on the minds of the unprofessional flower-culturist three main principles which should govern his labours. 1. Let him, by every reasonable attention to soil, culture, and other circumstances, endeavour to produce the finest corollas of which any given flower is susceptible: 2. Produce these flowers only in their proper season, and throw away as little time as possible in forcing blooms at unnatural periods: 3. To maintain a garden, as far as possible, in continual beauty, try to keep up *successional variety*, for in that is exhibited the experience and foresight of the gardener. The directions given in the foregoing pages, and in our floricultural calendar, it is hoped, will assist in leading to this arrangement, on which so much beauty depends; and, as a further aid, we offer the following hints furnished by a correspondent to the "Gardener's Chronicle:"—

Successional Variety.—"It is the desire of every one who possesses a garden to have as much variety of colour and succession of gayety throughout the season as the situation and means of the possessor can accomplish; yet, in viewing most gardens, even where expense is not an object, borders devoted to the cultivation of particular plants may frequently be observed to be only attractive when such plants are in blossom, and looking bare, if not unsightly, after the blossom is over.

"Supposing equal skill in the cultivation of plants in general to exist among gardeners, the great superiority in effect of one garden beyond another, consists in the distribution and arrangement of the plants themselves, so that a succession of blossom, and a due contrast of colour should, where practicable, keep every border furnished even to the end of autumn. In this respect most gardens are deficient. Succession is not attended to, except for the more limited space and favoured spots near the mansion, or in front of the conservatory. In most gardens it is considered sufficient to keep any border where plants have blossomed free from weeds and neatly raked. To the mind of the gardener this border tells its own history, of the beauty of which he had boasted but a few weeks since; but the visiter or casual observer, who walks through the garden, only seeking to please his eye with varied gayety, makes no allowance for the past, which he has not seen; and remarks, that though some parts are beautiful, a great portion of the ground has nothing worth looking at.

"By the following method, the comparative gayety of the scene may be kept up, and a relief to the eye, not without interest to the observer, preserved. Mix the seeds of the following annuals:—

Mignonette,	Heart's ease,
Carnation poppy,	Clarkia pulchella,
Papaver amœnum,	Do. white,
Dwarf Dutch poppy	Godetia of all sorts,
French poppy.	Antirrhinum majus,
Branching larkspur,	Do. sparlenum,
Eschscholtzia Californica,	Do. versicolor,
Do. Crocea,	Collinsia bicolor,
Campanula speculum,	Coreopsis tinctoria,
Candytuft, varieties,	Convolvulus minor,
Nasturtium,	Gilia tricolor, and other species.
Centaurea Cyanus, of various colours,	

"Then let this mixture of seed be very thinly scattered upon the borders early in the spring; it need not interfere with any ordinary work on the borders that may be required afterwards; and in places where the ground may be disturbed, many of the seeds will only appear at a subsequent period, and consequently flower later in the autumn.

"Most of these annuals will continue flowering until the frost kills them, and, if not removed too soon, will leave behind them sufficient seed for years to come. Every gardener has remarked the strength, the beauty, and the effect of single plants of self-sown annuals that spring up occasionally in a flower-border, and have escaped that destruction which the merciless hoe, in the hand of the undiscriminating labourer, inevitably entails upon them; yet if the intelligent labourer is properly instructed he will soon learn to confine his extermination to weeds, and his skilful eye will spare the annuals at proper intervals.

"One case yet remains of much consequence to present as well as to future effect, though generally but little attended to: this is the frequent examination of all annuals as they expand their first flowers, and the pulling them up, unless, in habit, form, and colour, they are fit to remain for stock. Crowded as annuals generally are in the patches sown in gardens, their true character and beauty are seldom seen; and if among the mass sown, some few blossoms appear more striking than the rest, and the seed of these is considered more worthy of preservation, it is generally too late to take away the worthless without destroying the plants most desired; and the seed so saved from the most select variety is but little better than that from the other plants.

"The system now recommended gives the advantage of separation and a power of selection, with the certainty that a selected plant will, by its position as a single plant, not only blossom in beauty and vigour, but afford that abundant harvest of good seed which will amply repay in future years the trifling care thus proposed to be bestowed upon it."

Garden-Walks.—In the previous article on Kitchen-Gardening, we have recommended walks to be three feet broad, laid with gravel bedded on hard cinders, and edged with dwarf-box. As an improvement, some place a bed of stones beneath the cinders, or at least the upper gravel, and on this point all must, less or more, be governed by circumstances. Where it can be afforded, asphalte pavement may be employed instead of all other materials. In the neighbourhood of London, where fine yellow Kensington gravel can be obtained at little cost, it is largely employed, and forms a beautiful walk, the yellow contrasting finely with the green of the plants. On the subject of garden-walks and borderings, the author of "The Manse Garden"* offers the following recommendations, in which we unite:—

"In making walks amongst shrubs and flowers, dryness and variety of edging are the chief things to be promoted—these not being here, as along a fruit-wall, for the sake of the trees, any scruple as to the burying of stones; and there ought to be none as to the trouble of a two-feet excavation; for every cart-load of earth so saved is worth money, and the convenience of depositing stones in place of the earth will save a great expense of carriage. Box, though tiresome, if there be no other, is by far the best edging for general use; but the planting of it is often bungled or done at a needless expense. Take up with a spade a portion of the edging that has grown too old, and part the roots: one yard of the old will serve for ten of the new—a supply that is not obtained from the nurseries without cost. In parting, tear all the old

* 'The Manse Garden,' by Nathaniel Patterson, D.D., minister of St. Andrew's church, Glasgow. Glasgow: Collins. London: Whittaker and Co. 1838. It affords us much pleasure to recommend this valuable and modest treatise to notice

bush down into the smallest shreds; throw away every one that is thicker than a crow-quill, and cut off all the roots beneath the uppermost tier of fibres; a single fibre is enough; with none the plant may do, but it is not necessary to try it. The plants so trimmed should be about four inches in length. Having filled the excavation with stones, all to four inches left for gravel on either side of the walk, dig the surface, set the line to a nicety, using many pins at every turn, to make the windings easy; bring the level exactly to the line, and beat all smooth and firm, so that the earth may stand cutting. With a trowel, cut by the line to the depth of three inches, pulling the earth towards the walk, and lay the green tops of the plants to the line, setting their heads above it, not more than one inch, and all touching one another. The roots will vary a little in depth, but let a few plants be held exact at the top with one hand, whilst the earth is applied to the unequal roots with the other. The reverse rule of evenness, providing for the roots and not the tops, is frequently adopted; hence the straggling appearance that ensues—some leaning out, and others in; some set like a tree, having a stem from which branches proceed, and others having branches sunk up to the middle. The effect is a strong feeling of indignation; and remarkable it is, that though correctness of lining be of small repute in matters of taste, yet, where a line ought to be and is designed, few things are harder to be endured than unmeaning deviations—as in the case of ill-set teeth, or the attempted dash of a clumsy handwriting. Box may be planted in September, October, or November; in February, March, or April. To wet clay, brought up by new trenching, coal-ashes may be added; and to avoid rotting by long moisture without growth, the plants may be set in May or June.

"For other edging, sea-pink is very good, but it soon gets deformed with blanks, unless taken up and replanted: whereas box, annually clipped in autumn, will serve for the half of a lifetime. London-pride admits of pairing, and will last for five years; coarse polyanthus or primrose does well beneath trees. Should the root of an old tree come in the way, it is easy to keep up the green line by planting periwinkle, which needs little soil, or ivy at some distance, and leading the runners past the tree, where they will take root all the way, and being clipped, make a handsome appearance. The propensity of ivy to run up the tree is easily counteracted; but should it be indulged, few things are more beautiful, and the tree is there rather for ornament than for the value of its timber. Double-daisy and cowslips may be used, and may be kept any length of time by occasional lifting and parting of the roots. Hepatica, blue and red mingled, make a beautiful edging, and will last an age: but the most brilliant of all is dwarf gentian; it lasts long, but must have half a foot in breadth, to secure plenty of its bright sky-blue flowers. The pansy or tricoloured violet is also fine, but must be replanted every year. For any place where the walk gets amongst high shrubs or trees, or where a sloping bank is of difficult keeping, there is nothing so fit for a low hedge as butcher's-broom; it suffers no injury by drop or shade, and grows immovably strong; and not agreeing with the shears, it is in such a place more suitable in the natural sluggishness of its growth."

The writer now proceeds to speak of the gravelling process:—"In the gravelling of walks, any rule for the avoiding of unnecessary expense, and the subsequent trouble of weeding, must be a desirable object. Let the top stratum of stones be such as are raked from the surface of the garden in dry weather, and made perfectly clean by sifting, which is by far the readiest way of getting quit of them in clearing the ground. By such method, the top stratum being of small stones, much less gravel, which perhaps must be brought from a considerable distance, will suffice. To have no unnecessary carriage, the gravel at the pit or river side must undergo one sifting with a search one inch between the wires, disposing of all large pebbles. Of stuff in this state walks are commonly made, and the result is evil continually. The small sand is a seedling bed for all manner of weeds, and the coarser part compacted with it renders hoeing almost impracticable; nor is the work well over till, in showery weather, there is need to begin it again. Thus the coarse and fine work to each other's hands, the one giving birth to weeds, and the other protecting them. Divide and govern; dissolve the compact, and the conquest is easy. Use a quarter-inch search for second sifting, and apply the coarse to one part of the walks, and the fine to another. The coarse, it is true, does not bind; but that is the beauty of it; it will not grow one weed for many years. No feet are idle on such a walk. Every one who comes into the garden does some good; the gravel is continually shuffled about, and an immense deal of work is saved to the hoe. For dryness it is admirable—a property which makes the roughness a pleasure, as every one feels in walking on the sea beach, though much rougher, and not more dry. And now for the small sort, which is almost pure sand, and in most cases will be three to one of the gravel; it binds and grows weeds, but the Dutch hoe pares it as easily as moss is scraped from a tree. For the wheels of a little coach, such walks have the smoothness of marble; and, as to the raking of leaves, on gravel the work is imperfect; on this as neat as the sweeping of a floor."

GREEN-HOUSE PLANTS.

These are of various kinds, both herbaceous and shrubby, and require to be distinguished from the preceding, only because they are exotics, too delicate for open-air exposures in all weathers, and require to be kept in a temperature above the freezing-point. This is done by placing them in a conservatory or green-house, which is a light fabric, covered with glazed frames, and, if necessary, heated a slight degree in winter by means of flues or pipes of hot water. The most approved situation of a green-house is against a wall with a southern exposure; and, if possible, placed in connection with a range of artificial vineries or hot-houses. In many instances, a conservatory is connected in a very agreeable way with the parlour of a dwelling-house, by which its beauties are enjoyed without the trouble of going out in bad weather or during the inclemency of winter. All the plants are in pots; and, whenever it can be done without risk of injury, the frames are opened and free exposure permitted. At the country-seats of various English noblemen, conservatories are formed on a magnificent scale, so as to allow the free growth of even tall trees, such as the palm and other large tropical plants.

The most beautiful green-house flowers usually cultivated are *Camellias*, *Geraniums*, *Fuchsias*, and those of the Cacteæ tribes, to which has lately been added the *Azalea Indica*. The *Camellia*, or *Camellia Joponica*, is a woody shrub, yielding splendid rose-like flowers, of colours varying from white to red. The *Geranium* is a well-known herbaceous exotic, with clustering bunches of flowers of different colours. The *Fuchsia*, introduced from Chili, is a handsome shrub, of different varieties, yielding exceedingly beautiful flowers, of a bright crimson hue; and the manner in which these flowers depend from the branches, like drops of ladies' ear-rings, has a singularly graceful effect. The *Cacti* are an interesting kind of exotics, distinguishable by their thick and substantial leaves or fronds, on which usually grow small and sharp prickles; the flowers are splendid. Besides these, we may enumerate, either for their great beauty of blossom or fragrant odours, the Nerium, Jasminum, Gardenia, Daphne, Heliotropium, Acacia, Mimosa, Eucalyptus, Diosma, Gnidia, Xeranthemum, Bignonia, Passiflora, Amaryllis, Gladiolus, and Calceolarius; the latter very beautiful and suitable for open air in summer.

An airy parlour or drawing-room, with windows facing the sun, may be considered a domestic green-house; and these apartments, as is well known, may be furnished with flowering plants, which will bloom and thrive if certain precautions be adopted. Flowers of nearly every kind may be thus treated, and made to form an elegant ornament, and means of delightful recreation, in a dwelling-house. According to their nature and size, they are planted in earthenware pots, or small wooden tubs or boxes, filled up with the appropriate mould, which requires occasional renewal, at least in part, with the removal at the same time of the outer rootlets. Bulbous plants will grow and blossom in glasses filled with water; but the plants are necessarily weakened by the process. The glasses should be dark coloured, for the roots of the plants are injured by light.

On the subject of the cultivation of flowers in windows, we find the following useful observations in an excellent periodical, the *Gardener's Chronicle*:—"The three principal things requiring consideration are *air*, *light*, and *moisture*. Plants kept in windows naturally extend their branches and leaves to the light, and they thereby become one-sided; and it is wrong to endeavour to make them otherwise by frequently turning them, as the plants will as constantly turn their growth to follow the light, which not only weakens them, but spoils their appearance. As for plants receiving no perpendicular light, it is more natural to spread them out, forming one good face or tier of healthy foliage to the window; for well-balanced heads under such circumstances are almost out of the question. Place them as near the glass as possible; of course, windows having a south aspect possess the greatest advantage.

"Judicious watering of plants in rooms is perhaps the most important feature in their management; and it is unfortunately in most cases ill understood, being too often given mechanically, as it were at stated times, whether required by the plants or not; and, by a too eager desire for their welfare, they are frequently surfeited to death with water, which is justly termed 'killing by kindness,' and is practised with success, especially by ladies, from a false apprehension of their wants. In summer this cannot be easily accomplished, unless the plants are allowed to stand in saucers constantly filled with water, which, by overloading them with juices, will soon engender sickly soft growths, unsuited for the production of flowers or healthy foliage. An exception to this rule is the growth of annuals in pots during summer: they, if well drained, may stand in feeders; but these, whenever used, should be half-filled with fine gravel or sand, which may be kept in a state of moisture. The best and only general rules that can be adopted are—in *winter*, keep plants not then growing fast rather dry; in *spring*, increase the quantity with their activity and the sun's power, keeping them in a medium state of moisture; in *summer*, water daily; and in *autumn*, decrease with the length of day and the returning torpidity of the plants, until the dry state of winter is again reached. All this resolves in the following:—Plants when growing fast may have free supplies of water, which must be lessened as their growths approach maturity, and cease, or nearly so, when that is attained, until the return of their growing season. As regards *air*, similar rules to those given for watering may be followed; and indeed they are analogous. In *winter*, when the plants are not growing, large supplies of air are not so important, enough being usually given by the room door. As *spring* advances increase the quantity, carefully guarding against the cold of mornings and evenings, or cutting winds; and if the plants are placed out in the middle of fine days, take care to bring them in before the chill of evening comes on. After the first or second week in May, they may be set outside for the summer; and towards the end of September, or as soon as heavy cold rains occur, they should be placed again in their quarters for the winter, setting them out of doors when fine, or supplying them with plenty of air by the window, until the cold weather and decrease of moisture at the roots bring them to a state of comparative rest. It should be remembered in spring and autumn that the plants must not go out to-day, because they were placed out yesterday, but the weather alone must determine: sudden changes must at all times be avoided. The leaves of plants act as lungs, by which they breathe; if they become dirty, their respiration is impeded; therefore an occasional careful sponging will be useful to them. In spring and summer allow them the full benefit of genial showers, which will do them more good than any artificial watering. Never use spring water if soft or rain water can be had; and always let it be about the same temperature as the air in which the plants are growing. It should hardly be necessary to mention the removal of decaying leaves and flowers; the last are exhausting as well as unsightly.

"One principal potting is usually required, and afterwards as often as the plants may fill their pots with roots, or seem to require it. The most important thing is good soil, which, if composed of three parts loam of a fibrous open texture, with a fourth dung, most plants will thrive in, using plenty of drainage to allow water to pass off readily. Never suffer the surface-soil in the pots to become hard or moss-grown, but let it be loosened occasionally with a piece of stick.

"Succulents are well suited for growing in rooms, as they are not so impatient of either air or water as most other plants; and the abundance of their beautiful flowers renders them objects of interest. Cactus speciosus, Jenkinsonii, flagelliformis and speciosissimus, Mesembryanthemums, and Flowering Aloes, deserve special notice.

"Green-fly is apt to infest the young shoots or undersides of the leaves; to destroy them, moisten the infected parts, and dust with Scotch snuff, or brush them off as soon as detected with a feather, or dip them in tobacco-water. Fumigation with tobacco will also destroy them."

To the foregoing is added the following list of flowers for pots, with the period of their blossoming:—

"*For Spring*.—Snowdrops, Russian violets, early tulips, crocus, narcissus, hyacinths, heart's-ease, mignonette, mimulus moschatus, ranunculus, anemone, myrtle.

"*For Summer*.—Pelargoniums, mignonette ten-week stocks, China roses, double wallflowers, pinks, carnations, cactus, aloes; annuals, as nemophila, schizanthus, collinsia, &c.; myrtle, heliotrope.

"*For Autumn*.—Pelargoniums, lobelias, campanulas, salvias, hydrangea, verbena, fuchsias, petunias, calceolarias, myrtles, heliotrope.

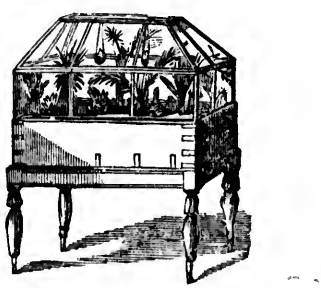
"*For Winter*.—Chrysanthemums, pelargoniums, heliotrope, myrtles, fuchsias, aloes, cactus.

"*Creepers suitable for training round the outside of windows*.—Rhodochiton volubile, maurandia Barclayana, lophospermum scandens, convolvulus major, tropæolum atrosanguineum."

DOMESTIC CONSERVATORIES

If the atmosphere of the apartment in which flowering plants are kept be liable to vitiation by the action of coal fires, by the breathing of the inmates, or other circumstances—in short, if the air is not preserved pure, it is clear that the plants will languish, and afford little pleasure to their amateur keepers. In order to remedy these and other disadvantages, a plan has lately been invented of keeping plants in a secluded box, formed chiefly of glazed frames, in which situation they grow flourish, and perform the remarkable function of preserving their own atmosphere in a state of purity. This being an exceedingly interesting department of floriculture, we beg to offer a full explanation of the subject from "Chambers's Edinburgh Journal," No. 422:—

"Any person, whether inhabiting the most humble or the most splendid dwelling, provided it be freely exposed to the sun's light, has it in his power to rear and cultivate a miscellaneous collection of plants, to enjoy the beauty of their appearance, and to watch their progress through all the stages of their growth, at an expense so insignificant as to be within the means of every man in very moderate circumstances. To do this he must provide an apparatus, consisting of a box, with a glass-case over it, of a size according to his desires and means, from the capacity of a small trunk to that of an ordinary closet. We shall suppose he wishes one of a small size, to stand at a window in an apartment of limited dimensions. Procure a strong wooden box, three feet in length, one and a half feet in breadth, and nine or ten inches deep; no top is wanted; it should be painted, or otherwise prepared to resist damp. Two small holes for corks are to be made in the bottom. The ledges should be covered with lead or zinc, and slope inwards. Over the box is placed a glass-case, resembling a garden forcing-frame in shape; it should measure eighteen inches high up to the sloping top, and then the top or roof should slope inwards on all sides, to meet in the centre. This case must be framed with lead or zinc, whichever be the metal employed for the ledges of the box. Difference of metal may cause a galvanic action injurious to the plants. When great elegance and durability are required, brass is used, and the box is made of mahogany. The case must be made to fit with nicety upon the ledges of the box, and in such a way that moisture will flow down the inside of the case into the box. The case should have a door on one side to open and shut at pleasure, but also to fit as nicely as possible; there must, in short, be no crevices to permit a free interchange of air betwixt the room and the interior of the case. The glass panes in the case should be fitted with care, and the putty well painted, to preserve it from the action of the moisture. The finer the glass is, the better will be the view of the plants. When we add, that the box, with its glass cover, are to be placed on a four-footed stand or low table, in front of a window which is exposed to the sun during several hours of the day, the entire fabric of the apparatus has been described. The apparatus, in a complete state, is represented in the annexed figure.



We now come to the preparation for the plants. Lay the bottom of the box with pieces of broken earthenware, to a depth of two inches, as an open subsoil. Next, lay a stratum of turfy loam an inch deep, and fill in the remainder of the space with good soil, mixed with a portion of peaty loam and sand. The artificial garden-plot is now ready to receive the plants. Set these in the usual manner, and then shower over them with a watering-pot from three to four gallons of water, till the soil be pretty well saturated, and the liquid runs off by the two openings in the bottom. When this is done, cork up the holes, place the case on the box, and the operation will be finished.

A question will here readily occur—What species of plants are best adapted for these domestic greenhouses? We are fortunately enabled to answer this inquiry by referring to a learned paper on the subject by Mr. Ellis, which was read to the Botanical Society of Edinburgh, January 13, 1839, and afterwards published in the "Gardener's Magazine," vol. xv., and also as a separate pamphlet. According to this gentleman, the plants most suitable are "those which partake largely of a cellular structure, and possess a succulent character, and especially those which have fleshy leaves; whilst, on the contrary, the continued humidity is unfavourable to the development of the flowers of most exogenous plants, except such as naturally grow in moist and shady situations. Plants, therefore, which have to grow and bloom in cavernous and moist situations, or at least in moist and warm climates, are best adapted for these cases. However, within this class of vegetables there are many beautiful and highly luxuriant plants, which it would afford no small pleasure to contemplate. The following is a list of plants from various countries, which were set in a box under Mr. Ellis's directions, and examined from nine to twelve months afterwards:—

Botanical Names.	*Country.*	*Remarks.*
Chamærops humilis	Italy, Sicily, Spain	Increased 1-4th its original size.
Gentiana verna	England	Flowered, but no difference in size.
Adiantum Capillus Veneris	England	Increased 1-8th.
Primula farinosa	Scotland	Flowered; atmosphere rather damp for it.
Scotica	Scotland	Flowered; atmosphere rather damp for it.
Verbascum Myconi	Scotland	Increased 1-8th.
Androsace villosa	Scotland	Flowered; not very healthy.
Chamærops *Palmetto*	Carolina	Increased 1-3d.
Dionæa Muscipula	Carolina	Made 1-8th.
Surracenia purpurea	Carolina	Increased four times its original size.
Epigæa repens	Carolina	Increased one-half.
Testudinaria elephantipes	Cape of Good Hope	Made a shoot ten inches long.
Aloe retusa	Cape of Good Hope	Made 1-3d. showing flower spikes.
Rhododendron chrysanthum	Siberia	Increased one-half.
Chamæcistus	Austria	Increased 1-3d.
Cycas revoluta	China	Increased 1-8th.
Nepenthes distillatoria	Ceylon	Increased 2-3ds.
Cypripedium venustum	Nepal	Increased 1-5th.
insigne	Nepal	Increased 1-4th.
Agave geminiflora	Mexico	Increased 1-3d.
*Goodyera discolor	Mexico	No perceptible difference.
*Echinocactus multipl.	Mexico	Increased one-half.
*peruviana	Mexico	Increased one-half.
myriacantha	Mexico	Increased one-half.
*formosa	Mexico	Increased 1-3d.
Ottoni	Mexico	Increased 1-4th.
candida	Mexico	Increased one-half.
Epiphyllum truncatum	Brazil	Increased 2-3ds.
Cereus flagelliformis	Peru	Increased one-half.
Lycopodium stoloniferum	Cuba	Very luxuriant.

Those marked thus * are growing in fancy pots, and suspended from the roof of the plant-case.

Plants, after the first preparation, require little or no care; the case need only be opened for the removal of dead leaves, or for a little trimming when required. Plants in open flower-pots are exposed to the vicissitudes of change of climate, and require constant watering; but the plants in these cases seem to be independent of any change of temperature in the air, and water themselves. The moisture rises by the sun's influence from the moistened earth, cherishes the leaves of the plants in its aërial condition, and during the cool of night falls to the earth again like rain or dew. In this manner there is a constant succession of rising and falling of moisture, in imitation of the great processes of nature daily going on in the fields around us. The plant-case is a little world in itself, in which vegetation is supported solely by the resources originally communicated to it.

Not the least remarkable point in the economy of the case, is the preservation of atmospheric purity. To all who reflect for the first time on this subject, it will seem incomprehensible how the plants can possibly thrive and blossom without the occasional interchange of fresh air with the atmosphere. This certainly does appear extraordinary, yet it is ascertained by experiment that no such reinvigoration is requisite; to account for the phenomenon, it will be necessary to remember that while plants inhale oxygen from the atmosphere, and expire carbonic acid, their leaves possess the remarkable property, in conjunction with the sun's light, of retransforming the carbonic acid into oxygen. At night, when the light of day has departed, the expired carbonic acid may be detected in the neighbourhood of plants, and hence one cause of injury to health by breathing night-air; but when the morning sun again bursts upon the scene, a great chemical process commences in the atmosphere—the carbonic acid is decomposed, oxygen is evolved, and all nature rejoices in a re-creation of its appropriate nourishment.

With reference to the closed conservatory, we now see that the deterioration of the atmosphere will be daily counteracted by an opposite process of purification: so that amidst the vicissitudes of perpetual change, the air is maintained in a state of nearly uniform composition and purity, and serves over and over again for all the purposes of vegetation. It may, however, be stated, to prevent misconception, that the more pure the air of the apartment, the plants will have the better chance of thriving, because there must necessarily be an interchange to some extent betwixt the air of the room and the case, in consequence of the daily expansion from heat and nightly condensation from cold. This interchange will be effected by the minute crevices in the apparatus, and therefore requires no special provision.

ROCK AND AQUATIC PLANTS.

If space and means permit, a flower garden may be much improved by introducing a piece of artificial rock-work, and a small pond; because, in connection with these, certain highly interesting plants may be reared or kept, which would not answer in a plain earthy soil or surface. In order to increase the effect, the pond should be at the base of the rock-work, and receive from it the trickling of water which has been conveyed to the summit in pipes. Let the rock-work possess a natural appearance, with rugged sides, and perhaps be ten or twelve feet high. Rocks of the same kind and colour should be placed together; if intermixed, they seldom wear a natural appearance. A dark cave, penetrating into the thickest part of the erection, is not very difficult to construct, and, when encircled with ivy, and inhabited by a pair of horned owls, which may be easily procured, it will form a most interesting object. Rock plants of every description should be profusely stuck around, and, in one short twelve-month, the whole scene will exhibit an impress of antiquity far beyond anticipation. The undertaking, when completed, will present a field of varied and interesting study, and more than compensate for all the attention and outlay bestowed upon it, the aquatic and rock plants, which formerly were "far to seek and ill to find; will thus be brought within the range of every-day observation; the wagtail, oxeye, and stonechatter, will be attracted to the spot, not, perhaps, because they are lovers of the picturesque, but because they find every thing here suited to their nature; and colonies of the wild bee will soon be seen and heard around the interstices of the rocks, and heavily laden with their winter store.

A weeping-willow adjoining and one or two mountain-ashes, will add materially to the beauty of the scene; and, if the spot be airy, there might with advantage be planted, on or about the top of the eminence, a variety of what is usually called the *Scottish thistle*. This tall elegant plant will not thrive in low or damp situations, and prefers a bracing to a warm atmosphere; hence, though a beautiful object in borders, it will be found difficult to bring to perfection in some situations. It may be remarked that there has been some uncertainty as to which is the true Scottish thistle, or that figured in the national emblazonment. Mr. Dovaston, in a communication to Leighton's *Flora of Shropshire*, states that, in a tour of Scotland, he asked many persons which was the Scottish thistle, and found many different opinions. A Hebridean gentleman pointed to the *Carduus eiophorus*, and Sir James Grant, at Inverness, indicated the *Carduus nutans*. For our own part, we do not believe that, when the emblem was adopted, any particular species of the plant was meant: the leading idea was the self-defending power of the thistle, as emblematical of the determination of Scotland, though poor, to submit to no injury or offence without retaliation.

Among the plants suitable for growing from the crevices of the rocks may be mentioned various heaths and mosses, the Valeriana diœcia montana, Trifolium alpestre, Thymus vulgaris, Epilobium alpinum, Campanula cervicaria, Alyssum calycinum, and Viola banatica. Many plants might be mentioned as suitable for the marshy borders of the pond, as the Acorus, Littorella, Lychnis flos-cuculi, Saxifraga irrigata, Epilobium angustifolium, Primula farinosa, and so forth. We should recommend the unprofessional gardener, in replenishing either a rock-work or pond with appropriate plants, to consult a nurseryman skilled in the subject; as soil, air, climate, moisture, and other circumstances, require careful consideration.

GARDEN PLOTS IN TOWNS.

The attempt to have a neat and flourishing garden or garden plot in populous towns, is very often defeated by the abundance of smoke and other impurities in the atmosphere; for, as repeatedly mentioned, pure air is essential to the proper growth of plants. It is found, however, from experience, that certain kinds of shrubs and flowering herbs are less delicate in this respect than others; and that, with a reasonable degree of care, open plots in towns may be made to yield a surface of vegetable bloom and beauty. On this branch of flower-culture, so important to many town residents, there appeared, some time ago, a well-written paper in that useful publication, "The Magazine of Domestic Economy," describing the experience of an amateur florist; we take the liberty of extracting from it the following passages:—

"When I first took possession of my garden [in town], I found it encumbered with old lilacs and laburnums, the common aster, and other ordinary plants. These I immediately removed; by my west wall I planted a Buddlea globosa, and a Virginia creeper; and by my south wall, which was partly covered by a vine, I planted the jasminum revolutum, the small white clematis, and the pyrus Japonica. The latter grew luxuriantly, and bore an abundance of flowers, which, glowing upon the light wall, enlivened my prospect in winter. I had a great deal of the south sun in my garden, but none of his morning beams reached it, and there was a corner which never had a gleam at all. In this spot I planted a quantity of roots of the lily of the valley, and they flowered well, although late. The laurustinus also grew well with me; and I should strongly recommend this pretty shrub, together with the laurel, instead of those deciduous shrubs which we see in town gardens. The latter become very shabby as they grow old; neither the lilac nor syringa flower well in confined situations; besides this, the untidy appearance of their falling leaves is a great annoyance. My jasmine grew quickly, and, with the clematis, soon covered as much wall as I could afford to them; the great inconvenience of the latter plant is, that it requires frequent attention as to nailing up, and this, where there is not a gardener always at hand, is troublesome; as, although the stem should be cut down within three feet of the ground every autumn, yet the young shoots soon grow beyond a woman's reach. However, it is worth while putting ourselves to a little trouble for the sake of the delicious scent of the flowers of this pretty trailing plant. As regards perennials, I dare say all who are fond of flowers have endeavoured to nurse the China rose, and induce it to flower in the town. I have grieved over many a healthy plant which refused to show a single bud, and watched the gradual wasting away of others, notwithstanding my unceasing care. The common Provence roses, both white and red, flower well in the town; but it is vain to attempt the China—it requires a very pure air, and I do not know any flower whose colour varies so much with the quality of the atmosphere. I am but slightly acquainted with the names given by botanists to the numerous varieties of roses; but I have tried many of them, and found the Tuscan, the rose de Meaux, the Tudor, the little early crimson, and one surpassing them all in beauty, the Bengal celestial (I believe), flower extremely well. With regard to spring flowers, the snowdrop I could not tolerate in the city—the smoke robbed it of all its beauty; the crocus, either the mice or the sparrows would not leave undisturbed; and, after replenishing the edge of my border several times, I gave up the matter. The hepatica and gentianella flowered well with me; anemones also I had of very good colours. Heart's-eases pined sway after the first year, but they were easily replaced, and they were too ornamental to be relinquished. Then followed the white lily, and a variety of irises, all of which increased fast, and flowered abundantly. The peony I could never persuade to flower; in the first place, it does not blossom well until it has been for years settled in a garden, and I believe its beauty even then is greatly dependent upon the purity of the air. My buddlea was every spring covered with its golden balls, and grew so quickly that I scarcely knew what to do with it. I am surprised this beautiful shrub is not more common; it is perfectly hardy, even as a standard; it will remove well, even when it has attained a considerable size; it is very easily raised by layers; and there is an air of grandeur about it, both as to leaves and flowers, that raises it above the common flowering shrubs of our gardens. But we go on in the old-fashioned manner of planting our gardens: the same varieties of deciduous shrubs are taken, without considering with how much advantage their places might be supplied by those more lately introduced. The magnolia, for instance, grows quickly, and flowers abundantly in the city upon a south wall; and the arbutus is not at all particular with respect to situation. The bignonia grandiflora also does not withhold its scarlet trumpet-like blossoms in the immediate vicinity of a steam-engine. To return to my garden, the glory of which in the autumn was the lobellia fulgens, I managed it thus: I sank in the ground, up to the rim, a large and deep seed-pan; this I filled to about three quarters of its depth with rich soil properly mixed, and planted my roots. As soon as the shoots appeared, I supplied them plentifully with water, and from time to time added more soil. The plants grew luxuriantly, furnishing tall and thick stems, with large and highly-coloured blossoms; indeed, the gardener who had assisted me said that he had never seen finer flowers. The sweet-scented marvel of Peru thrived well with me, and the tiger-flower also. Carnations and picotees I tried one year, but was so much disappointed in the result, that I gave them up, although very reluctantly as I believe carnations do not require a very pure air, and I have fancied since, that my failure with them arose from some other cause than the smoky atmosphere. Dahlias, also, although they flowered very well, I gave up. The amaryllis lutea flowered well with me, when once established, and the hemerocalias cerulea and flava did the same."

After condemning annuals in general, the same writer goes on to say—"I own I am willing to make some exceptions myself in favour of the coreopsis, and such brilliant flowers particularly; the French marigold, too, and the scarlet zinnia, I could scarcely give up. The lupinus mutabilis blossoms well in the town, but it is very liable to be destroyed by a caterpillar; the easiest method of preventing which is to strew a little soot around the plant. The grub, I suppose, will not rise through this: I found it more effectual than tobacco, which I also tried. The scarlet colutia is much eaten by an insect: I found the same method succeed in this case. I had forgotten to mention that all bulbs of the narcissus and jonquil tribe flowered well with me: the primrose and polyanthus gave miserable-looking blossoms. I planted the double pomegranate against my south wall, and it grew well: I left the house before the plant was old enough to flower. I should notice one great recommendation which American shrubs possess to those who are likely to change their residence—they may be removed without danger at almost any size. Mine were planted in a border of common earth, in a hole filled up with peat and loam fit for them; and when a rhododendron, four feet in height, was removed, it was found that the roots formed a complete ball, none of the fibres having penetrated beyond the soil which was proper for them. The common and Portugal laurel may be removed when very large: I have myself seen one of the latter, which three men and a boy could with difficulty lift, transplanted with success. Of course it was carefully tended as to water. The scarlet lychnis does not mind the corrupt air of the town; but it will not grow to so great a height in such a situation as it does in the country. There are many other plants which might be treasures in a town garden; experience, however, is the best teacher in this as well as in more important matters, and if a garden be stocked with the plants I have mentioned, experiments may be made as to others; should they all fail, the garden will still be gay."

To the foregoing we need only add, that much may be done to keep garden plots neat by frequent trimming and raking, and particularly by keeping the plots in grass close shaven. To be kept in the best trim, grass should be mown once a fortnight.

FLORICULTURAL MONTHLY CALENDAR.

January.—Little can be done in the flower-garden except the weather be open and dry; but advantage ought to be taken of favourable intervals to render the plots and borders neat; to protect by coarse screenings of leaf-mould fuchsias, China roses, and other choice shrubs; for though they may not perish by frost, the mulch tends to enrich the soil, when forked in.

Propagate, by division of roots, daisies and thrift: protect the beds of hyacinths, anemones, ranunculuses, and tulips, by a covering of coarse litter. Top-dress auriculas, using a compost of light loam and two year-old cow-dung, mixed with a twelfth each of sea or river sand, and rotten wood. Plant all the bulbous roots that are still out of the ground.

In heat, sow mignonette, annual stock, penstemon, [illegible] fusus, gentianoides, and other half-hardy annual and perennial plants, using the propagation-pot, by which means the entire number of seedlings (allowing for previous thinning out) can be transferred, with roots undisturbed, to the plots or borders. Commence sowing in the last week, for hot-house culture, seeds of Gloxinia and Gesneria these, if obtained from impregnated plants, may yield new and striking varieties. Sow also (broken up and mixed with sand) the berries of Psidium Cattleyianum; this plant is one of the choicest evergreens of the stove, or even green-house, for it is not tender.

February.—Attend to the foregoing general directions, and now cut turf for lawns; fork and clean the flower-borders. Plant anemones, gladiolus, perennial herbaceous roots; and transfer others, dividing the crowns, to multiply the species. In this way almost all such plants can be increased. For examples of this division of roots, select the primrose, single, double, and the polyanthus. Transplant the rooted layers of carnations, also the divided roots of campanula, lobelia, lychnis, mullpink, and dianthus sinensis. Sow in mild heat any annual flower seeds, and of auricula and mimula, in boxes or pans. We include the beautiful primula sinensis. Excite choice dahlia roots, placing them in hot-bed frames, or in troughs or pots of old tan, or any light moist substance, on the floor of a stove or vinery at work.

March.—Sow annuals, including balsam seed, collected from the best double flowers. Plant box-edgings, using much pit-sand; also evergreen shrubs of every description. Transplant autumn-sown annuals into pots, and protect them, till fresh-rooted, under glass; as Clarkia of every kind, Calliopsis, Œnothera Lindleyana, mignonette, Schizanthus pinnatus, and porrigens. Sow in the last week, in the open ground, and at the same time, a pot of each in heat, or at least under glass, stocks, foxglove, China-aster, Clarkia, dahlia, campanula, larkspur, penstemon, amaranthus, tobacco, and all the hardy annuals. Take cuttings of hydrangea from the tops of the shoots. These, if the buds be full, sometimes will produce a fine flower-head, and the effect is striking. Soil, pure heath mould, or leaf-mould, and sand. Use small pots, as for pelargonia.

April.—Plant dahlia roots in richly-manured loam, hollyhocks, carnations, biennials and perennials: at this season, every herbaceous plant is almost certain to succeed. Campanulas (the tall pyramidal), raised by cuttings of the roots in autumn, may now be transferred to pots of loam and leaf-mould; and as the plants grow, they are to be constantly shifted, till they come into pots, wherein they will bloom profusely. If placed in the borders, they will require no peculiar treatment. Sow in a pot the seeds of this variety of campanula (seedlings frequently produce the finest plants; they require profuse watering); also the seeds of the pansy or heart's-ease, to procure varieties. Propagate by cuttings, as directed for geraniums, or by single eyes, the Erythrina crista Galli, and laurifolia. In propagation pots, using the same soil, all the salvias, verbenas, rockets, double wall-flowers, and every species of fuchsia that has produced young wood. Try every plant by cuttings placed in ounce phials, three parts filled with rain-water. Bud China, noisette, and moss-roses, on dog-rose stocks. Divide the roots of dahlias, either retaining one single tuber with a sprouting eye, or twist out very cautiously a single shoot, so as to detach its base and the latent bud it contains, planting it in the smallest pot of sand and leaf-mould; a gentle hot-bed will facilitate the protrusion of roots.

May.—This is the season to stock the flower garden with those plants which have been prepared during autumn, winter, and spring; and therefore transfer, from the propagation pots, annuals raised in them, by lifting the whole mass, and depositing it in a spot prepared in the border: thus trouble and loss of time are obviated. Sow a few annual seeds in the open ground for succession. Plant the parterres with groups of fuchsias, calceolaria, petunia, Neapolitan violet, verbena; and at the latter end, form masses of the scarlet and variegated gerania, and many less prized but beautiful fancy varieties; such are, Diomede, conspicuum, succulentum speciosum, Moore's victory, Dennis's rival, &c. &c. Propagate, by cuttings, the China roses of every kind; plant them two joints deep, in a shady situation; also calceolarias of the shrubby kind, Peruvian heliotrope, &c.: by division of the roots, Neapolitan violet, placing them in beds of manured loam, twelve inches apart; the heart's-ease of the best varieties, in shady situations; the soil, rich loam and leaf-mould. These favourite prize-flowers require a frequent renewal of soil; they dwindle if retained in one site, and degenerate to the condition of the poor weak flowers of former years. Propagate, by slips, lychnis, double rocket, and wall-flower; thin out the superabundant shoots of asters, antirrhinums, penstemons, phlox, and indeed of every luxuriant herbaceous plant.

June.—Propagate, as during the last month, and plant young side-shoots of the best lobelias, in shady borders, under a hand-glass. The pipings of pinks, placed in sandy earth, are to be closely covered in the same way, till completely rooted. Salpiglossis succeeds best in the open air; the plants should be now turned out of pots, and set in a dry border. Green-house plants may now be arranged in a north aspect; the pots to stand on a deep stratum of coal-ashes. Azaleas, accacia armata, and some such plants, are greatly improved by being turned out of pots, and planted with entire balls in an open peat border.

July.—Bud roses on wild stocks. A pretty effect is produced by inserting one or two buds of the deep-red China in the common China rose. The former is strengthened in its habit, and the different tints of the two roses are very pleasing. Propagate, by cuttings, the Chinese azaleas, half-shrubby calceolarias, linums, pelargoniums, fuchsias, myrtles, and other exotic shrubs. Layer carnations in sandy earth, with a little chalk; peg them near the incision with hooks of fern-leaves. Sow the seed of mignonette in small pots, for winter; also, annual flower seeds for bloom in September.

August.—Bud, as before, but not the China rose. Plant seedling herbaceous plants, cyclamens of every kind, offset bulbs to gain strength; repot auriculas, removing the suckers, and detach the black ends of old roots with the finger and thumb. Sow the seeds of all the annuals mentioned under that head in a previous page. Use gentle heat; add any other favourites, as madia elegans, mimulus, the white night-flowering petunia, tall and dwarf larkspurs. Sow the seed of the best pansies. Take cuttings of all the fine pelargoniums that are out of flower early in the month; also of calceolarias, shrubby and half shrubby; of antirrhinum caryophylloides, penstemon gentianoides, &c.; these require no heat, but should be placed in a cold frame.

September.—Plant the crocus and some other bulbs. Transplant herbaceous perennials and pinks to permanent beds, if perfectly rooted. Propagate, by cuttings, China roses in the open borders; and by slips petunias, heliotrope, salvias, gerania, calceolaria, &c.; they require only a hand-glass and light soil. Sow auricula seed in pans in the green-house; also Clarkia, collinsia, chelone, and other annuals, to be preserved in pots all winter. If the pyramidal campanula be out of flower, take up one of the finest roots, blue and white; break it to pieces, and half filling a large pot with loam, place the pieces on the earth; fill the pot with loam, and keep it merely protected from frost all winter. Raise every geranium or other green-house plant now in open ground, and repot them in soil suitable to each. Cut back to low buds, well situated, the horse-shoe geranium, and place all the plants under glass, to recover from the removal; make cuttings of the best amputated shoots of geranium. Gradually diminish the watering of green-house plants.

October.—Plant towards the end bulbs of hyacinth, narcissus, and the common jonquil, and daffodil and anemones ...; also shrubs of every description, though evergreens generally succeed in spring cuttings, as before, if not completed. Hyacinths in pots, filled with a compost of light loam, sand, and vegetable earth, should be plunged to the rims in ashes, or light earth, under the glass of a cold frame; and when the plants begin to grow, the pots should be raised, cleaned, and placed in the green-house. Green-house plants must now be taken in, and be gradually inured to winter treatment, by the free admission of air and abatement of water. Take up the Persian cyclamen, and pot it in loam, sand, and leaf-mould. There is a geranium which merits much attention; it is called the scarlet globe, and appears to be a seedling variety of Pelargonium zonale: cuttings of it strike freely in the open border early in summer; the handsomest of those, taken up in September, and carefully potted in poor loamy soil, will flower throughout October and November, placed in the window of a south room: the flower-head assumes the figure of a Guelder rose.

November.—Bulbs; plant all, employing much sand about and above the bulbs. Protect fuchsias, if frost threaten. Screened leaves form the best substance to be placed as mulch. Dahlias should be digged up in airy and dry weather, when quite dry and clean; preserve the tubers in dry sand; damp is the worst enemy of the dahlia.

December.—Protect beds of tulips, hyacinths, and other choice bulbs or roots, with a layer of saw-dust mixed with sand, or with ashes. Saw-dust alone has been found the most effectual protector to the roots of potted plants in frames, the pots being plunged in it to the rims. If dry weather permit, lightly fork the surface of plots and borders; but at any rate, if it be frosty, scatter some light manures around the stems of shrubs and the more tender plants; it will tend to enrich the ground at the first spring regulation. Secure begonias and other plants which die down to the mould, by placing the pots in a temperate dry cellar.

Our recollection has been much assisted by referring to the excellent calendar at the end of Mr. Mantel's treatise on *Floriculture*, published in "Baxter's Library of Agriculture and Horticultural Knowledge," a work which we should be happy to recommend to every admirer of rural economy.

THE FRUIT GARDEN.

The hardy fruit usually produced in gardens of an ordinary description in Britain, are of three leading kinds—*kernel fruits*, of which the apple and pear are the principal; *stone fruits*, including the peach, apricot, plum, and cherry; and *berries*, of which there are many different species, as the gooseberry, currant, and strawberry. The kernel and stone kinds are produced from trees, and others from shrubs or more tender plants. All the garden fruits, of whatever sort, are greatly improved by a long course of cultivation from a wild state—this being a branch of vegetable economy which has engaged the unremitting attention alike of men of science and practical gardeners from a remote antiquity till the present time. Of the best means which experience has suggested for culturing fruit trees, and bringing their produce to perfection, we now propose to speak.

GENERAL MANAGEMENT OF FRUIT TREES.

Fruit trees are grown as independent plants in an orchard, in which case the tree is suffered very much to assume any height or bulk that nature permits; also trained upon walls, or constrained to grow in a particular manner upon artificial palings called *espaliers*. In whatever manner the tree is planted or designed to grow the tendency of the main stem and branches of the plant is directly upwards, and of the chief roots directly downwards. In general, the depth and spreading of the roots are proportional to the height and spreading of the branches, because the roots are the anchorage and food-seekers of the plant, and require a depth and compass of soil analogous to the bulk of the tree and its demands for nourishment. On these accounts, it is of the first importance not to stint fruit trees of a proper depth and breadth of soil corresponding to their expected dimensions.

Trees planted close to walls should have a depth of soil in proportion to the height of the wall. If the wall be six feet high, the border beneath will require to be trenched soil two feet deep; and so on to a ten-feet wall, which should have at least three feet of free penetrable soil. The principle is, the deeper the soil, the less will the roots straggle. As already said, their tendency is chiefly downwards; and it is only because they cannot get far enough down that they range abroad. Their object is to absorb nourishment wherever it can be obtained; and, abstractly considered, it is of little consequence whether this nourishment is procured beneath the main stem or at ten yards' distance. But, practically, the gardener is concerned in keeping the roots from straggling, and interlacing, as with a network, the under strata of his borders, thus impeding his operations, and perhaps robbing his culinary vegetables or bushes of a portion of their food.

It will therefore be observed, that depth of available soil is as essential in fruit tree culture as in any other department of gardening. If possible, a depth of three feet should always be obtained. Should the garden, when first taken possession of, not have more than eighteen inches or two feet of soil, our recommendation is, not to plant fruit trees upon it at all, till you have trenched the ground to a depth of three feet, and, by annual digging, mingled the lower layer with that immediately above it. (See article LAND IMPROVEMENT.)

In the course of these preparations, let the soil be well cleared of stones, meliorated by winter frosts, and enriched with old manure. Bear in remembrance, that fruit trees must never be excited by new and undecomposed manure. The material applied both before planting and also while the tree is growing, should be loam, mixed with a thoroughly rotted compost of leaves, &c. Some persons, following an old prejudice, place a paving stone a certain depth beneath to prevent the root of the tree from penetrating into the subsoil; but this is only waste of labour; for if the descent be counteracted, the roots will proceed laterally, and penetrate downwards as soon as they can conveniently do so. By giving a proper depth of soil, and keeping that soil in heart, no fear need be entertained for the tree receiving injury from the subsoil.

When we say that depth of soil is advantageous, it is necessary to guard against an impression being formed that deep planting is also required. In general, the roots of trees should be placed near the surface. Mr. M'Intosh, in his very beautiful work, "The Orchard," offers the following caution on this subject:—"Deep planting is an evil much to be guarded against; and many of the disappointments which have attended the fruit-grower may be traced to this cause. As some criterion for the guidance of the amateur, we would say, let every young fruit tree, of whatever kind, be planted at least three inches above the ground level; that is to say, let the part of the stem which was level with the surface while in the nursery, be kept three inches above the general surface of the ground when it is planted, and let the earth be heaped up to that height around it, for a couple of feet or so, in the form of a little hillock. Trees of larger size may be rather more elevated. This applies to soils of the ordinary description; but in damp soils, the elevation should be still greater. When trees are set in a pit, which should always be a third larger in diameter than that of the extent of the roots, so that they may be all spread out to their full extent, without being doubled or turned round, they should be spread as regularly as possible, and the bottom should be made perfectly level; by this means, the roots will have a horizontal direction given to them, which they will afterwards maintain. The intention of this arrangement is to induce them to extend themselves near the surface, and to prevent their extending downwards into a bad or cold subsoil.

Propagation—Grafting.

Fruit trees may be propagated by seeds, layers, cuttings, budding, suckers, or grafting. By any of these methods, a material object of the culturist is to improve, or at least not deteriorate, the quality of the plant. In a state of nature every fruit is inferior to what it will become by cultivation. This disposition to improve is taken advantage of by gardeners; and by attending to various circumstances in the economy of any individual plant, they are able to produce and propagate the best varieties. The principal means employed is to select such varieties as have attained a certain degree of perfection, and then crossing two of the most nearly allied, in order to produce an intermediate variety. The discovery of the sexuality of plants, as established by Linnæus, has rendered this a comparatively simple operation to skilled gardeners. The following is a short exposition of the method given by Mr. M'Intosh, who quotes from other authorities:—

"The means used in the process of artificially fecundating the stigma or female parts of the blossom of one flower with the pollen or male dust of another, have been beautifully described and explained by Knight and others. That eminent pomologist has obtained thousands of apple trees from seeds, many of which are of first-rate quality, by cutting out the stamens of the blossoms to be impregnated before their own pollen was ripe enough for the purpose, and afterwards, when the stigma was mature, by introducing the pollen of the other parent, either by shaking the pollen of it over the flower containing the stigma only, by introducing the flower when deprived of its petals or coloured leaves, or by transferring the pollen upon the point of a camel-hair pencil from the one flower to the other. By these means he prevented the possibility of the natural fecundation of the blossom within itself, and thus greatly increased the chances of obtaining intermediate varieties by making use of two distinct parents.

"This process is called cross-impregnation, and is in its nature highly curious. Dr. Lindley describes the action as follows:—'Pollen (the male dust) consists of extremely minute hollow balls, or bodies; their cavity is filled with fluid, in which swim particles of a figure varying from spherical to oblong, and having apparently spontaneous motion. The stigma (the female organ) is composed of very lax tissue, the intercellular passages of which have a greater diameter than the moving particles of the pollen. When a grain of pollen comes in contact with the stigma, it bursts, and discharges its contents among the lax tissue upon which it has fallen. The moving particles descend through the tissue of the style until one or two find their way, by routes specially destined by nature for their service, into a little opening in the integument of the ovulum or young seed. Once deposited there, the particle swells, increases gradually in size, separates the radicle and cotyledons, and finally becomes the embryo—that which is to give birth, when the seed is sown, to a new individual. Such being the mode in which the pollen influences the stigma, and subsequently the seed, a practical consequence of great importance necessarily follows, namely, that in all cases of cross fertilization, the new variety will take chiefly after its polliniferous or male parent; and that, at the same time, it will acquire some of the constitutional peculiarities of its mother.'"

Illustrating these principles by a reference to the propagation of varieties of apple-trees from seeds, Mr. M'Intosh observes, that "the kinds of apples that it would be advantageous to cross by artificial impregnation appear to be those which have a great many qualities in common, and some different qualities. Thus, it would be proper to cross the Golden pippin with other pippins, and even with some rennets, but it would be improper to cross it with codlings or the larger growing kinds. The numerous varieties of pippins raised by Knight and others, have been obtained by the above rule. It is, no doubt, true that a small apple—say, for example, the Golden pippin—crossed with a much larger sort, will produce a variety sufficiently distinct from the other; but it is almost equally certain that this new variety will be of inferior quality to either; 'the qualities of both parents,' as Mr. Loudon has very justly observed, 'of so very opposite natures being, as it were, rudely jumbled together in the offspring.'"

Grafting—its Theory.

Grafting, which is a practice of great antiquity, is the union of two plants in a growing state, through the medium of the circulating juices. It is now a well-known fact in surgery, that if a piece of a finger which has been accidentally chopped off be immediately applied to the stump whence it was severed, and the wound properly bandaged, it will adhere and become part of the living member as formerly. This, then, is grafting in the animal economy, and it is analogous to the grafting of one vegetable on another. The only dissimilarity is, that the piece of finger is restored to its own stump, whereas the vegetable union is between two distinct trees. But this is a point of [illegible] consequence; for it is probable that if two persons [illegible] equally good health were to have a finger chopped off at the same time, the pieces might respectively be changed, and each person might have on his hand the finger of his neighbour.

Gardeners assign five reasons for grafting:—1. The perpetuation of varieties of fruit, which could not be insured by sowing seed: 2. Increasing, with considerable rapidity, the number of trees of any desired sort: 3. Accelerating the fructification of trees which are tardy in producing their fruit: 4. Improving the qualities of fruits: and 5. Changing the sorts of fruit of one tree, and renewing its productiveness.

When a tree becomes old, but has still healthy and vigorous roots, and it is thought advisable to renew or improve its fruitful qualities, it is cut off across the lower part of the stem, and forms the *stock* on which *scions* are ingrafted, which scions taking root, become in time the fruit-bearing branches of the tree. As a general principle, the sorts to be united require to be considerably alike as respects disposition of woody fibre and sap and pulp vessels, so that no decided interruption may take place in the ascent or descent of the juices. Yet, to effect any improvement in fructification, there must be a certain difference between the varieties. For example, the wild apple-tree, which bears only crabs, too sour to be eaten, forms one of the best stocks on which a graft can be made; and for that reason alone, it is grown by nurserymen from seeds. The notice of this remarkable fact leads to a consideration of what are the radical principles on which improvement is effected by grafting. On this intricate subject we offer, in the first place, the explanations of Dr. Lindley:—"In proportion as the scion and stock approach each other closely in constitution, the less effect is produced by the latter; and, on the contrary, in proportion to the constitutional difference between the stock and the scion, is the effect of the former important. Thus, when pears are grafted or budded on the wild species, apples upon crabs, plums upon plums, and peaches upon peaches or almonds, the scion is, in regard to fertility, exactly in the same state as if it had not been grafted at all; while, on the other hand, a great increase of fertility is the result of grafting pears upon quinces, peaches upon plums, apples upon white thorn, and the like. In these latter cases, the food absorbed from the earth by the root of the stock is communicated slowly and unwillingly to the scion; under no circumstance is the communication between the one and the other as free and perfect as if their natures had been more nearly the same; the sap is impeded in its ascent, and the proper juices are impeded in their descent, whence arises that accumulation of secretion which is sure to be attended with increased fertility. No other influence than this can be exercised by the scion upon the stock. Those who fancy that the contrary takes place—that the quince, for instance, communicates some portion of its austerity to the pear—can scarcely have considered the question physiologically, or they would have seen that the whole of the food communicated from the alburnum of the quince to that of the pear is in nearly the same state as it was when it entered the roots of the former. Whatever elaboration it undergoes must necessarily take place in the foliage of the pear—where, far from the influence of the quince, secretions natural to the variety go on with no more interruption than if the quince formed no part of the system of the individual."

These explanations do not appear satisfactory; they rest upon an assumption that the sap taken up by the roots suffers no chemical change in its passage from the stock to the scion; that it is never altered in constitution till it reach the leaves. We confess we entertain strong doubts on this point, and should be glad to see the fact brought to the test of experiment by strict chemical analysis. Until this is done, all theory must be conjectural, and any expression of opinion useless. Mr. Knight, who made many valuable discoveries in pomology, coincides with Lindley in ascribing increased fertility in the scion to the partial obstruction of the descending sap; but this does not clear up the difficulty as to improvement in the variety and flavour of the fruit by grafting, which we should think arose in some manner of way from a chemical alteration in the juices. Knight arrives at a practical conclusion worthy of the notice of fruit culturists; that although increased fertility is produced by a decided difference between stock and scion, it is at the expense of durability; "but it is eligible wherever it is wished to diminish the vigour and growth of the tree, and where its durability is not thought important."

All things considered, therefore, it is preferable to ingraft the scion of any approved variety on a sound stock, properly prepared for the purpose. As already observed, crab stocks are often grown to form the foundation of good apple-trees, and so are several other stocks propagated by professional gardeners from seeds and layers. We may now describe the manner in which grafting is performed.

Scion Grafting.

Grafting is performed in two principal ways—scion or slip grafting, and grafting by approach, or in-arching

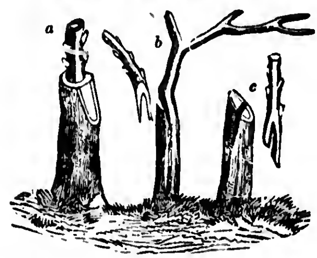


Fig. 1.

Of the first kind we have examples in the above representation, fig. 1. Three modes are shown—a, b, and c, in each of which the process consists in placing a scion in an opening or cleft of a growing stock: a is called whip grafting, b side grafting, and c tongue grafting. By either method, the scion may be a shoot of a single year's growth, cut from a tree in a healthy condition. The season for the operation is about the middle of March, when the sap is rising and the buds beginning to be developed. The grafting should not take place immediately on cutting the scion; after removal from its parent stem, place it in the ground for a few days, so that it may be partially exhausted of its juices, and be more ready to receive the ascending sap from the stock. Keep it in dry ground, and not exposed to the sun. A scion may be brought safely from a distance, by being stuck in a raw potato. Before applying to the stock, cut the extremity of the scion afresh.

Tongue grafting, by which a tongue or slip caused in the sloping cut of the scion is inserted in a corresponding notch of the stock, is the more common method of procedure. It is performed when the stock is young, so that the scion which is added forms the stem of the future tree. The cut in both pieces requires to be smooth, and the joining so neat, that the bark on one side of the scion must be even with the bark of the stock. Having joined the two pieces, bandage them together with a flat strip of mat, but not so tightly as to prevent the circulation or expansion of the fibre. Over the bandage, plaster all round a handful of soft adhesive material, formed of clay, cow-dung, and chopped straw, taking care not to disturb the united edges. This mass will form a hardened lump and may remain till midsummer, when, the union being complete, it may be removed.

The principle upon which the external plaster is applied to the junction, is that of excluding the atmosphere from the wound, and is thus scientifically explained by Rennie:—"It is to prevent the oxygen of the atmosphere from getting to the fluid pulp at the joining, where it would unite with the carbon, and form carbonic acid gas, and thereby rob the pulp of its solidity. The exclusion of light is necessary on the same account; for, as in the case of a finger cut, the oxygen would unite with the carbon, and prevent the thickening of the matter of the blood. On the same account, moisture, by supplying oxygen, would be injurious; and dryness might act both by exhausting the pulp and by causing the edges of the bark to shrivel and gape, which would facilitate the entrance of the air with its oxygen. It is also obvious, from the simple principle (never, as far as I am aware of, before stated with reference to grafting), that no composition, whatever may be said of its peculiar power of healing, can act in any other way than this, any more than the farrago of plasters and salves for healing flesh wounds and cuts, which are only good in so far as they keep the lips of the wound together, and exclude oxygen and light."

If the grafting has been properly performed, and other circumstances be favourable, the scion in two years will be in blossom, and yield a crop of fruit. What its quality will be, must depend on the nature of both stock and scion. If the scion be of a fine variety, that will remain; and if the stock be equally fine, the quality will be improved. The excellence of the scion, however, is the prime consideration, for it is the part which is immediately concerned in the production of the fruit.

For an account of the process of *budding*, which is analogous to grafting, we refer to the previous article.

In-Arching.

This is an ingenious mode of grafting, by which one growing plant, without removal, is made to strike upon another plant, and thus form a union. It may be performed in various ways, as represented in fig. 2; for example, two branches of a tree may be bent so as to meet and strike upon a wound in the main stem, by which a gap will be filled up; one growing tree, either from the ground or a pot, may be led to unite with another; or several suckers may be led from the ground arch-wise to strike upon a point in the stem, thus bringing fresh aid

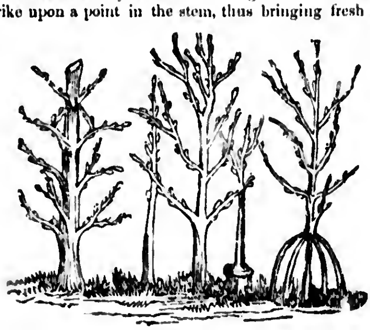


Fig. 2.

to the productive part of the tree. By means such as these, quickset hedges might be thickened like a network, so as greatly to improve their appearance and protective qualities.

KERNEL FRUIT TREES.

Kernel fruits, or *pomes*, as they are scientifically named, include the apple, pear, quince, and several others; those which require any notice here are the varieties of apples and pears.

The Apple.

The apple-tree is of universal European growth, and is believed to have been introduced into Britain by the Romans. It was greatly cultivated in the gardens of monasteries during the middle ages, and from that source the greater number of our cultivated varieties have drawn their origin. The *crab*, or wild apple, is the type of the fruit when left to degenerate, and to which it would speedily return, but for constant culture and crossing. Culture, without crossing or grafting, is found to prevent an immediate return to the crab; and therefore, when an improved variety is obtained, it will yield seeds productive of a similar variety. The extent, however, to which varieties may be preserved without crossing, has never been accurately determined, as the practice among professional gardeners is not to risk degeneracy in the fruit, and they uniformly resort to one or other of the methods of grafting above mentioned. The apple-tree, if favoured by a good soil and climate, will live to a great age, two hundred years being not an unusual duration in a fruit-bearing condition. Some orchard apples have been reported to be a thousand years old.

The varieties of cultivated apples are now innumerable. In 1834, the catalogue of the garden of the Horticultural Society of London described 1400 varieties, and there are most likely as many more. The numerous varieties are of three chief sorts—apples for the table, or to be eaten raw; apples suitable for baking and other culinary purposes; and apples for cider. Table apples are again subdivided into those which will keep, and those which will not. The choice kinds at present include Ribston pippin, which will keep till March, but is in its prime about Christmas; the Downton nonpareil, Scarlet pearmain, and Blenheim orange. The Keswick codling and Hawthornden are early ripe, but the fruit will not keep beyond October. The Nonsuch is a fine apple, and remains good in October. The Old nonpareil is in every respect deserving of its title; its flavour is high and musky, and it keeps long; few apples bring such a high price in the market in February. Other choice long keepers to be named are the Scarlet nonpareil, the Golden harvey or Brandy apple, the Winter pearmain, and the Easter apple, commonly called French crab. To this short list hundreds might be added; but those who can grow what we have enumerated, and bring them to their full complement of bearing, can require no others as stock trees. It must, however, always be borne in mind, that what will succeed well in one garden may not do so well in another, and that experience as to soil and climate, independently of advice from skilled neighbours, will in every case be necessary in the proper conducting of the fruit garden.

Mr. Loudon, in his "Encyclopædia of Gardening," mentions, that for *cottage gardens*, where the soil and situation are favourable for the production of the apple, the following sorts are recommended by Mr. Thompson:—"Where the space will admit of only one tree, the best is the Ribston pippin; where two, the Ribston pippin and Dutch mignonne; where three, the Wormsley pippin, Ribston pippin, and Dutch mignonne; where four, the Wormsley pippin, King of the pippins, Ribston pippin, and Dutch mignonne; where five, the Wormsley pippin, King of the pippins, Ribston pippin, Old nonpareil, and Downton nonpareil; where six, the Wormsley pippin, King of the pippins, Ribston pippin, Alfreston, Old nonpareil, and Downton nonpareil; where seven, the Wormsley pippin, King of the pippins, Ribston pippin, Alfreston, Dutch mignonne, Old nonpareil, and Downton nonpareil." Beyond this, Pennington's seedling and any other good sorts may be added. The same writer continues—"It often happens that one or more trees can be trained against a cottage wall or roof, or against some wall appertaining to a cottage; in these cases, the proper sorts are, Ribston pippins, Old nonpareils, and, if a large kitchen apple be required, the Bedfordshire foundling. In situations liable to spring frosts, which so often kill the blossoms of the generality of apples, the Court pendu plat is recommendable, as its blossoms expand very late in the season. Under less favourable circumstances, where the Ribston may not succeed, the Bedfordshire foundling will be a hardier substitute, or the king of the pippins, which is still hardier; the Northern greening may be planted for late kitchen use. For an autumn apple, perhaps none in this case is more to be recommended than the Keswick codling." To these observations we need only add, that the cottager will do well in all cases to prefer one or two copious-bearing trees to a number of fanciful varieties.

Standards.—Pruning and Training.

Standards are those trees which grow independently in open ground, and are classed as Large and Dwarf Standards. The proper object of cultivation is to give figure to the tree, of whichever kind, and bring it to a fertile or mature condition. Apple and pear-trees, as they approach to maturity, develop short *spurs* along the entire extent of the branches, and those spurs are the best in every respect which are produced naturally without the aid of the pruning knife. But, in addition to fruitful spurs, the trees produce a great number of superfluous wood shoots, which, if not entirely removed, or at least so curtailed as to convert them to bearing spurs, would render the tree almost useless; in short, to effect prolific fruit-bearing, the shoots must be kept in subjection, or in the state of spurs. A writer on this subject in the "Penny Cyclopædia," article *Apple*, observes—"If a tree be a free grower, on a free stock, as the crab, or a strong pippin, from seed, all the leaders will be checked by shortening them back every year to a distance from the point of origin, which varies according to their strength; where they are very strong, the leading shoots should not be reduced more than within twelve or fifteen inches of their base, but when they are weaker, they may be cut to within nine inches. By this means the onward growth of the branch is momentarily arrested, the ascending sap is impelled into the lateral buds, some of which we are sure to grow so slow as to become productive."

The foregoing directions comprise a view of the theoretical principles of pruning, and it affords an excellent groundwork for practice; but those who are strangers to the cultivation of fruit trees, and, as such, undertake the management of a plantation, will be surprised and perplexed at the anomalies which continually present themselves; it will then be self-evident that the gardening cannot, in its routine, be learned from books; that one tree assumes a certain mode of growth; another produces developments in an order which has not been foreseen or contemplated; another forms its fruitful spurs spontaneously, without solicitation or the adoption of means; while a fourth, in despite of the most rigid foreshortening, continues for years to yield nothing but growing shoots. We have seen numbers of spur trees purchased at the same period and treated upon the same principles, every one of which evinced a habit or constitution to a greater or less extent peculiar to itself; thus it is with trees as with the human genus—to be in any degree known, they must be individually and diligently observed and studied. This experimental fact being admitted, we may safely adduce the practice of pruning recommended by Mr. George Lindley for dwarf standards, in his "Guide to the Orchard," &c. (1831.) He observes, that "dwarfs on *crab stocks* are much more adapted for large and ponderous fruit than standards, as they not only produce larger fruit but are less liable to be blown down by high winds. Trees for this purpose should have their branches of an equal strength: those which have been grafted one year, or what are termed by nurserymen maiden plants, are the best; they should not be cut down when planted, but should stand a year, and then be headed down to the length of four or six inches, according to their strength; these will produce three or four shoots from each cut-down branch, which will be sufficient to form a head. At the end of the second year, two or three of the best placed of these from each branch should be selected, and shortened back to nine, twelve, or fifteen inches each, according to their strength, taking care to keep the head perfectly balanced (if the expression may be allowed), so that one side shall not be higher or more numerous in its branches than the other, and all must be kept as near as may be at an equal distance from each other. If this regularity in forming the head be attended to and effected at first, there will be no difficulty in keeping it so afterwards, by observing either to prune that bud immediately on the inside next to the centre of the tree, or that immediately on the outside. By this means, viewing it from the centre, the branches will be produced in a perpendicular line from the eye; whereas, if pruned to a bud on the right or left side of the branch, the young shoot will be produced in the same direction, so that if the branches formed round a circle be not thus pruned to the eyes on the right successively, or the left successively, a very material difference will be found; and the regularity of the tree will be destroyed in one single year's pruning."

What is here said refers only to the leading shoots which form the figure of the tree; others—side shoots (*laterals*)—are developed, and these require constant regulation. "In pruning these laterals or supernumeraries, they should be cut down to within an inch of the bottom, which will generally cause the surrounding eyes to form natural blossom spurs; but where the tree is in a vigorous state of growth, branches will probably be produced instead of spurs; if so, they must all be cut out close, except one, which must be shortened as before. In all winter prunings, care must be taken to keep the spurs short and close, none of which should at any time exceed three inches; cutting out clean all the blank spurs, which have produced fruit the previous summer, to the next perfect bud below."

It would perhaps be impossible for any writer to improve upon these directions generally; they comprise all the essentials for producing a balanced dwarf standard, that is, a tree low in stature, furnished with ten or twelve regular main branches, proceeding at a short distance from one central stem, each branch garnished from base to summit with fruitful spurs. But experience has instructed us to caution a pruner not to expect too much, but to watch the figure which his tree affects, and the course of its supernumerary shoots. If it evince a decided tendency to form short spurs naturally at a very early period, he may prune short, as Lindley directs; but if its habits be so luxuriant as to produce wood-shoots after each pruning, it will be wise to defer the summer cutting of the spring shoots till the middle of July, instead of performing it at or before midsummer; and then either to snap the shoots or to cut them to a bud situated at least five inches from their base. This pruning, late as is the season, will generally cause each shoot to break its leading eye; in August, therefore, this new shoot is to be checked by nipping off its point; and finally, in September the spring shoot is again to be cut at the eye, below the one at which it was first pruned in July. In this way the vigour of the tree will be moderated, and several of the lower buds will probably enlarge, while the leading bud only expands into a growing shoot. If these hints be understood and acted upon, a young pruner will experimentally be taught to apply them, and thereby acquire the tact to discover the constitution of his trees individually, and to coax them into a condition of maturity. At the winter regulation when the buds begin to swell, it will be easy to discern the fruitful eyes; and where any of these are discerned, the shoot projecting beyond them must be entirely amputated; and this may be done with safety, for spurs, when once fully formed, rarely break into barren shoots, though one of the eyes may do so.

Wall-Training.

The circumstance of apple-trees producing fruit only on the outer parts, which are freely exposed to the sun and air, has led to numerous contrivances for exposing the inner as well as the outer stems. One method, as is well known, is the training of the tree in a flat shape against a wall—a plan also advantageous for enjoying the heat, which the wall radiates as a reflector against the branches. A difference of opinion exists as to the comparative merits of training the main stem in a serpentine or in a straight upright direction, and also whether the branches should be led perfectly horizontal or with an upward slope. If the height of wall permit, the upright stem and fan shape, as represented in fig. 3, seems the

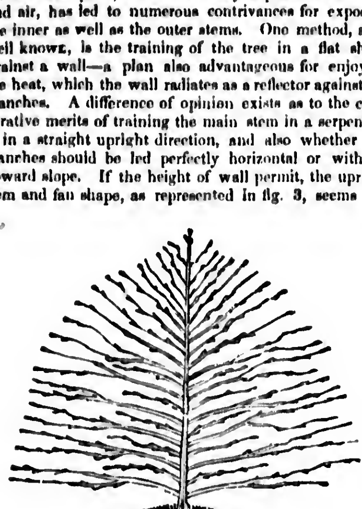


Fig 3.

most advantageous and certainly the least troublesome plan, and we would recommend unprofessional gardeners to attempt no other. Where the wall is low, the branches should proceed more horizontally; and the top being restrained by pruning, these lateral stems will gain greater vigour. In either case, the branches, great and small, will require to be held in their appointed situations on the wall by stripes of list and nails. The nailing should not be so tight as to prevent expansion in growth, or be otherwise injurious. Iron nails rust and disfigure the wall, therefore nails made of zinc are preferable. When a branch at any time becomes loose, it ought immediately to be refixed.

Espaliers.

These are rails generally formed of upright and cross-bars of wood, but sometimes made of cast-iron. The best are of wood ... d of from four to five feet in height. To these the trees are trained as on a wall, the chief difference being, that instead of being nailed, the branches are usually tied; the fastenings are soft hemp-cord or strips of bass, but twigs of willow answer much better. The situation of espaliers is generally along the sides of walks; and if the trees be carefully trained, they have a neat effect. Care must be taken that they do not prevent the sun and air from reaching the kitchen vegetables. When properly managed and well exposed, espalier-trees, observes Neill, "generally produce excellent fruit, the sun and air having access to both sides of the tree; they commonly afford abundant crops, and the fruit is not apt to be shaken by high winds. Farther, they tend to hide the crops of culinary vegetables from the eye, and to render the kitchen garden as pleasant as an avenue in the shrubbery."

The following hints on espalier training, by the author of the "Manse Garden," appear so eminently useful, that we take the liberty of giving them a place here. First, as to cultivation—"Have the ground well trenched and manured [taking a crop of vegetables the first season], and plant the trees three or four feet from the walk, and twice as near to one another as they should afterwards be when full-grown. The reasons for this close planting are, that the value of a few crops is more than the expense of the trees; your rails are sooner covered; and when the trees begin to meet and incommode one another, you can then, having ascertained their various qualities, give scope to the best, by diminishing or rooting out the less worthy. For one or two years after the meeting has taken place, you may delay the pain of execution by allowing the young shoots to pass one another on the opposite sides of the rails. To incur no more expense than is necessary, the stakes may be placed two feet apart, in which case the annual shoots will require to be conducted from one resting-place to another by pieces of lath or wild brier, or willow of two years' growth. These conductors require a firm and separate tying, distinct from that which fastens more loosely the living wood; they thus give strength to the rails, and provide for straighter training than is commonly done by having the stakes twice as thickly set, and consequently at double the expense of timber.

"Supplementary to both wall and espaliers is the following device, which has proved eminently successful:—Supposing that you have more garden ground than is necessary for the supply of vegetables, and that some part of it may be spared for a green shady walk amidst shrubs mingled with standard fruit-trees, on the south side of a row of evergreens, impervious to the eye, let a dry stone-wall be raised to the height of four or five feet, and coped with large stones, merely for strength and durability. Plant this on the north side with ivy, to assist the screen of shrubs, and in a short time not one stone will appear. From the south side take away all the good soil to a depth of two feet, a breadth of five feet, and a length equal to that of the wall, which may be sixty or a hundred feet, as you find convenient. This excavation, it is to be understood, runs close by the building, the foundation of which must, of course, have been secured by perhaps a foot of depth, and which will yet be uninjured, as the stones that cast up in removing the earth will immediately be thrown to the base in room of the materials taken away. Thus an effectual provision is made against the springing up of docks, nettles, or other troublesome weeds; the earth removed will be an invaluable treasure, whether for making compost or helping a thin soil, and the excavation itself will afford a most convenient receptacle for the immense quantities of stones which occur in trenching or raking the garden. Suppose the filling up in this manner to be nearly completed, let a row of large thin stones, set on edge, run along the southern boundary, and rise two or three inches above the surface of the ground. This will serve to keep the mass of stones distinct from the earth, that there may be no mingling in the process of digging. You have then on the one side of this excavation the low edging, and on the other a wall of four or five feet: and the design is, in the course of time, to fill up, with the riddlings of the garden or with clean stones, in whatever way, the whole space from the summit of the low edging to the top of the wall, to present an inclined plane facing the south, and nearly at right angles to the rays of the sun. On this [which is in reality a mound leaning against a wall] fruit-trees are to be trained. Before the bank is completed to its proper slope, the trees may be planted along the southern boundary, and trained for two or three years upon poles laid from the edging to the top of the wall, according to their future destination. When the surface of the sloping bank is raised within an inch or two of its proper height, let a layer of coarse sifted gravel be laid on the top

This will much improve the appearance, and increase the reflected heat, and being free from small sand and earthy particles, will give no birth to annual weeds.

"For the purpose of training, should peaches or apricots be planted, a close trellis will be requisite; but apples or pears will require nothing more than common espalier rails laid on the gravel, and held in their places by two slight spars running across, one at the top and the other at the bottom. In the mean time, the ivy produces a beautiful and beneficial effect, surmounting the wall, and adding to the closeness of shelter caused by the evergreen shrubs. It should be clipped along the top after the manner of box-edging. Nothing can exceed the real snugness of the trees so placed, or the beauty of their glowing blossoms spread out under the eye: and the quality of the fruit comes fully up to the theoretic advantages with which it is favoured. The heat is undoubtedly much greater than that of the best wall, and the open flowers find, in their humble height, a shelter, like the daisy of the field, from the sweeping blast which often scatters the petals of a higher tree like a shower of snow. Experience has fully proved the suitableness of this contrivance to all elevated situations. In some places very low and warm, the heat, so powerfully reflected, might possibly be too great; but in that case figs and nectarines might be so exposed, and would certainly take all that they can get."

THE PEAR.

The pear-tree, like that of the apple, is found in a wild state in all parts of Europe, and has been similarly domesticated and improved into many fine varieties. The tendency of the tree is to a handsome pyramidal form. It is much longer in attaining maturity than the apple-tree; and on a dry soil it will survive and continue fruitful for centuries. The tree may be propagated by seeds, layers, cuttings, budding, and grafting; it is more frequently raised from seeds than the apple, but grafting on its own species is also common, and is generally successful.

The observations already offered respecting soil for apple-trees apply equally to those of the pear kind, and nothing more need here be said either on that subject or on general culture. The pruning, however, is different, because the pear is a very independent growing tree, and, as a standard, will assume its own natural figure in opposition to all restraint. All branches which lash one another must be removed; but unless the pruner cut and deform his trees in his attempts to create fruitful spurs, there will seldom be a redundancy of wood. A little foreshortening or disbudding in the spring and summer may be useful; but, in general, as the pear can seldom become fruitful under seven or eight years from the grafting or budding, it will be prudent to watch the gradual development of the natural spurs, and to cut back the laterals to them, when formed, and not before. Mr. Knight pruned very little, shortening the main shoots occasionally, not sooner than July. He thus expressed his opinion in a letter to a professional gardener on the subject, in April, 1833:—"I would recommend the knife to be little used upon the young pear-trees, particularly upon the horizontal branches. As a general rule for pruning trees that are to be kept low in gardens, I recommend the upright shoots to be shortened about the beginning of July."

The finest pears are the Jargonelle, Marie Louise, Beurré de Capiaumont, Beurré Diel, Glout morceau, Easter beurré, and Beurré rance. The word *beurré*, which here occurs several times, is from the French word for butter: and that, as well as the other names, show how much we are indebted to our continental neighbours for perfecting this delicious fruit. In selecting pear-trees, the nature of the locality must be consulted, subject to which the jargonelle and others mentioned, also the Windsor, are general favourites. The summer, autumn, and winter bergamots are not excelled for rich muskiness of flavour. The pear requires a warmer climate than the apple, and hence some of the finer sorts, which grow well as standards in the south and central parts of England, will require a wall and shelter in northern or more keen situations.

ORCHARDS.

An orchard is a piece of ground specially devoted to the rearing of fruit trees, principally apple and pear, and is frequently an appendage of the English farm and manor house. It should be a well-fenced enclosure, and if there be room for a choice, its situation ought to be on the side of a dry knoll, sloping to the south-eastward; the best soil is a fresh sandy loam of eighteen inches in depth or upwards, reposing on a subsoil of dry gravel or rock. If the ground be wet, it must be thoroughly drained in the first place, as no fruit tree can answer its purpose if the soil be otherwise than dry. A damp clayey subsoil must be avoided; and the deep rich soil in the lowest dip of a valley is the worst situation to be chosen; for, though it may be sheltered against wind, it is most liable to keep the trees in a growing state too late in the autumn, and to be severely assailed by late frosts in the spring, when the trees are probably in flower.

Shelter is necessary to orchards against the autumnal south-west winds; but this is best obtained by high hedges or forest trees planted on that side. Winds from any other quarter need not be so much dreaded. Sheltering hills at some distance are an advantage, so as the orchard is not in the lowest dell at their base. Many orchards are almost barren, the trees covered with moss and lichen (a fine harbour for insects), only from their being too much sheltered, and deprived of a free current of drying air.

As an orchard is usually a pasture for sheep, cows, or other cattle, the trees to be planted in it must be standards; that is, trees trained in the nursery, with a clear stem six or seven feet high, from the top of which the branches diverge, and out of the reach of cattle. Sometimes the stocks are first planted, and when fairly established, are *worked*, that is, grafted or budded at the desired height.

If an orchard is to be formed out of an arable field, the ground may be prepared by the plough, laid into bands or ridges of eight yards wide, the trees to occupy the middle or crown of each ridge, these lying south and north. The trees should be planted in right lines, five, six, or eight yards asunder; and the whole area surrounded by a deep ditch and hawthorn hedge.

When the trees are planted (which should [illegible] the end of October), the ground may be laid [illegible] a crop of barley or oats, and grass seeds in the spr[illegible], and so remain.

If an orchard is to be formed in a grass field, it is drained, if necessary, and closed with a hedge and ditch as above; the trees are either planted in trenched pits or in trenched borders; that is, borders six feet wide are traced south and north, and regularly trenched fifteen inches deep, the turf being turned to the bottom. Along the middle of these borders the trees are put in at the distances already mentioned. This done, the broken ground is sown down with grass seeds, and the trees staked down and protected against cattle if they are in any danger. The pits, six feet square, are trenched and planted in like manner.

In planting the trees, the ordinary care must be bestowed as well in taking them up as replanting, each should be set on a little mound of the finest of the soil, on which the roots should be regularly spread, and kept near the surface—for deep planting must be carefully avoided; the uppermost fringe of roots should just be within the turf, but no deeper; and they should be encouraged to take a horizontal rather than a downright direction.

Orchards planted in either of these methods, if carefully performed, answer very well, if good care is taken of the trees till they are fairly established and can protect themselves.

The fruits chosen for such orchards are apples, pears, plums, and cherries, and of these, such as are known to thrive, and are most fruitful in the neighbourhood of the intended orchard; for all fruits are not equally thrifty in the same locality, and this is a point deserving the consideration of the planter.

Such orchards are planted chiefly with a view to the service of a family, any redundance being sent to market, or sold on the trees to the fruitmonger; but when fruit trees are planted as a special source of profit, a very different plan is followed. An acre or two of suitable land, with a proper exposure, is fixed on; the whole is trenched fifteen inches deep, and thoroughly drained, if necessary. The surface is levelled and laid into beds ranging south and north, and about twelve feet wide; along the middle of these trees are planted; and the intervals are occupied by two rows of small fruits, either gooseberries, currants, or raspberries. Some of the intervals may have a rank of filberts introduced, which, when kept as low bushes, and properly spurred on, are as profitable as any other kind of orchard fruit.

Such an orchard is intended to be a perfect thicket of fruit trees: all, whether yielding large or small fruit, must be kept as dwarfs, and trained in the *bush form*. Of course the sorts which are naturally of a dwarfish habit are preferred, and if not dwarfish by nature, they must be made so by art. The bush form is obtained by encouraging the lateral growth of the branches, and depressing by some means or other those which have a tendency to grow upright. A sufficient number of branches is gained by pruning while the trees are young, and so disposed that they may aggregately form a rotund, compact, but not over-crowded head, shading a circle twelve or fourteen feet in diameter, more or less, according to the fruitfulness or individual strength of the trees. This close planting and low stature of the trees render them a shelter to each other, both against the frosty winds at the time of flowering, and against the equinoctial gales of autumn.

The surface of this orchard is never dug. In dry summers, a mulching of half-decayed littery-dung is spread under the trees, and hoed in in the winter. Strawberries are introduced when the trees are young, but the ground must not be exhausted by surface-cropping.

The success of such a fruit garden depends very much on a proper selection of the kinds, and on the skill of the manager in keeping the trees fruitful and dwarfish, without the application of the knife; for this is quite practicable, and is an art which must be had recourse to in the treatment of dwarfed trees.

Cider.

In Herefordshire, Devonshire, and adjoining districts in England, orchards are maintained principally for manufacturing a beverage from their produce. *Cider* is the liquor made from apples; the trees in most estimation for the purpose being the New Foxwhelp, the Wilding, the Cherry Pearmain, and the Yellow and Red Norman. After the ripened apples are shaken from the trees, they are allowed to remain in heaps for a month on the ground, to become mellow. The process of manufacture into cider, which then commences, is described in the following succinct manner in the "Penny Cyclopædia:"—

"Cider is manufactured with very rude machinery by the following process:—The apples are thrown into a circular stone trough, usually about eighteen feet in diameter, called the *chase*, round which the *runner* a heavy circular stone, is turned by one or sometimes two horses. When the fruit has been ground until the rind and the core are so completely reduced that a handful of 'must,' when squeezed, will all pass without lumps between the fingers, and the maker sees, from the white spots that are in it, that the pips have been broken, a square horse-hair cloth is spread under a screw-press, and some of the must is poured with pails upon the hair, the edges and corners of which are folded inwards, so as to prevent its escape. Ten or twelve of these hairs are piled and filled one upon the other, and then surmounted with a frame of thick boards.* Upon this the screw is slowly worked down by a lever and with the pressure a thick brown juice exudes from the hairs, leaving within them only a dry residue, which, in years when apples are scarce, is sometimes mixed with water, ground again, and the liquor pressed out as before. This latter product is called 'water cider,' a thin, unpalatable liquor, which is given to the labourers early in the year.

The cider is received by a channel in the frame of the press upon which the hairs stand, emptying into a flat tub called a 'trin.' From the trin it is poured with buckets or 'racking cans' into casks, placed either out of doors, or in sheds where there is a free current of air. In about three or four days, more or less, according to the heat of the weather, the liquor usually will ferment; the thick heavier parts will subside as a sediment to the bottom of the cask, and the lighter become bright clear cider. This should then be 'racked' or drawn off into another cask, and the sediment be put to strain through linen bags, and what oozes from them should be restored.

It is during the fermentation that the management of cider is least understood, and there is the greatest hazard of injury. It is necessary also to know what fruit will by itself make good cider, which kinds should be ground together, and what proportions should be mixed. But it is in the preservation of strength and flavour after the cider is ground that the principal difficulty consists: *slight* fermentation will leave the liquor thick and unpalatable; *rapid* fermentation will impair both its strength and durability; *excessive* fermentation will make it sour, harsh, and thin. Other things being equal, that cider will probably prove the best in which the vinous fermentation has proceeded slowly, and has not been confounded with the acetous. The remedies used in cases of cider not clearing are either yeast or the addition of cider in a state of fermentation, isinglass, eggs, or a quart of fresh blood stirred up with the liquor, in which last case it is to be racked on the following day. These do not always prove effectual, but the common evils are excess or rapidity of fermentation; and if a better quality than farm-house or 'family drink' is sought, cider requires so much care to prevent its being spoiled, that the best and most careful makers frequently have it looked at during each night for some weeks after it is made; and if the bubbling hissing noise, the sign of fermentation, becomes frequent or too loud, the liquor is *immediately* racked off into another cask; this check often requires to be repeated several times; but although, at each racking, some portion of the strength will be lost, the body, flavour, and sweetness, will chiefly be retained. It is not the habit of the farmer to add sugar, treacle, brandy, or any colouring matter, to the liquor; it is only adulterated in the hands of cider dealers and publicans, who will not lose a hogshead; and if one has turned sour, or has been otherwise damaged, it must be 'doctored' in order to render it marketable.

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* This is the process in the Hereford district. In Devonshire, a lever press is used, and "reed," unthrushed straw, is spread in layers in the place of hairs. The method used in the south of France for expressing oil from olives is identically the same

At the beginning of January, the cider is moved into cellars, where, by large growers, it is frequently stored in casks of great capacity, containing 1000, 1500, or even 2000 gallons; these are cheaper in proportion than smaller vessels, and are thought to preserve the cider better. In March, the liquor is bunged down; it is then fit for sale, and may be used soon afterwards, though it will greatly improve by keeping. If bottled cider is required, it should be bottled and wired in the September or October after it is made; some persons prefer an earlier time, the end of April or beginning of May; a greater degree of effervescence is thus attained, but a considerable loss accrues from the number of bottles that will burst."

Good cider is a remarkably wholesome beverage, and may be had at a very small price, the best not being above 1s. 6d. per gallon. *Perry*, or the liquor of pears, is also a pleasant and wholesome beverage, and in some instances almost approaches the quality of sparkling champagne.

STONE FRUIT TREES.

The finest wall fruits of the garden are included in this division; these are, the peach and nectarine, the plum, the cherry, and all their numerous varieties. Under these well-known names, we shall take a cursory view of each, referring the reader for minute particulars to the catalogue in Lindley's "Guide to the Orchard and Kitchen Garden," and to that of the "Fruit Cultivator," a small work of great merit, by the late Mr. Rogers of the Southampton Nursery.

Besides the familiar term, stone fruits, botanists refer all the trees which bear fruit with a kernel contained within a hard, bony shell, surrounded by a rich and saccharine pulp; this, consequently, would embrace that division which has the almond tree for its type. The peach and nectarine were till lately considered a species of the almond, but they have been separated from that family, and the peach, with its variety, the nectarine, constituted a distinct genus.

Peach and Nectarine.

Both are natives of Persia, introduced from that country in the year 1562, and extensively cultivated since that period. Each admits of two leading sub-varieties—the Melting Peaches and Nectarines, or *free stones*, and those with more solid flesh adhering to the nut, and therefore termed *cling stones*. The French consider them as one fruit, but arrange them under four divisions; but we prefer to simplify our description as above, and shall even dismiss the cling stones altogether from our catalogue, deeming them comparatively worthless, being later in their season, and of a flavour altogether inferior to the true melters.

The peach and nectarine can be raised by sowing the stones, and many excellent varieties have been so obtained; therefore it is not a fact that the trees raised from seed are wildings: but as there is no certainty of what a seedling may ultimately become, it is not prudent to trust to this mode of propagation; and though we would urge every practical gardener to make himself intimate with the process of budding—that approved and certain method to perpetuate approved varieties—yet as much time must thus elapse before a wall be stocked with fruitful trees, we think it advisable that he purchase of a good and trusty nurseryman such varieties as are found to be adapted to the locality. The peach and nectarine are seldom grafted; it is usual to select buds of trees that are approved bearers and of fertile habits, and to insert them into young vigorous stocks of the muscle plum or seedling peach. Nurserymen raise their trees in this way, preferring the plum stock; the operation is performed late in July or early in August. The buds swell, but remain torpid till the spring of the following year, at which time the head of each budded tree is cut back to an inch above the inserted bud, which then expands, and forms one or more shoots. Trees in this condition are called maidens, and many prefer such: but in general the nurseryman prunes and trains them into form during the two succeeding years, when they are sold as trained trees, at a price varying from 4s. 6d. to 7s. each. The mode of training thus commenced is usually that which is called the *fan* or *peacock's tail*. It is formed upon the principle of rejecting a central stem, and of leading all the main branches and their secondaries to assume the figure of an expanded fan. It is to obtain such trees that we recommend the planter to purchase the *trained* plants of the nursery garden. But there is another very excellent method of forming a tree, called the *Seymour training*, from the name of the gardener who introduced it. This plan requires a central stem, from which all the main shoots are trained at angles, varying according to the height of the wall and the vigour of the trees. The branches are led to the right and left alternately, at as nearly equal distances (about nine inches) as possible, and when a tree grows kindly, and the pruner is a man of dexterity and foresight, a handsome well-balanced tree is the result. To obtain these Seymour trained trees, the planter must purchase maidens, and either train them himself or employ an adroit pruner who is willing to attend to the required directions. We shall now state the principles upon which all judicious pruning is founded.

The peach produces its fruit upon the spring wood of the previous year; occasionally, also, if the habit of the tree be very vigorous, upon secondary shoots from that wood; but this is by no means desirable under ordinary circumstances, because it proves that the tree is too luxuriant in young wood, which, being developed after mid-summer, can scarcely become duly mature. A tree cannot be expected to produce or support a crop of fruit in a period short of four or five years from the budding; but during that period, the art of the gardener should be employed to lay in six or more regular branches to the right and left, which will form the skeleton or figure of the tree, and remain the permanent supporters of the young-bearing wood. In the fan method of training, secondary fruitful shoots are permitted to form at the under as well as the upper sides of these main branches; but in the Seymour training, the fertile secondaries are led off from the upper sides only; all those which break from the front (called *fore-rights* and *breast-wood*), or from the back next the wall, or from the under side, are obliterated as they appear, either by pinching them off with the finger and thumb, or by amputation with a sharp knife; this process is termed *disbudding*. The quantity of wood to be retained, year after year, so as to obtain a regularly increasing proportion of fruit, without crowding the tree with redundant wood, is chiefly produced by the judicious use of the knife in disbuddings. We will suppose the example of a tree trained in the nursery during two years, then planted in October against a wall fronting the south or south-east, and cut back in February following, so as to leave all its branches about six inches long. The shoots of the first spring form the bases of the permanent branches, and are to be nailed, as they advance, in the most regular order, leaving them at their full length till February of the second year, when the strength and condition of the tree are to be consulted. As a first rule, we are taught, and experience sanctions the rule, "that every shoot is to be shortened in proportion to its strength, by pruning to the point where the wood is firm and well ripened, by which all the pithy wood is removed, causing a supply of that which is better ripened for the ensuing year." But, in order to facilitate the ripening of the wood, it must be trained thin, retaining those shoots only that may be required for the ensuing year. After two years' growth in a good soil, we may reasonably expect that six or eight permanent shoots, a yard or four feet in length, will be formed and trained in, on each hand, and that all these branches are furnished with three or more secondaries laid in at nearly equal distances from one another, and which, by the end of June, may be a foot or more in length. The tree will continue to grow till the end of August; but disbudding must be effected repeatedly, so as to leave it pretty nearly in the form and condition just described.

It has then become a bearing tree, which condition implies a series of strong woody branches of two, three, or more years old, that have produced other shoots in the spring, which, when ripe, are of a deep reddish-brown tint on the sunny side. These latter are the fruitful shoots, and they never bear twice; but, if neglected, run on to an uncertain length, sending forth other weak laterals, which might indeed bear a little fruit, but such as could never compensate for the ruin, or at least, disfiguration, of the tree. It is a maxim among good pruners, that a peach tree should be *green* throughout or all over; that is, every space, even close to the main stem, has one or more leafy and fertile shoots. This maxim would be violated in two seasons were all the shoots permitted to extend themselves, and the tree would be found bare; every part of the centre becoming verdant and productive only at the remote extremities; hundreds of fine peaches and nectarines can be found in this condition; and, in fact, the greater proportion of those in private gardens afford irrefragible evidence of neglect or want of knowledge.

The bearing-shoots, therefore, must be shortened to twelve or fourteen inches, if strong, and the weaker to eight or ten inches, or even to half that length, if very slender. The pruner should cut sloping from behind and a little above a *treble* eye—that is, an eye with a shoot-bud between two blossoms, if there be such; for a branch or shoot not in a mature or bearing state has no treble eyes; but in furnishing a tree, it is not needful to cut away the wood-shoots as useless; because, by pruning back to an eye seated rather low on the shoot, two good fertile shoots may be provided in lieu of a barren one. A single sharp-pointed eye is the origin of a wood-shoot; the blossom-bud is more round; but by deferring the winter regulation till late in February, the condition of the two will be no longer doubtful.

When it has once been so pruned, the leading branch will break its extreme bud, which will thus elongate that branch; and the fruitful laterals will also develope several minor shoots. It is from the last that a selection must be made to effect two objects of the greatest importance. The first is, to attract the sap along the entire shoot, in order to nourish the young fruit upon it; and this will require that the shoot at the extreme point, or at least one beyond the uppermost fruit, be permitted to extend itself, and be nailed securely to the wall, when it shall have acquired some strength and toughness. The second object is to provide a shoot to succeed the one now bearing fruit; and in doing this, the lowest should be selected, because it will, by its situation, replace the present shoot in a manner most conformable with the gardener's maxim before adduced, and tend to keep the tree compact and fertile—*close home*. A third shoot ought also to be retained, to guard against emergency or accident; all the others should be removed, by disbudding, early in May. In July, also, a general regulation must take place; when, by removing useless shoots, and nailing those retained, the fruit will be duly exposed to the sun's rays. Thus the growth of shoots and fruit proceeds; and if regularity and order be maintained, the tree will, year after year, elongate, and add branch to branch, retaining complete verdure throughout. A few lines from "The Guide," by G. Lindley, will suffice to complete our concise directions:—"Should young shoots, indicating extraordinary vigour, anywhere make their appearance, they should be immediately cut out, unless where a vacant part of the wall can be filled up; because an excess of vigour in one part of the tree cannot be supported without detriment to the other. Peach trees, when in a state of health and vigour, generally throw out laterals from their stronger shoots" (he means *secondary* laterals, before alluded to); "when this is the case, they should not be cut off close, but shortened to the last eye nearest the branch" (this is, in fact to spur them, in the hope to convert the lowest bud into a fruitful one); "and if there is room, one or two of those first produced may be nailed to the wall; or the middle shoot may be cut out, leaving the two lowest laterals, and allowing them to take its place, thus frequently obtaining two fruit-bearing branches, when the former one would in all probability have been wholly unproductive.

"In the thinning of peaches and nectarines, and indeed any other drupaceous fruit, it is necessary to proceed with caution, as they are apt to fall off after having attained a considerable size. In order, therefore, to secure a crop, it will be the best way to thin them at three separate times; the first, as soon as the fruit is of the size of a hazel-nut; the second, when of the size of a small walnut; and the third, as soon as the stone has become hardened; after this, it rarely happens that either peach or nectarine falls off before it is matured."

These directions apply in every part to the order of training by the Seymour method; for all the bearing wood of one year must be replaced, if possible, by young shoots proceeding from the base of that wood; this fact, if appreciated, will of itself render any adroit man an able trainer and pruner of the peach tree.

Peach trees are but too liable to be molested by insects and mildew; the former are usually some species of the aphis, commonly called *green fly*, though, as in 1840, it was *black*. Some trees doubtless escaped; but those which were attacked suffered to an extraordinary degree, insomuch that the crop dwindled and the growth of the trees was checked—three distinct broods having succeeded each other between the middle of April and July. They obstinately resisted every kind of wash, though in general tobacco water is effectual. Scotch snuff and fumigation failed; and at last premature close-shortening was resorted to, and thus the new wood was seriously injured. We allude to this fact, as being in strict accordance with the concomitant visitation of the black aphis that locally destroyed the bean crop, and deformed kidney-beans, peas, and even the nettles and other weeds of the fields and lanes. A disease produced by frost, which is called "the bladder blight," frequently swells and distorts the leaves of peach trees; we are acquainted with no other remedy but that of timely hand-picking. By these attacks the regular training and figure of the trees are much disturbed; and at times an entire season may be irretrievably lost.

With respect to soil and preparation of a border, what we have said under the head *apple* applies strictly to the peach. As wall-peaches must have a border, we can devise no plan more effectual or simple than that of clearing out a space of the required length, of eight to twelve feet in breadth, the depth of soil at the wall to be twenty inches, sloping to fifteen inches—making a fall of five inches from back to front. To effect ample drainage, the bottom should be paved, as before recommended, with chalk or fragments of stone, &c., rammed hard, and inclining to a rubble or stone drain running parallel with the wall, to carry away the superfluous water from the bed. A natural substratum of chalk or rock would suffice, but in that case depth of soil must be provided. The bed itself should consist of the rich but not clayey loam and turf, of a common or pasture, having in it no manure whatever. The trees may, indeed, be top-dressed every winter with littery manure a yard or more round the boles, and so deep as to protect them from frost, just above the collar at the critical periods of blossoming. It will also be a great preventative of drought in summer; and of this any one may satisfy himself by raising the mulch in the very driest weather, when the soil under it will be seen black and moist, though in other parts it be parched to aridity. The fruit can be one month accelerated, and its value proportionably enhanced, by growing a tree in a pit 24 feet long, 60 inches deep at the back wall, and 30 inches at the front. The lights will thus obtain a sufficient slope, if their length be seven feet. Hundreds of fine fruit can be produced in July or August by one tree; but great watchfulness will be required about the period of blooming, to check the ravages of the aphides in their earliest approaches; by three days' neglect, we have seen the destruction of a crop and the ruin of all the bearing wood of the year, in despite of every usual application. A strong lining, twice renewed between February and June, will greatly accelerate the advance of the fruit.

Selection of a few of the finest melting peaches adapted chiefly to the midland counties.

1. *Bellegarde or Galande.	4. *Noblesse.
2. *Chancellor	5. Royal George.
3. Late Admirable.	6. Rosanna, or Yellow Alberge.

Nectarines.

1. *Elruge, or Claremont.	3. *Violet Hatios (the best.)
2. Fairchild's Early White.	

The trees marked thus (*) are stated by Lindley to be also suitable to the Highlands of Scotland.

The Apricot.

It is believed, upon the authority of Pliny and others, that the apricot is a native of Armenia, whence its present Latin name, *Armeniaca vulgaris*. It partakes of the habits of a plum and peach, and till lately was considered a plum—*Prunus Armeniaca*. It is multiplied by budding, either upon the common plum or the muscle plum. Lindley says that it is usual to bud the *Moor-park* upon the former; but he is persuaded that the tree would be better, and endure longer, were it budded upon the muscle: and if he be correct in this, we may safely assert, that all the best apricots will succeed upon that stock without having recourse to any other.

The operation of budding, like that of grafting, may be most readily acquired by observing the practice of a good budder. The season of budding is comprised between the third week of July and the 16th of August, and showery weather is propitious. The buds should be selected from shoots of the spring wood; and in taking them off, a piece of bark one inch and a half long should be retained, from which the strip of wood it contains ought to detach itself freely, without bringing with it the eye of the bud. This eye or point is a vital organ, without which a bud cannot grow. This remark applies to every kind of bud, whether it be that of the apple, pear, peach, or any of their kindred: or of any ornamental tree or shrub which admits of being thus propagated.

The best varieties of apricot are—1. The Peach apricot, fruit high-coloured, and very large. 2. Moor-park, of high flavour, and also pretty large. 3. Brussels—oval, and capable of ripening on an open standard. 4. The Roman, hardy, and an abundant bearer.

As to pruning and training, when the figure of the tree is formed by having three or four branches proceeding from a main stem, each is shortened in the winter regulation, soon after the leaves fall, to six inches, in order to obtain new branches. These are secured to the wall in May or June at five or six inches' distance from one another, removing all supernumeraries. At the second winter pruning, the leading shoots may be cut back to ten inches, the others growing upon them to six inches, more or less as position and strength indicate. In May or June following, more wood is laid in from each branch; and thus, by disbudding and winter-shortening, a regularly formed head is obtained, upon the shoots of which short fruitful spurs are duly and progressively developed. In all winter prunings and curtailments, the longest shoot that is retained ought not to exceed eighteen inches in length; thence diminishing, according to the strength of each, to nine, or even six inches.

These rules comprehend the essence of all the best practical directions; but one remark, which we seldom meet with, appears important. The apricot tree comes early into bloom, when very few leaves, if any, are expanded; and it frequently fails to set or retain its fruit. This failure we have remarked particularly with low trees horizontally trained. On the contrary, when the tree having a six-feet main stem without a branch is then trained with a central leader to the height of from twenty to forty feet, and suffered to branch obliquely to right and left, the crop of fruit is frequently very great. We also saw, at the end of March, after the severe frost of 1838, one solitary branch of a tree which had been trained upon the breast of a vinery chimney, with fruit larger than nutmegs, and foliage fully expanded, while every other branch remained torpid as any of the exposed trees of the garden. These facts prove that the high wall of a dwelling, and the proximity of a warm chimney, are most favourable to the productiveness of this very fickle tree.

The Plum.

The common plum of Britain is the type of this genus, *Prunus;* but we cannot believe that this wilding is the parent-stock of those rich and luscious fruits which have been so long cultivated throughout Europe. Plums are propagated by budding upon the common plum stock; and for standards, Lindley recommends the insertion to be made nine inches from the ground, when, under favourable circumstances, the buds will produce vigorous shoots, standard high the first year. Open standards require little attention; they should be divested of all the superfluous shoots by pruning them out close to their origin, just before the season of spring growth. But wall trees and espaliers are to be treated as espalier pear trees; that is, by training them with a central stem, and a series of horizontal branches proceeding from it on each side, nine inches apart. These branches are not to be shortened; and the spurs which form naturally upon them are to be kept short and compact as they advance in length. Artificial spurs may be obtained by July foreshortening; but as fertility is promoted by whatever checks the luxuriance of the wood, it will, we think, be preferable to train in the supernumerary laterals, depressing them below the horizontal level till some natural spurs are formed near their origin, and then to cut the shoots back to the lowest spur.

The plum ripens in September and October. Of the earlier dessert plums, the Green gage and the two Orleans are the best. Coe's Golden drop, and the Goliath, come into season in October; and for preserving, we name the Winesour, the Violette hative, the two varieties of Magnum bonum, and the prune Damson. The Imperatrice is the best late plum, being delicious in November. The soil already mentioned is favourable to the plum, though the tree will prosper in one of more binding quality.

The Cherry.

The cherry-tree, or *Cerasus*, as it was called by the Romans, has been known as a cultivated tree for at least three centuries; orchards, the produce of which was sold at a high price in the year 1540, existing to a large extent in Kent. This circumstance conferred the name of Kentish cherry on that peculiar species. Lindley enumerates and describes twenty-eight, and Rogers twenty-five different kinds of cherries; among which the best for general cultivation are the Kentish, the May-duke, the Graffien or Bigarreau, Harrison's heart the Black heart, and Morella. All may be grown as standards, but the May duke and Morella produce larger fruit when trained against a wall.

Standard trees form their own spurs, and require only a little thinning out of superfluous branches; but wall trees must be treated as the apricot and plum, avoiding, however, to shorten the leading branches. The Morella requires a somewhat different treatment, because it not only bears on spurs, but, like the peach, on young wood of the last spring. Mr. Rogers offers some remarks in the form of anecdote, which are deserving of attention:—In the Surrendon Gardens, of which he had the charge, "a north wall ten feet high had a border twelve feet wide, and very shallow, reposing on loose rubble rock. The soil was a dark hazelly loam, of rather inferior quality: the roots were very near the surface, those nearest the stem actually above it. Five trees were originally planted, but subsequently the second and fourth were removed, leaving the centre tree at thirty-two feet from the end ones. Even at this distance the branches met; and in their progress, being kept very thin of bearing wood, the crops were magnificent." The trees were simply planted on the natural surface of unprepared ground without any manure or deep trenching. "Neither was this border ever dug with spades, but slightly stirred with blunt forks, and having a little well-rotted horse-dung bestowed every second or third year. There cannot be a more mistaken notion and injurious practice, than overloading and poisoning the fruit-borders with rich dung. In the early training of the Morella, the knife should be used freely, to gain a sufficient number of leading branches—thinning out the laterals, but never shortening them."

The cherry-tree grows to a large size, and its wood is highly valued by turners and musical instrument-makers, from its suitableness for being bored and formed into smooth tubes; in the luxurious East, it is much used for the tubes of tobacco-pipes. The fruit of the cherry seems less impaired by growing in a wild state than other garden fruits; in Scotland, the wild cherries, called *geans*, are small but fine flavoured; and in Germany, the favourite liquor *Kerschwasser*, is distilled from the juice of this species of fruit.

BERRY-BEARING TREES AND SHRUBS.

In this division will be comprised the Currant and Gooseberry, both members, with all their now innumerable varieties, of the same family or genus, *Ribes*—the Raspberry, Strawberry, Cranberry, and Grape-vine.

The Currant.

The currant is a native of Britain; nevertheless we are indebted to the Dutch for the great perfection to which it has now arrived. The Dutch red and white currant are unquestionably the best produce of the garden; the Naples black is preferred. Currant-trees prosper only in cool climates, and they are somewhat arbitrary in their choice of a situation even in our own moist country; they grow to an astonishing perfection in the rich moist vales of the middle counties, but the berries dwindle in hot and arid situations. A loam such as has been so frequently mentioned, will also suit the currant, but it likes manure; and this can be advantageously and freely applied as a top-dressing in November, to remain on the surface till after the pruning in February, when it should be lightly forked into the soil without disturbing the roots.

Mr. Knight raised three or four hundred trees from seeds in the course of his scientific experiments upon crossings, but of these very few excelled their parents. One of them, the Red crystal, is superior in all respects. We have also raised currants from seeds, and have acquired one fine white variety, but have thus been instructed that seven or more years elapse ere the plants become fruitful, and therefore that propagation by cuttings is greatly preferable. Take cuttings of the young spring wood, with a small heel of the older wood attached to it; divest it of all the buds excepting five of the uppermost and those of the heel; dibble holes six inches deep in a shady bed or border, and fix a cutting firmly in each hole, by pressure and watering. They succeed perfectly if planted in August, provided they be kept moist and entirely shaded, or in a north aspect; but the season extends thence to the beginning of March. The soil should be rich and light. Cuttings may be placed at first where they are intended to remain, or they may be transplanted after they become rooted plants, cutting away all but the upper whorl of roots: in either case, cut back to two or three buds the shoots made the first spring, and subsequently prune on every side at an outside bud, to make the bush spread at top, and render it open towards the centre.

Prune for fruit just after the buds begin to swell—never before February, or the birds will reduce the expected crop; and in pruning, shorten all the leaders and spur in the laterals, till the bushes appear like deformed masses of scrubby twigs. The long pruning is comparatively worthless.

By these spurrings and shortenings, the trees progress somewhat slowly, but the fruit is produced in massive clusters from the numerous spurs. The skeleton of each bush ought to consist of nine, twelve, or fifteen bearing branches, diverging at equal distances from three lower short limbs, which emerge from one main central stem; this is the best form of a neat bush, and the knife should be exercised to keep it open in the middle. If the spring shoots push very vigorously, the first high wind generally breaks down more than half of them; but this natural pruning is frequently advantageous. The black currant requires a still more moist and cool site, and that the wood be kept young, but never pruned or spurred. Whatever shoots become black and scaly must be cut entirely out, leaving those bearing branches only which are of a delicate brown colour. The trees require frequent renewal, by taking vigorous cuttings, for old wood produces small berries. If the soil and site be congenial, and the trees be young, the berries are frequently seen nearly as large as small black cherries.

The Gooseberry.

This universally known shrub is a native of Britain, and therefore much more easily cultivated than exotics; it is, indeed, so hardy, and suitable for even keen climates, that remarkably little fostering is required to keep it in perfection. After a long course of culture, there are now hundreds of varieties of gooseberries; still, the kinds which keep their place in public estimation are few in number: these are the old rough red, dark purple, green, and yellow gooseberries; they are still pre-eminent in flavour, but as the genuine culture of all is the same in principle, a few simple rules will instruct the grower in all that he need perform to obtain healthy and productive bushes.

To propagate, take cuttings of any chosen sorts eight inches long, of the last spring's wood, having a small piece or heel of the older wood; they are inserted about the end of October to the depth of three inches. The situation should be shady, the earth rather sandy, and each cutting should be fixed firmly in the soil. It is customary to remove all the buds excepting four or five at the top, which are left to form the head, produced from one central stem: but we prefer to secure the rooting of the cutting by retaining the lowest, and planting it four or five buds deep. It is from these buds that we expect roots; and though none may be developed till spring, nature will not be idle and whenever the eyes break, and shoots elongate, it will be time enough to select the strongest and best as a leader to form a stem, obliterating all the others both below and above the surface. Should three or four eyes break at the upper part of a cutting, it will be desirable to remove all others lower on the stem, as soon as it shall be manifest, from the vigour of growth, that there are good and sufficient roots to support them. A central stem is most desirable, and people think to obtain one, and to prevent the growth of suckers, by destroying the lower buds in the first instance: we believe that the want of success and the loss of the cutting are to be traced to this practice, and therefore we disclaim it. When the head is formed, gooseberry-trees can be spurred as directed for currants, avoiding to shorten the leading branches; or at each pruning in February, a certain quantity of the last year's wood should be retained, and a corresponding portion of the two and three years' old wood cut out; thus, as it were, renewing the trees annually. Larger berries are thus obtained from strong young wood than by the spurring system.

The Raspberry.

The raspberry is a native of some counties in England, but has been greatly improved by culture. The choice sorts are—1. Red Antwerp, fruit large, of high flavour, ripe in July; but by being planted behind a north wall, can be retarded, and the season thus protracted some weeks. 2. Yellow Antwerp, light coloured, very bristly wood, of luxuriant growth; fruit admirable in flavour, luscious; peculiarly adapted to the dessert. 3. New Double-bearing; it is rather an autumnal raspberry than strictly a double bearer; still, by due and timely pruning, a second crop is frequently obtained in autumn. The raspberry is propagated by suckers taken up from among those which rise in abundance from strong plants. The fruitful shoots bear but once, and should always be cut down in August to admit air and light to the young shoots of the summer; and from these suckers (of which four or five are amply sufficient) some should be selected to renew the stock every five or six years, changing the soil and situation. Care should also be taken to remove the disorderly suckers which rise from the wandering roots. The soil for this plant should be a rich light loam. The plants, if placed in row, should stand a yard or four feet asunder. They may be supported by strong stakes made to slope to the north; and, confining the bearing shoots to them, the successional shoots will rise perpendicularly, without interfering with the others.

The Strawberry.

The strawberry is one of the few fruits indigenous to Britain, and is found, like the bilberry and juniper, in a wild state in uncultivated spots, chiefly in woods and on tangled shrubby banks. It is likewise found in all the other northern countries of Europe, particularly in Norway, among whose rocky mountains it grows in great abundance; it prevails also in the temperate regions of South America, and abounds in the colder climate of Canada and Nova Scotia. This delicious small fruit is, in short, very generally scattered over the earth, and was the delight of ancient as well as modern times. In Latin its name is *fragaria*, which is supposed to be significant of the fragrance of the fruit; the French, perhaps from this source, call it *fraise*, and hence the common surname of *Fraser*, which is of French origin, and the well-known heraldic object, the strawberry, which is borne by families of that name. The origin of our name *strawberry* is much less obvious; by some, it has been traced to an old practice of placing straw beneath the berries to keep them clean while growing; but others allege that it originated in the circumstance of the berries being anciently threaded on straws, and offered for sale in that condition. The strawberry is one of those plants to which nature has given the means of extensive multiplication. From the main bush or stems there spread forth tentacula or suckers over the surface of the ground, and these fastening themselves by a root at every joint, as many new plants spring up as there are joints. A single bush will in this manner, if, not kept within bounds, soon spread over a moderately sized garden. From this abundant growth of the strawberry, it has been inferred that the fruit is of essential importance as an article of food in summer; but this is scarcely philosophical; for to what plant has nature given the means of propagation more abundantly than the dandelion, and what is so little used or held in less esteem by mankind? Be this as it may, the strawberry is universally acknowledged to be exceedingly wholesome and refreshing as an occasional summer diet, and it is also allowed to possess certain medicinal properties, which give it a still higher value. With respect to these medicinal qualities, Phillips speaks of it as follows:—"As a dietetic fruit, the strawberry affords but little nourishment: the moderate or even plentiful use of it is salubrious, and recommended to those of inflammatory habits. Boerhaave considers the continued use of this fruit as one of the principal remedies in cases of obstruction and viscidity, and in putrid disorders. Hoffman furnishes instances of some obstinate diseases being cured by strawberries and other mild, sweet, subacid fruits, and affirms that he has known even consumptive people cured by them. Linnæus informs us that, by eating plentifully of strawberries every day, he kept himself free from gout. They promote perspiration, and dissolve the tartarous incrustations on the teeth. Strawberries should be taken sparingly by those of a cold inactive disposition where the vessels are lax, and circulation languid, or digestion weak." The medicinal qualities of the strawberry appear to us to consist somewhat in the abundance of small hard seeds on the fruit, which act mechanically on the stomach and bowels, and also in the weakness of the sub-acid; in other words, the pulpy substance is of a simple and harmless nature, remarkably easy of digestion, and at the very least cooling in its effects. Taken in moderation, it will save the use of some kinds of medicines, and, as an alterative from hard food, it cannot be too highly commended.

In most parts of England, strawberries are eaten alone, or dipped individually in sugar, before being put into the mouth; and to suit this mode of consumption, they are brought to table with their stems, which form shanks to hold by. But in Scotland they are consumed in a far more wholesale manner. There they are brought to table stripped of their stems, and are ladled out and eaten with a plenteous infusion of cream and sugar. "Strawberries and cream" is, in fact, one of the grand national treats which strangers may reckon upon seeing set before them in the early weeks of July, and to which generally full justice is done. In the neighbourhood of Edinburgh, there are a number of suburban villages deriving celebrity from their extensive strawberry grounds, and to these parties proceed from town to enjoy the fruit in perfection, that is to say, along with the richest and most delicious cream. In the vicinity of Dublin, the celebrated "Strawberry Beds" in the same manner attract immense crowds of persons in the summer evenings, when the fruit is in its prime. Those who are accustomed to see strawberries only in the small pottles in which they figure at Covent Garden market, can form but a feeble idea of the mode of consumption at either the Scotch or Irish metropolis.

Of late years there have been many changes and improvements in the strawberry world. Fifty or sixty years ago, only about a dozen sorts were known, those of the largest size being called *hautboys*.* According to horti-

* So called from being originally found in the *haut bois* or *high woods* of Bohemia.

culturists, there are now some hundreds of select varieties, produced by crossing, change of situation, and other circumstances. An old and respectable strawberry, known as the Old scarlet, was introduced from Virginia in 1625, and has been the prolific source of several varieties. The Austrian scarlet, the Roseberry, the Scotch scarlet, the Aberdeen seedling, the Grove-End scarlet, the Downton, Sir George Mackenzie's Late scarlet, Nova Scotia scarlet, Prolific hautboys, and Keen's seedling, may be noticed among hundreds of others. Latterly, some poor sorts may have been banished from the market, and given place to Keen's seedling, which combines good flavour with largeness of size, and is an excellent bearer. The object in cultivating so many varieties is to obtain a succession of fruit through the season, some sorts ripening and being ready for market in May, while others come to maturity in the course of June and July. It should be understood, however, that it is only in the neighbourhood of London that the successive cropping of strawberries, or the forcing of them at particular seasons, is methodically conducted on a large scale. In most parts of the country, the vicinity of Edinburgh included, the fruit in its different varieties comes almost at once into the market, the season lasting about three weeks, and then all is over. The exceeding precariousness of the crop, from the chance damage of rains, makes the rearing of strawberries a business of little profit, and lately it has been abandoned by a number of our market gardeners. This is a circumstance to be regretted, and we should hope that, by a greater attention to the cultivation of *late* sorts, which would not arrive at maturity till late in July and in August, a greater degree of success in rearing might be secured.

The following comprehend the general directions for culture:— The seasons for planting are March or September. The soil that all affect is a rich unctuous loam, trenched to the depth of two feet. The best and strongest rooted runners of July are always to be preferred; and these should be planted at the periods above named, with all their roots, into beds or borders recently prepared. Many persons retain their beds or rows, during an indefinite number of years, in a tolerable state of fertility; but the triennial system appears to combine every advantage, while it avoids the two extremes of annual renewals and of protracted duration. When a bed is formed and in full bearing, it will require an annual surface-dressing of loam and manure, two parts of the former to one of the latter, early in the winter, to protect the plants and receive the new roots, which always are emitted just below the lowest leaf-stalks; in March the old leaves ought to be all cut off, leaving the hearts untouched; and the beds should be cleared of litter by a wooden rake. Prior to the fruit becoming ripe, the mowings of a lawn or of any soft grass laid over the surface, will prevent the berries from being soiled by mould or worm-casts.

Triennial System of Planting.—1. A plot or border of earth being trenched, as before directed, select, after the first rain of September, a quantity of strong and well-rooted runner-plants, and, with a garden fork or trowel, set them one by one, fresh from bed, in the new ground; if in single border row, a foot apart; if in a bed, at the same distance plant from plant, but the ranks two feet asunder. Fix each plant firmly, and give water over it from the rose of a watering-pot. If a set of plants be thus merely transferred without much disturbance, and watered three times, few will fail. Hoe the ground occasionally; and prior to or during the first frost, sprinkle some manure over and around the plants, and lightly pass the wooden rake over them. Suffer no blossom to expand in the following spring, but leave the plants to acquire strength. Stir the ground occasionally, and cut off all runners.

2. In the second September, prepare and complete a corresponding plantation. Manure and dress the plants during winter, and those of No. 1 for the second time, and in March trim off the old leaves, and rake the surface. Let the plants of No. 1 bear their full complement, the fruit of which ought to be early, abundant, and of first-rate quality.

3. In September, repeat the work, and thus complete the plantations. Treat this and No. 2 exactly as directed for No. 1. In the following spring, suffer No. 1 to bear a second crop, No 2 its first crop, and obliterate the blossoms of No. 3. In the September of the fourth year, dig up all the plants of No. 1, turn the ground, manure, and replant it. Thus the routine will be completed; and thus, year after year, there will be a plot progressing in one of the three stages; and if, with each approved variety, a similar routine course be adopted—and especially if a plantation be formed in the three aspects, east, south, and north, the last under a hedge or fence, to screen it from the south sun—the season of strawberries can be extended between the latter end of May and the middle of August. For the latter period, Knight's Elton is peculiarly adapted; and they who can at that time command a supply of a fruit so fine and beautiful, will have ample cause for self-congratulation.

The Cranberry.

This is a small wild fruit, which may be easily cultivated in gardens; the plant is so exceedingly productive, that 140 bottles (five bottles to the gallon) have been known to grow within a space of two and a half square feet. The berries are used chiefly for tarts. Cranberry plants require a very moist soil, and if placed near a pond, so much the better. Give them some bog earth, and in dry weather let them be frequently irrigated.

The Grape Vine.

The vine, from the juice of whose fruit wine is made by a process of fermentation, is a plant of eastern origin, which, in the course of ages, has been introduced into all the countries of southern and central Europe, also England. Requiring a fine climate, it will not bear fruit in the open air farther north than York, and it is only in fine seasons and in good exposures, that its fruit is worth eating even in the southern parts of Britain; in general, the grapes grown in gardens about London are small, and not presentable at table. In the north of France and Germany they are little better, and we do not really get fine grapes of a proper size till we reach Italy or Portugal. In England, however, grapes produced in hot-houses surpass in size and flavour the fruit of the Portugal vines.

Throughout the continent, the practice is to grow vines in large fields, either on plains or the sides of hills, which are fully exposed to the sun. They are trained in rows, tied to stakes, and are pruned to a height of about four or five feet; on the Rhine, they seldom exceed three or four feet; and, at a distance, the ground has somewhat the appearance of being covered with staked beans or peas. In Italy, the vines are trimmed to a greater height, and are made to cling to horizontal palings, as if from the roof of a hot-house.

To those in the southern parts of England who desire to rear the vine in gardens and on walls, we offer the following directions:—The varieties most suitable for culture are—1. The White sweet-water, with round berries, somewhat tinged with yellow, and faintly streaked with red on the sunny side. 2. The White muscadine, bunches rather loose, berries not very large, yellowish, and abounding with saccharine juice. 3. The Small black cluster, with berries between red and purple, closely packed, very sweet, and luscious in flavour. 4. Turner's hardy, or the Esperione, a fruitful tree, and very certain bearer; berries of medium size, varying from dark-red to deepish-purple.

Mr. Hoare's treatise on the vine has added importance to the culture of this graceful tree, and has thrown great light upon the treatment it requires. Our limits forbid us to recur to the statements therein given, and we can only observe, that no one who possesses a gable-end, a brick-walled house, or, indeed, a wall or fence of any kind, need be without a vine; it affects no richness of soil, but will grow on the shallowest ground, over and in chalk or rock of any description; yet, if a border can be formed with a dry and well-drained bottom, the tree will be rendered more vigorous, though the fruit may not be exalted in flavour.

A sound turfy loam, to the depth of eighteen inches, rendered open by small fragments of old lime-rubbish, and a portion of crushed bones, will support any vine, and promote its fertility; and these materials can be introduced by degrees, first near the roots, then at a greater distance to replace a corresponding quantity of old soil; thus little expense will be incurred, and still less labour. But if a new border be contemplated, and outlay be not considered, it will, of course, be best to complete the work in the first instance.

Vines are propagated by single eyes, by cuttings, and by layers, placed in pots when it is intended to remove the plants to borders or vineries. The soil should be a light rich sandy earth, or perfectly decayed manure, and sand, in equal parts; but they who wish to raise vines without loss of time, should plant cuttings taken from vines of known fertility, and of the yearling shoots which are themselves actually fruitful. Each should have three bold eyes on the young wood, and each should retain at its base a small piece of the previous year's wood. The season for planting is the month of March, and the method very simple. Dibble a hole from four to six inches in front of the wall or fence, deep enough to receive the entire cutting. Mix together equal parts of black leaf-mould and white sand; put in the hole enough of this to raise the bottom one inch, and ram it hard with a blunt stick; then insert the cutting, and hold it firm in the centre of the hole, while that is filled brimful with the compost, which is brought into still closer contact with the shoot by pouring water into it two or three times. Make the ground quite even, and its surface level with the uppermost bud, then cover the cutting with a small hand-glass. If the ground is kept moderately moist, not two cuttings in a dozen will fail. If more than one shoot break, and attain the height of five or six inches, the stronger only should be retained, slipping the other off below ground. This shoot must grow till its point become spindling, when it should be nipped back; and all future growth should be thus stopped above its lowest leaf, as also the laterals that appear during the growth of the main shoot. Great care must be taken to keep the vine regularly nailed and secured by soft and roomy ties, to prevent accident, and the danger of being snapped by the wind.

As the aspects suitable to the vine are confined between south-east and a small point to the west of south, the cuttings, if not duly supplied with water, may be droughted and perish before they become completely furnished with roots; but when once established, the main shoot will grow rapidly, perhaps attaining the height of a common fence, and ripen their wood early. In the end of September, let each be cut down to an inch above the three lowest buds; mulch the ground around the stems and over the roots as winter approaches, and watch the spring progress of the eyes. If possible, obtain and secure two equal shoots; and if the wall or fence be from eight to ten feet high or more, lead these shoots horizontally right and left about six inches above the soil, and secure them by shreds and nails. If the wall be six feet or under, retain but one strong shoot, and train it perpendicularly. In September, cut back according to the strength; thus, if the wood of the single rod last mentioned measure from one-third to half an inch in thickness, and the eyes be full, and from four to six inches apart, cut the shoot at the top of the fence, removing also the remains of all laterals, and tendrils. The two horizontals will perhaps be rather slighter, yet if they be fully ripe, and furnished with bold eyes, they may be left three or four feet long on each side of the short main stem, but all the buds on the under side of each must be cut away; mulch the ground as before; and in March following fork in the manure.

Bearing Condition of the Vine.—The fourth spring will find the vines in a fruitful state; but previously, the trees prepared for a dwarf fence should be so pruned as to retain but three horizontal branches on each side of the main stems, about eighteen inches asunder, the intermediate branches being cut back to their lowest bold eye beyond the stem. This eye is designed to produce a new shoot, to take the place of the bearing shoot, which, after the fruit is taken, must be cut away. Thus the vine will henceforward produce, year by year, two systems of branches, one of which will comprise year-old bearing wood, the other a corresponding series of green wood, which will produce the fruit of the following year. This description would almost suffice to elucidate the habits of the vine; yet, to leave no doubt on a subject which involves the entire theory of pruning, it will be understood that this tree bears its fruit solely upon the green shoots of the present year, which spring from the eyes of the pale-brown wood of the previous year. When, therefore, a vine is of age, and has acquired sufficient strength to support a crop of fruit, it will generally be wise to provide a new series of bearing wood every year because the fruit of new wood (in the white varieties particularly) is always superior. In this horizontal alternate system for low fences, each new branch may safely be permitted to extend itself at least two joints beyond its predecessor, always remembering to cut back, early in the autumn, to a short distance above a bold eye seated on perfectly ripe wood; for thus the tree will acquire strength and extent at the same time; and experience proves that, in ordinary circumstances, the fertility of a tree should be moderated, and kept below the supporting power.

The trees on the second system of training for high walls must be pruned in a similar manner, and upon corresponding principles. In the autumn of the third year three out of four branches will be cut down to the lowest bold eye, and a few vertical shoots, from thirty inches to a yard apart, will remain; and these also must be pruned to a strong eye situated on mature wood. This system will furnish new bearing-wood every year, increasing in length as the power of the tree augments; while, also, the low horizontal stems will extend gradually in due proportion. At first one, or at most two bunches, must be permitted to remain upon each upright branch. In the fifth season, a greater crop may be taken, always, however, remembering to restrict the fertility of the vine, for by so doing, its vegetating power will keep in the advance, till, in the end, the entire fence will be filled with vigorous branches, annually renewed, from which a very heavy crop may be gathered, without tasking the vine in any degree that shall produce debility.

The spur system of pruning back the bearing shoot annually, may occasionally be adopted with black grapes, and not without advantage; yet the system of yearly renewal leaves the vine at the entire command of the pruner, and procures large clusters of fruit. The few remarks above offered enter little into minutiæ, but they elucidate general principles; and if applied practically, will, we believe, lead to improvement in grape-growing. We again profess to be much indebted to Mr. Hoare, and recommend his treatise to every cultivator of the vine.

The fruit of the vine grows in clusters or bunches, as many, perhaps, as a hundred grapes in the bunch. It is not desirable that so many should cluster together, for, when numerous, they are apt to be very small, and to be so compact in the mass, that those within do not ripen. Bunches with many grapes, therefore, should be thinned, by clipping out those of the smallest size, which will allow the others to grow to the proper dimensions. In very many instances, grapes grown on walls in gardens are spoiled by vermin, the interstices in the bunches being often filled with spider's webs and insects of different kinds. All this is a result of carelessness in not keeping the walls clean, and pruning and otherwise attending to the bunches. As a preventative, let the walls in winter be lime-washed, including all branches of the vines, and take some pains to remove all vermin which appear in the fruit season.

Forcing.—Of the growing of vines in hot-houses or vineries, it is not our intention to speak; but for the class of persons whom we address, the following account of a method for forcing vines in humble edifices, given by Mr. M'Intosh, in the "Orchard," seems so suitable, that we take leave to offer it:—"In many parts of the continent, and even in some few instances in this country, vines are forced in very humble edifices. The Dutch, Flemings, and Germans use pits, often not exceeding three or four feet in depth. These are sometimes heated by dung or tan being placed within them, which give out a mild, humid heat, serviceable to the vine while the buds are breaking; and this, with the proper husbanding of the solar heat by judicious ventilation, is often found sufficient to produce ripe grapes at an early period. Other instances occur of such pits being heated by a smoke flue, to which very moderate fires are applied. But what is most novel in these pits is, the vines being planted outside—the wood that is to produce the fruit is trained under the glass within, while the young wood for succeeding crops is allowed to grow without, where, under a brighter sunshine than we enjoy, the wood becomes perfectly ripened, and when the crop is gathered, the old wood, or that which produced fruit this year, is entirely cut out and replaced with the young wood hitherto growing without the pit. Vines are also ripened on the continent by having glass frames placed against the wall on which they grow, about the time the fruit is half or three parts swelled, at which period those glasses are not in use which have been employed in forcing early crops of melons, salads, &c. The solar heat collected by this contrivance ripens the fruit well, and fully matures the wood for the following season. We have it in contemplation, founded upon the success of this mode, which we have often witnessed on the continent with admiration, to erect a portable structure in the new gardens now preparing for his Grace the Duke of Buccleuch, at Dalkeith Palace, and of which the following brief description will convey a sufficient idea:—Supposing a south wall, built hollow and heated with hot water (as all our walls are to be), be planted with the early ripening sorts of grapes, late peaches, and some of the best late ripening plums, such as Coe's Golden Drop &c. The trees not to be excited in spring (which should never be attempted with hot walls), but rather retarded in their blossoming, by keeping the branches as far from the wall as possible till they begin to blossom, at which time they are to be laid in to the wall, and the blossom protected with thin canvas awnings, particularly during night. In July, at which period the roof-sashes of the early forced peach-houses and vineries will be removed, these are intended to be employed to cover the above wall in the following manner:—A permanent stone curb, twelve inches high or more (or a wooden plank of the same height will answer as well), is laid along parallel to the bottom of the wall, and at two feet distance from it. This curb is furnished with a groove an inch and a half deep and three inches wide, to receive the bottom rail of the sashes, the top rail to run in a corresponding groove, in a batten of wood fixed to permanent brackets near the top of the wall, the distance between the top and bottom grooves to be equal to the length of the sashes, the bottom rail of each sash to be furnished with two brass rollers, to facilitate their movement. The glasses, it will thus appear, will stand perpendicular to the wall, and at two feet from it, and ventilation and the necessary operations of pruning, gathering, &c., can be carried on from without, the lights being made to pass each other in the grooves, as in the manner of what is called barrack windows. The concentration of solar heat in August, September, and October, with the power of applying fire heat by means of the hot-water pipes in the walls, which may be safely used as soon as the glasses are put, will not only ripen our best autumn fruits, but also mature the wood and buds for succeeding crops. Grapes and plums may be prolonged by this mode, we think till Christmas, or indeed until the glasses be required to be again put on the early forcing-houses; and our finest Flemish pears, late peaches, and nectarines, which do not often ripen well in England on the open wall, and never in Scotland, will be brought to the highest perfection. Hot walls we have long ago proved to be of little or no value in spring but their efficacy in autumn no one can doubt, and their utility will be greatly increased by having this covering of glass before them."

For information respecting the construction and management of hot-houses and green-houses, we refer to Loudon's "Encyclopædia of Gardening," also to the beautiful works of Mr. M'Intosh (Orr & Co., London).

MISCELLANEOUS FRUITS.

The following are fruits which cannot be strictly ranked among the preceding classes, and are grown almost exclusively in gardens of a high order:—

The Fig

The fig-tree is a delicate exotic like the grape-vine, and great care is required to bring crops of the fruit to maturity in the open air. There are many kinds of the fig-tree, but the greater number are adapted to culture only under glass. The following are four excellent kinds:—The Brown Ischia; fruit large, rather globular; brown pulp; purplish-red; very rich in flavour, and melting; ripens in August. Brown Naples, colour brown without and within; a hardy fruitful tree. The Large Blue or Purple Fig, like the Brown Naples, ripens about August. It is one of the best fig-trees; fruit long and of regular figure; pulp red; of rich and fine flavour. Lee's Perpetual Bearer, which is well qualified for gentle forcing in pots. The best soil for fig-trees is a light fresh loam; but the chief essential to promote fertility is a hard and dry bottom of chalk, gravel, or artificial pavement; a dry substratum and little depth of soil (that is, from one foot to eighteen inches) are therefore what the gardener must provide, if he expects to render the trees permanently fruitful.

Culture and Training.—Both are extremely easy Rogers says, and very justly—"That the knife is seldom wanted" (that is, in shortening; though from the extreme luxuriance of the wood, it is frequently necessary to cut out many entire shoots); "pinching off the points of the young shoots during the months of May and June with the thumb and finger, is the most effectual pruning." Mr. Knight restricted himself to compressing the points of the green shoots till the substance was felt to yield under the finger and thumb, by which pressure a check is given to luxuriance, and the milky sap is diverted to the embryo fruit, which lies embedded at the base of each leaf-stalk.

But to secure fruit in due season, the pruner must recollect that, in Italy and the south of Europe, two crops of figs are produced yearly. Those large figs which are seen on fruitful trees here late in summer, are developed in spring, and would ripen early in a warm climate; but our winters check their progress, and generally destroy them. The crop which ripens in August is developed late in the preceding summers, and is extremely minute, almost invisible, in September : it is situate near the terminations of those green shoots which have been pinched or compressed : therefore the large green figs (which have properly been termed *sterilizing encumbrances*) should be displaced by mid August, and then it will frequently be seen that two minute embryos form in lieu of the one; and these, if the tree be protected, will ripen at the season mentioned. As to protection, it will be proper to unnail and bend down the upper shoots, so as to bring them into moderate compass, then to pass a few straw bands among and across them, and finally to cover the whole with a mat or canvas sheet.

In April, train in, straight and regularly, all the bearing wood; and as the trees grow, suffer the breast wood to curve forward at its pleasure, placing the points as directed. Not one shoot is to be cut shorter ; but if the wood become redundant, some branches which obscure the fruit should be entirely removed, reserving that which will manifestly be fertile, and which can be duly trained in at the regulation of the following spring.

The Filbert.

The filbert is believed to be an improved variety of the common hazel-nut. Both plants are monœcious ; that is, they produce male and fruitful blossoms very early in the year on the same tree, but separate from each other : the catkins that become visible in autumn are the males or pollen-bearing flowers : the *crimson threads* are the pointals of the fertile nut-bearing flowers. As the trees are pruned—spurred, as it is termed—in autumn, care must be taken to reserve a number of catkins, otherwise the crimson points will fail to perfect the nuts. The chief varieties of the filbert are the Red-Skinned, the White-Skinned, and the Cob or Barcelona-nut. The following are the methods of culture;—Strong suckers, taken in autumn, are either planted in the nursery, or at once in the places where they are to remain; and these grow three or four years, and are then cut down within a few inches of the ground. From the stem several strong shoots are produced, which, in the second year after cutting down, are generally shortened by one-third of their length. Regular figure and an open head are procured by placing a small hoof within the branches, to which the shoots are fastened at regular distances. In the third year, as the bush approaches maturity, short shoots (spurs) spring from the eyes, and are suffered to grow till the autumn, when they are cut back nearly to their origin, whilst, also, the leading shoots of the previous year are shortened two-thirds.

In the following spring, several small shoots arise from the base of the small branches which were cut off the preceding autumn, in consequence of the curtailment of the leading trained branches, and upon these secondary spurs the fruit may be expected; these shoots augment in number yearly, insomuch that many must be cast away. The largest are removed; the lesser remain being more fertile in their habit. Many decay yearly, but whether they do so or not, those which have borne filberts are always cut away, and a fresh succession provided as future bearers. The leading shoot is every year shortened two-thirds or more, if the tree be weak, and the whole height of the branches must not exceed six feet. In order to strengthen the tree as much as possible, the suckers of the roots are eradicated, by exposing the roots, at a moderate distance from the stem, to the frost. The excavation is in the spring filled with manure.

The crops thus produced are sometimes enormous, followed, however, by intervals of barrenness. We have not heretofore adopted the method of pruning, leaving the trees more to the order of nature; but it is right to try experiments; and when a row of young trees exists, a comparison might readily be obtained, by pruning alternate trees, or one of every three trees, by the "spur-system;" always, however, observing to keep the head of every tree open, and to cut away its upright central leader.

The Mulberry.

The mulberry is a native of Italy, introduced in 1548. The structure of its flowers and fruit is very singular; like the nut and filbert, the males are distinct from the females; the latter do not always expand at the same time as the males, and therefore are not fertilized. The calyx swells and becomes fleshy ; each individual contains one or two seeds; and a congeries of these swollen organs form what is supposed to be a single mulberry. There is but one known species of the black mulberry, and this thrives best in loam, of the quality so often named; but the bed ought to be deep, and to rest on a dry sandy subsoil. The fruit sometimes fails; and on this subject Rogers observes, that fertility may depend very much on the warmth of the weather at the time of blossoming, and on the circumstances of both male and female flowers coming forth at the same time; sometimes, also, the male catkins drop before the fruit blossoms expand. Williams, of Pitmaston, suggests that "no tree receives more benefit from the spade and dunghill than the mulberry; it ought, therefore, to be frequently dug about the roots, and occasionally assisted with manure." Others consider a velvety piece of turf as the best site; and certainly if the finest fruit fall, grass turf must preserve it clean and sound. We have known several old trees on turf never dug or disturbed, which always bore immense and fine crops; on the other hand we have seen young trees on dug and enriched ground fail year after year. When the buds expand in this third spring, it is desirable to obtain four shoots on each side of the upright stem, and all the shoots that will break from the two horizontals, which latter are to be led upright, and secured as they advance.

ARBORICULTURE.

The Oak.

Scientifically, as well as popularly, the term *Trees* includes all those plants which reach a considerable stature, and possess stems more or less solid. They are, as all must know, by far the grandest objects in the organic world, and they are not amongst the least elegant. The timber produced in the stems also renders them of very great importance in many of the arts cultivated by man, and in none more so than in that which has enabled him from ages beyond historical record to transport himself across the bosom of the deep, and communicate from one land to another the various productions of the earth.

Trees are divided, with a regard to their structure, into two great classes. Some, which spring from seeds of more than one lobe, and grow by additional layers on the outside of the stem, are for these reasons respectively called *Dicotyledonous*, or Exogenous Trees; others, which spring from seeds of one lobe only, and grow by additions in the interior of the stem (palm, sugar-cane, &c.), are called *Monocotyledonous*, or Endogenous Trees. As our treatise regards the practice of arboriculture in our own country, where there are few trees of the latter kind, we must be understood in all general descriptions to refer to the former only, unless the contrary is mentioned.

In the organization and organic functions of trees, as well as in other plants, there is some general analogy to those of animals. When cut across, they appear to the naked eye composed of fibres or thready substance; but in reality the substance of trees is almost altogether composed of vessels or tubes, through which the sap flows, like blood in the veins of an animal. Seven millions of these vessels have been counted in the surface of a square inch of wood! The vessels in trees, like those in animals, are of different sizes; but it has been ascertained that there is nothing in trees performing the same functions as the heart in the higher classes of animals—that is, propelling the blood throughout the system, and, by its return again to the heart, completing the circulation. The vessels simply extend from one end of the tree to the other, sometimes joining with each other, as the veins and arteries of animals do, and, moreover, exhibiting circles which, when the tree is cut across, have the appearance of rings. One of these circles of vessels grows round the outside of the tree (under the bark) every year, and is called *alburnum*, or sap-wood, while the inner and harder matter is called *duramen*.

A tree consists of four principal parts—the Root, the Trunk, the Branches, and the Leaves.

The *Root* consists of two parts—the body or bulb of the root, and the long branch-like fibres, great and small, which disperse themselves abroad into the soil. The body of the root differs little in substance from the trunk, but the rootlets terminate in slender spongy threads, fitted for absorbing the sap of the earth, and sending it up into the rootlets, whence it ascends into the trunk. It is observed that the earth is only exhausted of its nourishing matter in the neighbourhood of those soft extremities of the roots.

The *Trunk* is called by Linnæus *caudex ascendens*, or root above ground, an illustration perhaps more fanciful than real. In common language, the trunk is often named the *bole;* and it is this part which affords the timber for which most trees are reared. The trunk, and also the branches, are covered with *bark*, consisting of a series of thin layers, one of which is formed (next the timber) every year; while in the outside of all is a very thin layer of a different substance, called the epidermis or cuticle, analogous to the outer skin of the human body. The new inner layer which is formed every year, receives the name of *liber;* it was on this substance that the ancients, before the invention of printing, were accustomed to write; and *liber*, it is well known, is the Latin word for a book. Within the bark is the wood, consisting chiefly of vessels, great and small, which may be torn asunder from each other, and which are employed in conveying sap to the upper extremities. In the very centre of the trunk is a small space filled with a soft substance called *pith*, which is supposed to be a reservoir of nutritious matter for the development of the buds in spring.

The *Branches* require no further notice than that they precisely resemble the trunk in every respect, except that they are upon a minor scale in point of size.

The *Leaves* consist principally of tissue, like the trunk, with vessels throughout, and an external cuticle enveloping the whole; and they are connected with the branch by a small stalk called the *petiole*. The leaf is one of the most important parts of the whole tree. By a most curious process, not perfectly known to us, the crude sap rises through the wood, in the manner just described, and is elaborated or prepared into juice of a more nutritious sort, by the leaves. That process, according to some, is effected by means of an alternate contraction and dilatation of the sap-vessels, and, still more, by a respiration, perceptible and imperceptible, in the leaves, and by the action of the atmosphere; but, according to others, it is rather the exhalation from the leaves, than what are properly their respiratory functions, that effects the ascent of the crude sap. It is then converted into proper sap, or *cambium*, and, being fitted for the nutrition of the whole tree, it descends by the returning vessels of the leaf-stalk, and the longitudinal vessels of the rind or inner bark. At length it reaches the roots, which originally supplied the crude sap itself. This elaborated sap is like human food digested into chyle; and as it forms the only real nourishment of the tree, it becomes apparent that the plant must decay if stripped of its leaves.

Such is an outline of the economy of trees, of which a more minute account has been already given in the article on Vegetable Physiology.

CLASSIFICATION OF TREES.

In a view of arboriculture, trees may be classified according to their uses; for example—1. Trees which produce straight timber for masts and long planks, as the various tribes of pines. 2. Trees which afford crooked timber for knees or bends in the ribs of ships, &c., as the oak, sweet chestnut, broad-leaved elm, &c. 3. Trees which give tough pieces of timber, as the yew, holly, thorn, ash, hickory, maple, laburnum, &c. 4. Hard-wood trees, as the oak, beech, plane, walnut, box, holly, and yew. 5. Soft-wood trees, as the poplar, large willow lime, horse-chestnut, &c. 6. Wood grown for flexible suckers, and spray, to form hoops, baskets, besoms, poles, &c., as the dwarf willow, birch, &c. To these may be added woods of foreign growth, as rosewood, satinwood, and mahogany, which are employed for ornamental purposes.

According to another classification, trees are arranged as of three kinds—resinous, hard-wooded, and softwooded. Those which are resinous are also termed coniferous, from their producing seeds in cones. For the sake of clearness, we will adopt this simple arrangement, confining ourselves to trees which may be propagated in Britain.

Resinous or Coniferous Trees.

There are three tribes of these trees, one of which, the Abiétinæ, has four genera cultivated in the British islands—the Pinus, Abies, Larix, and Cedrus. Of each there are several species, all distinguished by their spicular leaves, their cone-like seed-pods, and their resinous wood. Each may be easily raised in nurseries from seed. The more common species is the

Scotch Pine, or *Pinus sylvestris*.—This is a tall and generally straight tree, with few branches on the lower part of the stem, the leaf apparatus being confined to the top of the plant, these forming a massive clump. It is indigenous to the Highlands of Scotland; but little that is generally used comes from the forests in that quarter, the greater proportion being imported from the north of Europe, where a variety of it attains great perfection. For strong beams and spars required by house-builders, this timber is exceedingly suitable; but for smoothness and whiteness of fibre, it is excelled by a tree of much inferior strength—the Canadian pine (*pinus resinosa*). On account of the heavy import duties levied on foreign pine, much of Canadian timber is employed in its stead, being thus devoted to purposes for which its properties no way qualify it.

Spruce Firs.—These are a well-known genus (*Abies*) of the Coniferæ, the more common being the Norway fir, a tree which attains great height, but no great bulk, and furnishes white deal and spars of inferior size; it is also very suitable for masts and poles of all kinds. North America produces three species of spruce, the white, red, and black, each esteemed for particular uses connected with ship-building.

The Silver Fir.—This tree, called also the Pitch Fir, displays a greater depth of branches than the other firs, and becomes a majestic tree on arriving at full age. In this country the silver firs are only seen as objects of ornament on dressed ground; but how they would answer if planted closely together, and pruned up to form clear butts of timber, is uncertain, this having never, we believe, been tried in these kingdoms. The quality of the silver fir timber of British growth is yet to be tested. The common silver fir, the balm of Gilead, and the hemlock spruce, have been long in our pleasure-grounds, but the yew-leaved, Fisher's, Douglas's, and Fraser's double balsam, are only in nurseries or in pine preserves.

The Larch.—Of this valuable genus there are several species grown in Britain and other countries; the more common is the *larix europæa*. The larch is the most beautiful in figure of any of this class of trees; shooting straight up, its elegant stem, tapering to a point, is furnished with pendulous branches, ornamented with delicate drooping spray. Its qualities are rapid growth, flexibility, and durability in situations between wet and dry, a circumstance perhaps attributable to the quantity of resin in its fibre. In many parts of the country it is gradually superseding the common fir, over which it possesses a great superiority in point of ornamental effect.

The Cedar Larch.—This tree is remarkable for its long horizontal and often crooked branches, and the great mass of dark green spicular foliage with which it is covered. It is a native of the mountains of Libanus and other high adjacent regions, where it attains great bulk, and grows to a very long age. From its solemn aspect, it forms a suitable accompaniment to cemeteries or ecclesiastical buildings, and also for sequestered glens in mountain scenery, or for extensive lawns.

Hard-Wooded Trees.

In this class are included a large number of trees with [illegible]ich every one is familiar. The list embraces — [illegible]k, a[illegible], elm, beech, chestnut, walnut, common, sycai[illegible]ntain ash, whitebeam, acacia, birch, wild [illegible]tch laburnum, holly, hazel, box, elder h[illegible]nd yew. The following are the principal [illegible]

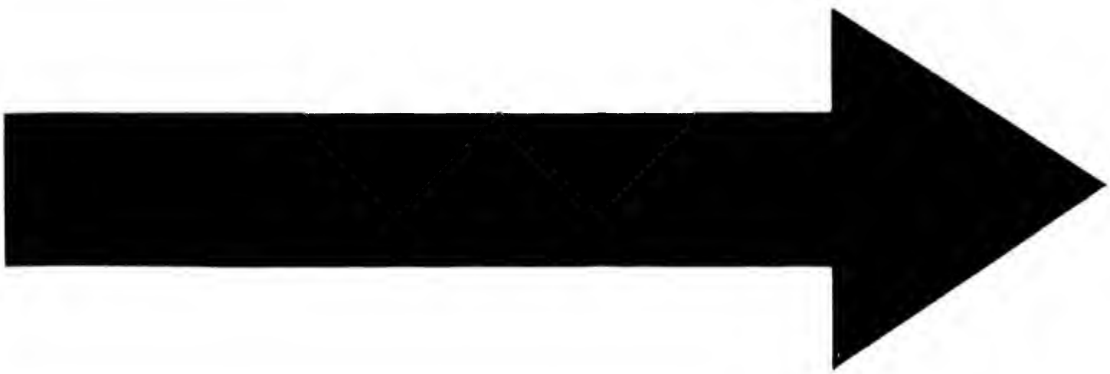
[illegible]—[illegible]his tree (the *quercus* of Linnæus) is the most [illegible]f all the timber trees grown in Britain, not only because it is a hardy native, but for the many important purposes to which its durable timber, its astringent bark, and even its nutritious fruit, are applicable; and, moreover, for the delight which it gives to the eye in sylvan landscapes, the oak being the most picturesque tree of the forest, when it has arrived at its mature age and form.

There are two sorts in our woods, whether natural or planted—namely, the stalkless, and the stalked-fruited, one of which may be only a variety of the other. The former is said to be the old Druidical British or naval oak, though the latter is more frequently met with, especially in woods which have been planted in remote ages by the hand of man. The latter, or stalked-fruited, is also of quicker growth, and is altogether what may be called a more elegant tree when full-grown. The quality of the timber of both, when any difference is observable, is more owing to the difference of soil they have grown on, perhaps, than to any specific difference of the trees.

Besides these two common sorts, which are natives, there are thirteen other species which are exotics—namely, the willow-leaved, the evergreen, ash-leaved, cile-cupped; ilex, of which there are six shrubby varieties; chestnut-leaved, scarlet, velanida, white, Italian, durmast, Luccombe, and the Turkey, of which there are four varieties. This last is a fine free-growing tree, and deserves a place in every plantation. The other exotics are chiefly planted for ornamental purposes, not being yet considered as foresters.

All the species are readily raised from their acorns (oak-corns) when they can be procured; and in default of these, most of the foreign sorts may be grafted on the common. The young plants are transplanted twice or thrice in the nursery; and when four or five years from the acorn, may go to their final stations. Any kind of damp clayey soil is suitable for the oak; but a good loam, or gravelly loam, upon a subsoil of blue ferruginous clay, produces the finest timber in the shortest time.

The Ash (*Fraxinus*, L.) is also a very valuable hardwood tree, its timber being useful for many rural purposes, and particularly for implements and machines. The common ash, being prolific in ripening seed, is dispersed pretty generally over the face of the British isles; it is, nevertheless, much better managed when planted for



timber or for underwood, unmixed with any other sort of tree. It should never be allowed a place in a hedgerow, nor on pasture-land, as its numerous surface-spreading roots engross to themselves every particle of nutritive moisture, to the destruction of all other surface-plants.

An ash tree is in its prime when, by free and vigorous growth, it has attained a diameter of about twenty inches; for though on rich gravelly loam it will continue to increase until it is four or five feet in diameter, it has probably begun to rot at the core long before it has arrived at that vast bulk. Therefore, in order to raise ash-timber of the most valuable description, it is necessary to sow or plant a piece of land of the above character thickly, placing the trees about two feet apart. These will rise rapidly; and as soon as they appear to be choking each other, one-half of the poles may be drawn, and the rest allowed to stand till they arrive at a marketable size, which is when they are from eight to twelve inches in diameter, and from forty to sixty feet high. When *ground-ash* is of these dimensions, it is suitable for every mechanical purpose where flexibility and extreme toughness are required.

Seed should be gathered in the autumn, and immediately sown in nursery-beds; or the sowing may be deferred till spring. Some of the seeds may not rise till the second or third year; but as soon as the seedlings are five or six inches high, they should be rowed out to gain strength till finally transplanted. There are several varieties of the common ash, one of which is the creeping-branched, but which, by grafting it high on the tall stem of the common one, is made a rather ornamental weeping tree. Other species are the yellow-barked, curled-leaved, various-leaved, and a great many other exotic species.

The Elm (*Ulmus*, L.) is a lofty tree, valuable both for its use in the arts and its ornamental appearance. The small-leaved or English elm is generally preferred for planting, particularly in hedgerows, avenues, and the like. This tree is not a forester, never being seen but about dwellings, or where dwelling-houses have formerly stood. It is probably an exotic, as its seeds never ripen in this country, and is therefore propagated by suckers, which rise abundantly from the old roots, which circumstance makes the tree so eligible for hedgerows; for where once planted, fell the principals as often as wanted, a succession of young stems constantly appears. They are also propagated by layers, and often by grafting on the common wych-elm, especially when wanted for dressed ground, or for avenues where it is desired that no suckers should be seen.

Besides the common wych-elm, found wild everywhere in the hedges of Britain, and which grows, where allowed, to a large size, yielding large butts of coarse-grained but useful timber, there are several other sorts raised in nurseries, namely, the cork-barked, smooth, declining-branched (a truly picturesque tree), spreading-flowered, the white, and several others. All the elms delight in a gravelly loam, or in any soil which is not too wet, and they are well worth the planter's attention. No tree bears lopping or shredding better than the elm, it being hardly possible to hurt it by dismemberment. It is raised from seed when produced.

The Beech (*Fagus sylvatica*, L.) is a native forest tree, occurring most commonly on the chalky districts of the kingdom. When full grown, it is a beautiful and stately tree, and its timber is convertible into many kinds of domestic articles, very durable when polished by the cabinet-maker, and equally so if kept constantly under water. The beech is a very fruitful tree; and its mast or nuts, together with acorns, used formerly to fatten vast droves of swine and herds of deer, the then common food of the feudal lord and his vassals. The seeds are gathered after the husks open, by beating the branches with poles which shed the mast upon large cloths spread upon the ground under the trees. Many are sold to the oil-millers, who express an oil from the seed useful for lamps and other purposes.

Young plants are readily raised from the seed sown on beds, and covered with loose soil about an inch thick. Like other seedlings, they are, when five or six inches high, rowed out on fresh ground, till large enough to be transferred to their final stations. The beech is not at all fastidious as to soil, so as there is some portion of calcareous matter present; but a subsoil of chalk or limestone is most congenial. There are several species; the white American, the dark-purple, and the iron-coloured-leaved, are ornamental, and are propagated by grafting on the common.

The Chestnut, or sweet chestnut, sometimes also called the Spanish chestnut, is a splendid forest tree, exceeding all other British plants in its huge mass of foliage; it is also valuable for its timber, which is but little inferior to the oak. In the south of Europe it is chiefly regarded as a fruit tree; but here, even in the south of England, in the finest summers, the fruit ripens but imperfectly. As a timber-tree, however, the Spanish chestnut deserves to be more generally planted than it has been of late years; and for a coppice or underwood plant it has no superior. For the number, the straightness, and durability of its poles, it excels all others, when a little trouble is taken to keep the growth properly regulated with respect to the purpose for which the crop is wanted. When timber or ornament is the object, the trees must constantly be divested of the shoots, which are apt to rise from the collet of the stem. A loamy gravel seems to suit this tree best; and young plants are easily raised from the nuts, dibbled in rows in the spring, and, while in the nursery, kept free from bottom shoots.

The Walnut.—This is chiefly regarded as a fruit tree, but it is no less valuable for its excellent timber, which, from its lightness and durability, is well adapted for gun-stocks. And where its fruit is of no great value, and especially where it does not ripen, if planted among other forest trees, it would be drawn up into a shapeable single stem, as valuable as many others. Young trees are readily raised from the nuts, like the chestnut, and are similarly managed.

The Sycamore is a hardy native tree, which attains a large size, and has the property of growing more quickly than most other hard woods. It is employed to form household utensils and objects in turnery. The maple is a species allied to the sycamore.

The Mountain Ash, familiarly known in Scotland as the *rowan-tree*, from its beautiful clusters of red rowans or berries, is a tree of small dimensions, but elegant form, and is grown principally for ornament in shrubberies.

The Acacia.—This is not only a highly ornamental, but also a highly valued timber-tree, when allowed to attain a proper size. Though a native of Virginia, and there called the *locust-tree*, it has been recommended as a coppice plant for this country, because of the very quick growth of its young shoots, which rise from roots after the stem is cut over; and for the excellent and durable quality of the poles for fencing, and particularly as props for hops and other trees. But whether planted thickly for underwood, or in more open order for timber, the acacia requires much attention from the pruner during the first five or six years of its growth. It produces large luxuriant lateral shoots, which are but slightly attached to the stem, and which, if not stopped—that is, their points pinched off when they are about one foot long—are very likely to be blown off by the wind. This care may cease after the tree or pole is ten or twelve feet high, for after that height, the growth becomes moderate. Young plants are raised from seeds or layers, and thrive on any light sandy soil. The timber is highly prized by millwrights for cogs, &c.

The Wild Cherry-tree.—This hardy native is seldom cultivated as a timber-tree, nor has it that care bestowed upon it which it really deserves. The best specimens to be met with are those which have risen by accident in woods; but when such are felled, they are readily purchased by the cabinet-makers. As mentioned in a previous article, the wood is very suitable for boring and forming musical instruments. It is therefore a tree not to be neglected by the general planter, and should have place among others. Young plants are raised from the stones, sown thickly on a bed of good soil, either in autumn or in spring, and afterwards rowed out, to receive the ordinary nursery treatment, until fit to be finally planted.

The Hornbeam.—This is a timber-tree, but it ranks as an inferior one; its timber, however, is remarkably tough and durable, and consequently invaluable to the plough and cart-wright. It is a scrubbed tortuous-growing tree, unless it has some pruning bestowed upon it when young. It is also a pretty good hedge-plant, and useful for forming screens or boundaries in gardens. Plants are raised from the keys, or seed, of which plenty are produced every year by old trees.

The Birch.—This is another inferior timber-tree, but useful as a coppice plant for many rural purposes. It is a beautiful and elegant tree, on which account it is introduced into ornamental scenery, especially if water be in the composition. Of the common birch there are several varieties, not to speak of the poplar-leaved, the tall, and the black American. Young plants are most conveniently raised from seeds, and the exotic species are raised from layers, or by grafting on the common one.

The Holly (*Ilex aquifolium*, L.) is a remarkably hardy evergreen, with smooth shining leaves furnished with prickly points. It is a native of Britain, and attains a great age, but seldom reaches a large size. Its timber is white and hard, which renders it suitable for veneering, and for making mathematical instruments. Different varieties are grown as ornamental shrubs.

The Box (*Buxus sempervirens*, L.) is generally grown as an evergreen shrub, but when planted out with a proper soil and climate, it attains a height of from 20 to 30 feet. It grows to perfection in Turkey, whence its timber is imported for use in all cases in which exceedingly fine cross grain is required. Sawn across and planed, its surface is as smooth and fine as polished metal. Box is on this account employed for wood-engravings.

The Yew (*Taxus baccata*, L.) is more frequently grown as an ornamental shrub than a forest tree, and, like the cedar, it forms a plant suitable for places consecrated to solemn feeling. Its timber is very tough, and is adapted for making bows and staves.

Soft-Wooded Trees.

In this class are included the horse-chestnut, lime, alder, poplar, and willow.

The Horse-Chestnut.—This tree is only valued for the beauty of its flowers and the majestic port of the full-grown tree in park scenery. The timber is very inferior, and the nuts are only useful for deer. There are several species of this tree—namely, the smooth, Ohio, ruddy, and the pale-flowered. All these have prickly fruit, and are easily raised from their large nuts. A section of this genus is called *Pavia*, or buck's eye, their fruit being round and smooth. But the flowers of some of these last are magnificent, being of a glowing red, and are most conspicuous in the spring or beginning of summer. Avenues of these trees, as seen in the neighbourhood of Geneva, are of the most splendid description when in flower. The pavias are often propagated by being grafted upon the common horse-chestnut, and some of them are only shrubs.

The Lime, of which there are several varieties, is a beautiful leafy tree, grown chiefly for ornament, and very suitable for avenues. Those which have most effect are the red-twigged and broad-leaved American, the latter possessing elegant pendulous flowers.

The Alder.—This tree requires a peculiar locality, that is, a damp bog-earthy soil—is but seldom ranked among forest trees, and, except to occupy a spot where nothing much better will grow, is seldom noticed. It is most profitable kept as underwood; large poles, suitable for the turner, or for piles or planking for bridges, fetching a good price. Of common species there are four varieties, together with the hoary-leaved, oblong-leaved, wave-leaved, glaucous, with several varieties of these, and some shrubby species, the most of which are propagated by cuttings, or by grafting on the common one.

The Poplar.—There are several species of this tree, as the common black poplar, the trembling poplar, the Lombardy poplar, and black Indian poplar. They grow rapidly, and rise to a great height, but narrow in mass, so as to be very conspicuous in hedgerows and landscapes. The timber is of little value; but where undrainable spots are wished to be decorated with stately trees, no better kind can be chosen.

The Willow (*Salix*, L., and usually called the *Saugh* in Scotland) is an extensive genus, comprehending those shrubby species, the osiers, used for basket work. A few species of the willow attain to the height and character of trees, the best of which, as yielding very good timber, is the white or Huntingdon; and the crack-willow make excellent pollards, furnishing every five or six years a large crop of poles indispensable to the farmer. Another of the tree willows is that elegant plant the Babylonian or weeping-branched one, which forms so suitable an accompaniment to pieces of water, whether artificial or natural. The common osier is the sort mostly cultivated for the basket-maker, and the annual crop of rods from established stools pay the owner as well as any other crop on the farm. They are all propagated by cuttings.

GROWTH OF TREES.

Trees grow spontaneously in all countries in which soil and climate will permit, and, as is well known, form forests of many hundreds of miles in extent on the North American continent. Whatever be the peculiar nature of any species of trees, it appears that the dimensions and form of all are more or less affected by their relative situation. If crowded, they have a tendency to grow tall and slender; if left abundance of space, they extend in breadth. The comparative absence or possession of air and light causes these distinctions. In a forest, each tree struggles upward, for its leaves to get a sufficiency of pure atmosphere and sun's rays, and therefore becomes all stem and top; whereas the tree in an open ground shoots out branches nearly from the bottom of the trunk, and attains a grandeur in its mass of foliage. Trees which are freely exposed are also much thicker in the trunk than those in forests. This arises not only from having plenty of air and light, but from being exercised by winds. The well-understood principle in the animal economy, of exercise strengthening a limb—as, for example, the legs of a dancing-master or the arm of a blacksmith—is extended to the vegetable kingdom, in which those plants that are gently moved to and fro by winds arrive at greater perfection of fibre than those kept altogether still.

In connection with this remarkable effect in the economy of plants, it is to be observed that all exposed trees have the largest roots; because, being liable to be blown over, they require to take a much firmer hold of the ground than if they were sheltered on all sides; in other words, the action of the tree, and the free air and light, cause numerous branches and a large breathing apparatus of leaves, and the tree must have a corresponding mass of roots for the supply of sap. So exact is this correspondence between the exposed and underground portions of the tree, that the extent of roots may always be judged of by the extent of branches, the one being of the same breadth as the other. The practical lesson acquired from these facts is, that to have trees with large bushy heads, they must be planted widely; and if wanted to be tall and slender, they should be crowded.

The generally thin soil and comparatively ungenial climate of Britain, render this country unsuitable for the growth of the more delicate and fine kinds of foreign timber; but all the forest trees already noticed, when planted and attended to with some degree of care, attain great perfection. The business of planting is seldom performed by the unprofessional culturist, being more advantageously left in the hands of nurserymen, who rear the trees from seeds, layers, or cuttings, in grounds set apart for the purpose, and at the proper time transfer them to the locality where they are to remain. For the sake of general information, we offer the following observations on different departments of this interesting subject.

ORNAMENTAL PLANTATIONS.

Even on the smallest possessions, a sprinkling of forest trees in the hedges or corners of the enclosures gives a dignity to the spot which otherwise it would not possess. There cannot be a more cheerless object in a landscape than a house, however substantially built and furnished, standing naked and alone, without a sheltering tree or bush to indicate either the taste or competence of the occupiers within. The lowliest hut, environed by two or three aged oaks or thorns, is an interesting spectacle, and far more delightful to the eye than the proudest palace unaccompanied with lofty trees.

To secure these embellishments, planting on an ornamental scale is necessary, and much good taste must be brought to bear on the subject. It is now allowed by all who have studied landscape gardening, that, in the part surrounding the mansion, trees should not be dotted about at equal distances, nor in lines; they should not be placed as blinds to the principal windows, but so arranged as to form irregular glades, diverging in as many directions from the house as can be done with effect and propriety. These glades should always be laid out with reference to some distant interesting object, or some striking feature of the surrounding country. The offices, which are generally in the rear, or at one end of the house, should be hidden by a screen of trees and shrubs; and all eye-sores, visible from the windows or elsewhere, should also be screened by plantation, which has a double advantage, namely, hiding a deformity by a profitable screen.

When it is intended to increase both the beauty and the value of an estate by planting, and whether for the personal interest of the proprietor, or with a view to that of posterity, ordinary prudence will direct him to fix on those parts which are the least valuable for agricultural purposes. The precipitous slopes of an undulating surface, where cultivation is difficult or impracticable—moist swampy hollows—or the ridges of bleak hills lying to the northward or eastward of the superior portions of the park or parks, whether arable or pasture land—will all be found the most eligible for conversion into woodland. And while such plantations yield the finest shelter and covers for game, they keep rapidly adding to the real value of the estate.

Whenever a project of planting is entertained, if only to occupy waste or worthless ground, it is not easy to separate the idea of ornament from the utility of the design, if it be no more than establishing an acre or two of coppice. For even such a feature, especially in a naked country, requires a little attention in the execution. Coppice, when properly stocked with the right sorts of plants, only appears in all seasons as a thicket of shoots of nearly equal height. Consequently, the eye of taste would condemn the plantation as too lumpish, and wanting in variety of outline. But this, though but a trifling defect, may be easily obviated by planting tufts or groups of trees, variously disposed, to remain for timber, or the same thing may be effected by leaving at the first fall a few groups of the most promising saplings, here and there irregularly over the area. These permanent groups will not injure much of the underwood, while they will give as much variety to the whole as may be necessary. This point, however, will be again adverted to when describing the manner of laying down underwoods.

As the beauty of many places constitutes their chief value, and as that beauty is mostly if not entirely owing to the tasteful disposition of the plantations, it behoves every improving proprietor to study well the genius and character of his property before he begins planting on a large scale. The safest plan, in order to avoid taking any step which may afterwards be regretted, or to be done over again, is to sketch an idea, or upon the map, a comprehensive design, embracing every thing that may be done with propriety. This being well digested and settled in the first place, may be called the general plan, and of which *as much only* as is most obviously called for, and practicably expedient, may be first of all executed, leaving the more distant and less necessary operations to be done as time and opportunity may allow.

Such a general plan of planting an estate, whatever its extent may be, requires a considerable acquaintance with the principles of landscape gardening, and can only be designed and executed properly by the owner himself (who can do nothing wrong in this way, so as he pleases himself) or by a professional adviser.

It has already been observed, that some proprietors may only think it advisable to plant the inferior portion of their acres, while others, who are determined to have a tastefully planted park or a highly embellished estate, place their groves, or groups, or single trees, on any eligible spot, without regard to the quality of the soil, whether the worst or the very best. In this case, every thing is sacrificed to obtain such a disposition of the trees as will produce the most striking pictorial effect; and such kinds only are selected as blend harmoniously with each other.

The character of the general surface surrounding a mansion fixes the style of planting and the kinds of trees. If the surface be moderately undulating, having easy swelling knolls and gently falling hollows, without asperities of any kind, such a surface is said to be beautiful, and consequently the plantations should be beautiful also; that is, composed of trees of the finest foliage and most elegant forms. If, on the contrary, the surrounding country be wild in character, and marked with bold and rugged features, as naked rocks or cliffs, deep ravines or glens, &c., then a different style of decoration must be pursued—as planting in irregular masses all the most grotesque, rugged, and sombre-tinted trees that can be selected, in order to harmonize with the natural features of the country. Such scenery is said to be picturesque; and where such tracts of country are chosen for a manorial residence, and the grounds are laid out and planted by a skilful gardener, the scenery is much more interesting to the eye of taste than any other, especially if water chance to be in the composition.

Great changes occurred in the style of planting during the eighteenth century. Up to the beginning of the reign of George I., all transplanted trees were arranged in right lines, as single, double, or quadruple avenues, or vistas, or as boundaries to the enclosed grounds belonging to royal or other palaces, colleges, and other public buildings. But about this time it was discovered that very few ranks of trees were to be seen in the works of the great masters in the schools of painting; a new idea was entertained, that, in all real scenery about to be created in the parks of the nobility and gentry of the

British Isles, ranks of trees were inadmissible, as being too stiff, formal, and not agreeable to nature. Thus a sentence of condemnation was passed upon every private avenue in the country, and they quickly disappeared before the axe of the woodman. A few only were saved, but they were curtailed in length; and now, very few new avenues are planted. Along with the avenues, all the old regularly laid-out terraces and flower-gardens were swept away, to make room for a new style, distinguished by the prevalence of *irregularity* and *curved outlines*.

Soon after this revolution in landscape gardening, a great many ridiculous pranks were played in obtaining *extreme* irregularity, and *tortuous* lines; and some of the performers got severely handled by the satirists of the day. Kent, who began the revolution, died without having gained much reputation; but his successor, the famous "Capability" Brown, became highly eminent, and was universally employed. He did more in altering the gardens and grounds of the country-seats of these kingdoms than any other professor before or since his time. His aim was to produce unmixed beauty, by neatness and general smoothness, especially near the house; for which purpose he cleared away every obstruction, whether built or planted, in order to set the mansion fairly out upon a naked grass plot or lawn. Even the kitchen gardens were removed as far off as possible; and every bush, or other appearance of inequality of the surface, was shaven off, to produce the wished-for smoothness.

In this proceeding he and his copyists fell into the opposite extreme; instead of beauty, *baldness* was the result; instead of intricacy, *tameness*; and instead of the embosoming shelter of surrounding groves, complete nakedness and exposure to every wind that blows. This exposure detracted from the consequence of the building, whatever might be its size or style of architecture; because a partial display is always more interesting than a view of the whole at once. Nevertheless, Brown had the honour of laying out many beautiful parks and gardens, which remain to this day as monuments of his good taste and judgment; but many of his immediate followers brought discredit upon his style by their very awkward imitations.

The severe animadversions published against the Brownian style, tended to correct some of Mr. Brown's most ostensible errors; and the works of Messrs. Repton, father and sons, Loudon, and others, having improved the style of English gardening, and brought it much nearer to the principles of real taste. The *clump* and the *belt* have been greatly modified; the first is now expanded into a less formal group, and while the latter has lost its continuity, it has been increased in depth, and its lengthened form as a boundary judiciously broken. Undergrowths, which were swept away by Brown, are again introduced; and the banks of lakes and rivers, formerly smoothed down to the water level, are now left more abrupt, broken, and irregularly fringed with overhanging trees, and aquatic shrubs and herbs.

PLANTING FOREST TREES.

The different methods pursued in establishing or laying down woodland, seem to have been determined by the number of acres or nature of the ground intended to be planted. To secure a full supply of the plants required, and these of the proper sort and age, it is requisite that they be previously raised from seed on the premises, or be easily procured from a nursery-man in the near neighbourhood. Where a great extent of planting is intended to be done, the former plan is most economical; but the latter, in general, is the most convenient.

To raise forest trees from seed is an easy affair; it is only choosing a piece of good mellow soil within some enclosure; this must be trenched or double-digged, laid level, and freed from stones, &c., by the rake, divided into beds four feet wide, with one foot alleys between. In the month of March, sooner or later, according to the forwardness of the season, the seeds may be sown either in drills lengthwise of the bed, and deeper or shallower according to the size of the seed; that is, nearly an inch for small, and an inch and a half for large seeds, such as acorns and chestnuts; or small seeds may be sown broadcast, by withdrawing with the rake towards the alleys about an inch of the surface each way. On the fresh soil, the seeds are thrown as regularly as possible, and covered by having the removed soil again drawn over regularly and smoothly. The seed-beds must be guarded from birds and mice; and if the weather be warm, and parching winds prevail, they should be covered occasionally with mats, and also watered, if necessary.

Seedling trees are usually transplanted into rows in nursing beds, some in the second, others in the third year; and there to stand till planted out for good, which should be done when they have arrived at a proper size—the nature and condition of the ground intended for them, as already observed, determining this point.

The surface to be planted may either be in a state of nature, and covered with heath, or with a turf of some kind or other; or it may have received some kind of preparation, as paring and burning; or ploughed, digged, or deeply trenched. It is almost unnecessary to add, that the first is in the worst, and the last in the best condition for the reception of young trees. There are many cases, however, where there is no choice but the first; and yet the success which has attended such undertakings as planting a naked hill or a barren common is a direct encouragement, and proves that such naked portions of the country may be in a few years covered with useful trees.

When a large extent of such description of land is intended to be planted, it must necessarily be executed in the most economical manner. The first step is forming an effectual fence against cattle, without which in no case should planting be attempted. If the enclosed surface be acclivous, and covered with short herbage and thin staple, two or three year old plants of larch, Scotch fir, birch, intermixed with a few oak, beech, and ash, may be inserted by a one-handed tool somewhat like a cooper's adze. One or two blows of the tool raises a triangular piece of the surface, under which the root of the plant is properly placed, and the raised sod turned back and trodden down with the foot. In this simple and expeditious way of planting, many hundred acres of hilly land have been stocked with trees; and though many of the plants are liable to suffer, if a dry summer follows the planting, a majority are sure to succeed, which well repays the cost. When such ground is level, an opening is made by first cutting the turf in the shape of a cross, and turning back the four corners from the centre, breaking up and making a hollow for the root; when the tree is placed upright, the turf is returned to its place and trodden firmly down.

There is yet another method of planting rough unprepared ground, called *pitting*. The surface-covering is first cleared off, the pit broken up with a mattock, and the loose earth thrown out with a spade; the tree is then placed, and planted with the removed soil. This method of planting is expeditiously performed when the ground works kindly; but if wet or clayey, the business is more difficult, the holes requiring to be opened, and the land drained, long before the trees can be planted safely.

All the above methods of planting forest trees are only had recourse to when the ground cannot be prepared in a superior manner. And notwithstanding the risk of being defeated in such attempts, it is quite certain that in numberless cases they have succeeded admirably; and very valuable woods now ornamenting both England and Scotland have been raised by these simple modes of planting.

When it is intended to plant a field which has been or may be ploughed, it is got in order by receiving a thorough fallow, to clear it of every kind of weed. The ploughings (with a strong team and plough) should be made as deeply as possible. Supposing the land to be got in perfect order by the middle of October, if intended for timber only, the trees may be immediately planted; but if intended for underwood as well as timber, the last ploughing may be deferred till January; and if the ground be then pretty dry and mellow, the whole may be immediately sown broadcast with a mixture of seeds, and harrowed in, after which trees may be planted at the distance of four or five feet. The mixture may consist of the seeds of oak, ash, beech, Scotch fir, and birch; and if a sprinkling of common furze be added, it will be no detriment. If Spanish chestnuts are intended to be a part of the underwood (for which they should always be preferred), the seeds should be dibbled in, as they are too large to be covered by the harrows.

This method of laying down woodland, if carefully performed, is always successful, as there is not only a full number and choice of trees for timber established, but the field answers the purpose of a nursery for many years, from which may be drawn unlimited numbers of young trees for planting elsewhere. The finest and most profitable woods we happen to be acquainted with were laid down in this way about the year 1775.

The next successful method of planting forest trees is placing them on deeply dug ground; for if digging be practicable it is proof that the land is in a good condition for their growth. The action of the spade forms a bed sufficiently deep for the generality of the best sorts for timber, and the loosened state of the soil renders the planting easy.

But by far the best preparation of the ground is trenching it eighteen or twenty inches deep. The surface, which is usually covered with vegetation of some kind, or the remains of vegetation, being turned to the bottom of the trenches, forms a fine nutritious stratum for the roots to luxuriate in; besides, the staple being opened and intermixed so thoroughly, admits all atmospheric influences, without which no plant can thrive.

When trees are planted upon either a dug or a trenched surface, seeds may also be sown and pointed in, for undergrowths are always valuable for some purpose or other. This is particularly necessary when the plantations are required as covers for game; and in park scenery, hawthorn, holly, and juniper berries, should always be sown when the trees are planted.

When ornamental plantations are made in a park, and especially if they are in view from the principal windows, they are wished to rise as quickly as possible for the sake of immediate effect. The trees, therefore, receive extraordinary treatment. The ground is not only carefully and deeply trenched, but a most liberal dressing of good rotten dung and vegetable mould—the first trenched down, and the latter dug into the surface—is bestowed, and which of course excites the trees into much stronger and more rapid growth than if only the ordinary expedients were employed. But this superior and expensive practice is seldom necessary, and much seldomer executed.

Planting on Bad Land.—The preceding directions are sufficient in all cases in which the land is tolerably dry, or which may be rendered suitable by a little preparatory culture; but when the ground is moist, and barren of all useful produce, the following methods of preparation will require to be pursued.

The first thing to be done with a piece of wet land is to drain it, and then enclose it with fences. The draining operations will consist in making wide and deep ditches around the land to receive and carry off the water, and into these smaller cross drains are to be led. (For a minute account of the best methods of draining, we refer to the article on LAND IMPROVEMENT). If the drains be finished in October, so as to allow the water to run off for three months, planting may begin about the middle of February, provided the weather be dry. "I would recommend," says a writer on this subject, "strong plants, three years old; for I have seen many small things stuck in among rank grass, but I have rarely seen any of them grow. The ordinary way of planting does well enough for the firs; it is done in this way:—A cut is made at right angles to the line of the labourers' feet, another is made at right angles to that, and the soil raised; the root of the plant is inserted; and the spade being withdrawn, the soil is or ought to be firmly trodden down around it. I say ought to be, for very often it is not. The labourers ought to have the importance of this reiterated upon them; and I would, if possible, always have a big man in preference to a little one to wield the spade. There is an emphasis in the tramp of his foot, which, for the success of the young tree, is invaluable. The other mode of planting is more tedious; but where the proposed plantation is small, I think it is worth while to give all the additional trouble. This method consists in making pits for the reception of the plants. A square piece is dug out, the plant is placed in the middle, the soil is broken and put round the roots, turf is cut in two, and being turned upside down, the halves are placed one on each side of the stem of the plant, and firmly trodden down all round. This, it will be seen, is tedious. Three plants may be planted by the first method for every one by the second; yet, where the plants are large, it is worth while to bestow the additional labour: especially in planting trees of the deciduous kind, this method ought always to be adopted. I have always found it advantageous to plant pretty close; but care must be taken to begin early to thin, otherwise the young trees fall into consumption. Ground treated in the manner now described, be it never so wet, will grow fine trees; that is to say, if there is any thing like a soil at all.

Let us next suppose the ground to be planted to consist of a thin poor soil on a hard close bottom. To plant such ground just as it lies, is a piece of the most consummate folly. Far better burn your young plants at once: they never will grow to any thing. The plan which I have now to propose has a most formidable objection against it—it is very expensive. But let the proprietor arrange the matter in this way: instead of planting, say ten acres in one year, let him plant only four. It is far better to have a few trees thriving, than a great many pining out a miserable existence, to the disfigurement of the face of nature and the bitter regret of their owner. The first thing to do is to set about trenching the ground. To the ordinary mode of trenching there is a most decided objection. That part of the soil which is at all good, is mercilessly buried at great labour and expense, and the hard till, which has about as much nutrition for plants as freestone rock, is brought up to form the soil. This will never do. We must keep the soil which is at the top still at the top, and stir the till below. At first sight there is some difficulty here, but the difficulty must be overcome, and that may be done by a little calculation as to arrangements in the matter of digging and filling up the trenches. The cost will be only a little more than that of ordinary trenching, and it is vastly superior to it. It would also be an advantage as each trench is cleaned out, to give it a rough course of picking along the bottom, which would make the soil although never so wet before, dry and sweet as a garden. The best time for performing this operation is in the months of February and March, and then only when the weather is dry. It would be well if planting could be carried on simultaneously with trenching. And see that the plants be put in *deeper than usual,* and well trod round the stem.

Ground thus treated will produce the finest trees. They will grow fast, keep free of moss, be healthy in the bark, and straight. It would be advisable, even with this trenching, to open drains throughout the whole that is planted, in order that the surface-water may be carried freely away. Land, when thus dried, becomes richer by every shower that falls. The water, in percolating through the soil, carries down with it a fresh supply of oxygen gas, which the roots of the trees, with their thousands of little mouths, are gaping to receive as their most nourishing food; and being thus fed, is it not natural that they should grow apace and be in good health? In this way you will have in six or eight years fine plantations, forming an ornament to your property and a shelter to the fields. By the other method you may plant thousands of trees; but where the soil is positively wet, you will never see any of them do more than make an ineffectual attempt to grow.

I have now a few observations to make regarding the after-treatment of trees planted in the manner now recommended. They must not be left to themselves; and if hedges be planted, they will require much care, for the first three years especially. They must be kept perfectly free from weeds, at whatever expense of labour. Thin, board-like hedges, cut close upon each side, are not the thing. I never saw any so treated do well. They must have breadth, and should be tapered on both sides to the top. But let us attend to the trees. Exactly a year after they are planted, where the ground has been trenched it will be requisite to give it a partial hoeing, that is, to cut down all tall weeds which may be overtopping any of the trees. Should any of the hard wood, in place of being green, become yellow, there is a plan which, if adopted, will completely restore them. Two years after they are planted, let them, in March or April, be cut over about three inches above the ground; in the month of July a careful person must go through and pinch off all the young buds except one, the healthiest, and the one which offers fairest to shoot into a main stem. This has a most magical effect. It insures a healthy tree, with a free bark, and perfectly straight. I have had oak, ash, and other timber thus treated, which have made beautiful shoots of upwards of two feet in one year. Trees which are on the whole thriving and sufficiently straight, but which are getting hard in the bark, I have generally improved very much by the following process:—You enter the point of a common gardening knife as near the root as possible, and run it up to the first branches. In a year or two this cut will be covered with new bark, an inch or two in breadth, greatly contributing to a free circulation of the sap, and consequently promoting the health and the growth of the tree. I have seen trees twenty and thirty years old materially benefitted by this simple process. A handy labourer will do many hundreds in a day.

If the hints I have now given be followed, I am quite confident that they will save much disappointment to proprietors who are disposed to plant, and that many fine trees will be raised on situations in which, by the common management, they never would have attained to either beauty or value."

Pruning and Thinning Plantations.

When woods are planted as sources of profit, a very material part of their subsequent management is the labour of pruning and thinning the trees. It is not enough that trees grow and be annually increasing in bulk—they should also be assisted to take the finest and most valuable forms. A round straight butt, of moderate length, is far more useful and saleable than a crooked knotty one of twice the size. To have fine timber, it is absolutely necessary to bestow a little trouble to start them fairly off, during the first ten or fifteen years of their growth. The best method of raising a plantation is by using a mixture of different sorts, which may be deemed *principals* and *secondaries*. The first are those for which the land is judged most suitable, the second are nurses or supernumeraries, intended to be drawn out as soon as they press injuriously upon the principals, or when they have attained to a useful or saleable size.

To have tall and straight stems, the trees must be planted thickly at first; that is, only about four feet apart, or even less. In this order they shelter and prompt each other to ascend; and if in the spring the woodman pays his annual visit, armed with a light keen bill and a narrow *turning-saw*, he may direct the growth with the best effect. Every lateral branch which appears to be attracting too much of the powers of the plant, and especially if, as already observed, it be contending for supremacy with the leader, should be sawn off *close* to the bole as soon as it has attained a diameter of one inch. Such a wound will be soon healed up, and present no flaw when the tree is cut up at the saw-pit. All branches of a smaller size need not be removed, for they serve to enlarge the trunk, and have no effect in distorting the grain until they attain the size when they should be pruned off. If branches are allowed to remain until they have acquired a diameter of from two to four or more inches, and then cut off either close, or, what is much worse, at some distance from the bole, the timber is sure to be deteriorated. Such wounds, it is true, will be healed over in time, but the timber will be wanting in its best property—namely, soundness and freeness from knots. All branches originate at the pith of the main stem; and whether they are alive or dead when the tree is felled, they are equally objectionable in the estimation of the builder or mechanic. The knots in fir timber are less objectionable, because they are preserved sound by the resinous quality of the sap; but neither are they desirable, if trees can be grown with a clear uninterrupted grain.

The most valuable part of a tree is the bole, and the longer and freer from knots this is, the more saleable; and if any or every tree may be made to grow into fine sound boles of fifteen or twenty feet in length by a little such attention as is recommended above, it is surely well worth the trouble and expense.

All species of the hardy pine and fir tribe intended for profit should be planted pretty thickly; the supernumeraries thinned when young, but leaving a full number of principals to grow up to a marketable bulk, or until they cease to thrive, when they will all be ready for the axe together; for such woods cannot bear to be thinned gradually like other trees, being particularly liable to die if they lose the protection of their neighbours. When planted as nurses among deciduous trees, they are easily kept within bounds, and from damaging the other trees, by pinching off, from time to time, the *leading buds* of their branches. This induces a spray-covered rather than a naked stem, and thus maintaining their character as nurses. By the same means, fir-trees may be formed into impervious screens, or sheltering hedge-like boundaries, very useful in many cases of rural improvement. Respecting the pruning of fir-trees planted for profit, and which are intended to grow up with clear-grained butts, a rule has been laid down by planters which is easily followed: it is this—prune off the lower branches every second or third year, always leaving *five tiers* of branches to form the head. This regular method of keeping the butt divested of its lower branches, and continued up to the highest convenient height, will certainly ensure fine butts of clear-grained timber, as all the knots will be small, and all near the centre of the axis. The fine clear-grained butts imported from America and the north of Europe, are trees which were never pruned; but having grown up in very close order, the lower spray was consecutively killed by the want of air and light, shut out by the close canopy of branches above. This is gaining sound timber by accident, and which may be done in any country, but by no means in such a short time as may be done by hand-pruning.

In very many instances, trees are suffered to remain in the ground considerably beyond the time they should be felled and put to the proper object of their growth. They are seen to get rotten at the core, or the branches are seen to die; still, from an unwillingness to remove what may be viewed as old friends, they are allowed to remain till accidentally destroyed. Instead of following this practice, we recommend the proprietor of forest timber to have his woods periodically examined by a person skilled in timber, who should mark all the trees that seem ready for removal, and let them be removed accordingly. Unless for particular reasons, every tree should be cut down on arriving at maturity, and a new one planted in its stead.

Trees grown for ornament in lawns, require no other pruning than what may be necessary for the removal of rotten or decaying branches; and in general it will be found advisable to leave each kind of tree to assume its own natural form. Ornamental trees are always most beautiful in their proportions when the branches and spray reach towards the ground; but this will not be the case if cattle are allowed to browse beneath and around them. These animals nibble away all the foliage and spray within reach, so as to form in park scenery what is called the *browsing line*—an even bottom of foliage, any thing but agreeable to the eye. The only plan of avoiding this inelegance is to exclude browsing animals altogether from ornamental grounds; but this is attended with opposite evils, and takes away that pleasing assemblage of forms which is the great charm of woodland scenery. Where cattle or sheep are permitted to browse, all young trees, at least, must be protected for some years by circular palings, otherwise they would be disbarked, and generally destroyed.

To ensure dryness of timber, it has been found a profitable practice to disbark the oak and larch a year or two before felling. On this point Monteath, in his "Forester's Guide," says he is decidedly of opinion, that the larch treated in this way at thirty years of age, will be found equally durable with a tree cut down at the age of fifty years, and treated in the ordinary way

Transplanting Trees

Trees may be lifted from one place to another or transplanted. The art of accomplishing this exceedingly delicate operation in tree culture, was some years ago brought to perfection by the late Sir Henry Steuart, of Allanton, whose treatise is the best authority on the subject. The transplanting of a full-grown tree has, in all ages, been deemed next to impossible; and when it was attempted, the operator thought it necessary to cut off a great number of the branches, (and consequently the leaves,) from an idea that, if suffered to remain, they would require more sap than the roots could supply in their new situation. Of course, just in as far as they deprived the tree of its branches, or, we may rather say, of its leaves, they deprive it of the principal organ of its existence, and it invariably decayed to a corresponding degree. The lopping was like a cutting off of the lungs in a human being; and it would be as absurd to expect a man in that state to be healthy and strong, as it was to hope for vigour in the stripped member of the forest.

Sir Henry Steuart, having studied the internal structure of trees, began, a good many years ago, to practise the art of transplanting on what he justly calls the preservative principle: that is, without mutilating either roots or branches, as was universally practised till his time. His seat, Allanton House, is situated on an irregular slope, on the right bank of the river Calder, which is a tributary of the Clyde. The neighbouring ground, though diversified, has no very picturesque natural points, but he contrived, by the removal of large trees, and forming an artificial lake and river, to realize in some measure the miracle of bringing new and picturesque scenery into actual existence, in an almost endless variety of combination.

The following are the rules to be attended to in the transplanting of trees. The best season for transplanting is certainly during the months of October and November; for though trees may be transplanted in any of the winter months when the weather is mild and moist, they never do so well as when removed in the first-mentioned months. Taking up a tree requires as much care as replanting it; the spade and the pick-mattock are both necessary to raise the roots from their seat; and as the most tender fibres are the most active and useful, the greatest care should be taken to preserve them entire. Neither should these delicate fibres be exposed to a dry or frosty air; they should be kept moist and shaded till again put into the ground. The root should be placed no deeper in the new place than it was in the old; and all the ramifications laid in their natural positions, and imbedded in the finest of the earth.

Trees may be transplanted from the age of one up to ten, or even twenty or more years; but when they are from four to six years from the seed, they are, both from age and bulk, in the best condition to be removed successfully. In planting with the one-handed tool, the smallest-sized plants must be used; for pitting, plants from two to three feet high may be chosen; and on digged, ploughed, or trenched ground, the young trees may be from two to six feet high, in which case the tallest may need propping against the south-west winds.

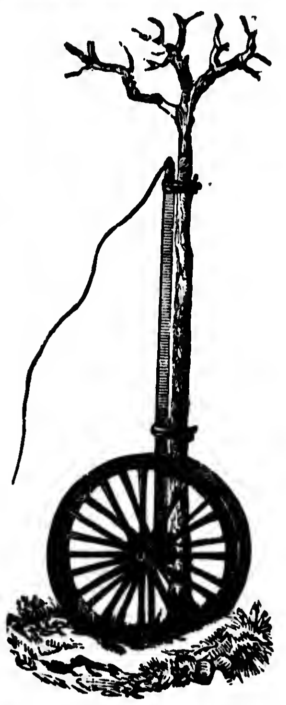
When single trees are to be planted on a lawn, a space of from four to six feet must be stripped off the turf, and rolled back; the soil within should be deeply broken up and excavated, to receive the full spread of the roots. A heap of richer loam or compost is laid in the centre, on which the tree is placed and the roots are covered with the same, and watered to consolidate the earth about the fibres. The other soil is then thrown on, and the turf returned to its place and beaten down firmly. Single trees should be staked; and if on a pasture, a cradle will be requisite to defend them from the browsing or rubbing of cattle.

Much has been written on the subject of transplanting large trees, and many successful exploits of this kind have been performed both in past and present times. Shady groves have been formed in the short space of a few months; proving that, with care, skill, and physical force properly directed, any tree of moderate size, say from twenty to forty feet high, may be transplanted with safety and success. One precaution very much facilitates the execution; it is that of digging a circular trench at a proper distance, say six feet, round the trunk, and deep enough to be below, and to cut through all the roots except three or four of the largest, which are left at equal distances to act as spurs for the better security of the tree when placed in its new situation. The trench, after the stumps of the roots are cut smoothly off, is filled with prepared compost, for a new fringe of roots to strike into, and after one or two years the tree is in a condition for removal. In doing this, a deeper trench is made on the outside of the first, into which the mould from among the roots is drawn, until the whole is loosened from the soil; the spur roots are also followed out and laid bare. The method of raising the tree by a machine is mentioned beneath. In replanting, much depends on laying out the roots, and firmly embedding them in moistened earth, and also adding a pretty heavy covering of soil round the stem, to keep the tree steady against wind.

Every tree about to be planted requires a little pruning; broken roots should be removed, and the head may require thinning. The branches should be equally balanced; and if any one appears to be a rival to the stem, it should be cut off close; so those rising with two stems should be deprived of the weakest. These remarks only apply to deciduous species; the pines and firs need no thinning when transplanted, unless some of the lower spray is dead.

Machine for Transplanting Trees.

This machine is formed on the principle of the common timber-truck, being a strong lever attached to the axle-tree of a pair of wheels. The latter are strongly constructed, at least five feet in diameter, and with a six or nine inch tire. The axle-tree is correspondingly substantial, and to its middle the pole or lever is securely fixed. The pole should be made of the best ash, seven inches square, with the edges planed off, and somewhat reduced in thickness towards the end. The length should be at least ten feet, for the longer it is, the greater the purchase in raising a tree. The pole is strengthened by side braces let into the axle, and mounted with an iron eye and ring at the point. When used, it is backed against the tree, and the pole is raised and made fast thereto, as here represented. The



wheels rest in the hollow made by baring and loosening the roots, though not upon any of them; and when all is ready, the strength of men or that of a horse, is applied to the pole chain, which is, together with the tree, pulled to the ground, the root being lifted out of the soil; and when thus borne on the machine, it is drawn away, root foremost, to its new place, previously prepared for its reception. The wheels are drawn into the new opening, the pole and tree are set at liberty, and, if the root be heavy, the tree will resume its former position with but very little assistance. The machine is then loosened from the tree, and removed out of the way; the roots are then laid out carefully, and embedded in loose soil, well consolidated and watered, which finishes the planting.

When a machine is made on purpose for removing large trees, the axle-tree may be made to fit a pair of cart-wheels for a temporary purpose; but the axle should be formed with *straight*, not *drooping*, ends, as they are usually made, because this renders raising the pole much easier. Upon the upper side of the axle there should be a thick block of wood bolted, to give more elevation to the root when drawn along; and on this an old sack, or a thick band of straw, is bound, to prevent chafing the bark of the tree.

Renovation of Decayed Trees.

In favourable circumstances as respects soil and climate, trees seem to be immortal; but in our own country, these favouring circumstances are afforded on a limited scale, and consequently we can show no trees which are beyond the reach of decay. A time invariably arrives when they begin to show symptoms of decay, and the means to be adopted to prevent, as far as possible, the occurrence of this evil, require now to be noticed. On this delicate and important department of arboriculture, we have great pleasure in laying before our readers the detail of a process discovered by the late Sir Henry Steuart, communicated in a letter to Admiral Sir T. Livingston, Bart.

"Dear Sir,—Agreeably to my promise, I shall now give you an idea of my method of reviving or resuscitating old trees, which has often succeeded with myself, and which I have recommended to others; but there is no account given of it in the notes on any treatise on the application of the science of physiology to practical tree-culture, and particularly in removing large trees for ornament or use.

"The decay of old trees, both in England and Scotland, has been a subject of general complaint during at least a century; and it is observed, with regret, that their place does not promise to be very speedily supplied by existing woods and plantations. The general causes of the decay of trees are twofold. The first proceeds from diseases to which all woody plants are subject; the second, from extreme old age, but more frequently from their having exhausted the pabulum within their reach. The pathology of the vegetable tribe, in this respect, differs materially from that of the human species. Among the sons of the forest, there are no vicious efforts made by individuals, as among us, by means of disease, to shorten life. There are no gourmands nor sensualists, by fatal indulgences and artificial luxuries, to bring on premature old age. The laws of nature in trees are allowed fairly to operate, and their existence, therefore, may be reckoned on, and even prolonged by art, to an indefinite period. It has been said that the roots of trees in a favourable soil will go abroad in search of their food at a distance from the stem equal to the entire height of the tree taken from the ground; and wherever this is found to hold good, trees will live to a very great age, especially in a deep and calcareous soil.

"Of your two fine old trees at Westquarter, Stirlingshire, which I lately examined—a holly and a double-flowering thorn—I must say that they appear to me to have declined chiefly from the *latter* of the two causes above mentioned, namely, their having exhausted the food or pabulum in their immediate neighbourhood; and, in the case of the thorn, in some measure from the ground being overstocked with other plants, that greatly crowd upon it, even to the exclusion of light and air, without which no plant can flourish. As to the holly, it seems stunted and hide-bound, and sends out no free shoots at top, such as a tree in health, in so fine a soil and climate, ought to do. The terminal growths of the thorn, also, have begun to decay; and if some salutary remedy be not speedily adopted to *excite the roots to fresh action*, it is plain that the evil will ere long extend to the greater branches, and as a necessary consequence to the trunk itself.

"The first thing that I should recommend to be done with this noble thorn, is to cut away the ivy that now strongly adheres to it. That parasitical plant has covered nearly the whole external surface of the stem. It already intercepts the kindly influence of the sun and air from the bark of the tree, under which the finer vessels of the descending sap lie, so that it may be said to prey upon the very vitals of the plant. The next object should be, to clear the ground, for a considerable space, of overshadowing shrubs and bushes. So venerable a tree, standing single, would be the most graceful ornament of the verdant turf that surrounded it.

"The second thing that I would do would be to dig a trench round the tree, not exceeding three and a half or four feet out from the stem; which trench should be five feet broad at least, and as deep as to penetrate through both the soil and subsoil, however deep either may be, until you reach the rock, gravel, pure sand, or obdurate clay (*Scotticè*, till) that may lie below. In doing this, the workmen may fearlessly cut through all the roots they meet with, leaving only three or four great ones, on the south and south-west sides, to act as *cables* in resisting the severe winds that usually blow from those quarters in every part of the island.

"Next, let whatever parts of the trench that consist of good earth, or of earth capable of being easily made so, be thrown aside, and the sand or gravel, if any, be wheeled away; so that you may obtain a depth in the trench of two feet or more, if the soil permit, of well-mixed mould. For this purpose, let good compost or rich garden mould (of which I saw abundance near the spot) be intimately mixed, by two or three times turning, with the better parts of the contents of the trench, adding about a third part of good well-rotted dung, so as that a proper chemical action may be excited throughout the mass, and the whole rendered fit for the food of plants. This done, let the trench be filled up with such compound somewhat higher than the original soil; and let the space which has been left untouched, of four feet out from the stem to the edge of the trench, be covered eight or nine inches deep, with the same prepared and friable compound, pointing it in with the spade only about three inches deep, so as not materially to injure the roots. In order to complete the process, let all the dead wood be carefully pruned away from the branches with a saw, but dressing the extremities afterwards with a sharp hedge-bill.

"In the following spring, all moss or other impurity should be scraped off the bark, and the entire stem well washed, two or three times, during the summer season, with soap and water and a soft brush.

"By following the above method, which, however elaborate it may appear in the description, will be very easily reduced to practice, I feel confident that many fine old trees in gentlemen's parks, that are now allowed to decay, might have *another century* added to their existence; because the extension of fresh pabulum at pleasure to greater limits, would be a labour well repaid, and attended with little expense, and as little difficulty. There are few persons who would not bestow more labour than this on a favourite tree; and there are perhaps fewer who will not admit that it might easily be applied to purposes of general utility as well as local ornament. The principles on which this process has been instituted are in accordance with the laws of animal as well as vegetable physiology, and will be confirmed by practice, if they be allowed to govern the process. I have uniformly found that the roots, where cut through in the opening of the trench, will send forth an immense body of vigorous ramifications, of from a foot to fifteen inches in length, during the first and second months after the operation, with thousands of capillary rootlets emanating from them, all which will go abroad in search of sap, for renovating the vigour of the tree. In a tree of considerable age, such as the two above alluded to, at your beautiful place, it is to be observed, that much figure cannot be expected to be made, during the first year, in the elongation of its terminal shoots; and for this plain reason, that effects must necessarily be preceded by their causes, whether they lie on the surface or otherwise; but the leaves will speedily become larger, and of a deeper green colour, than for some years past; and by the autumn of the second year, it will be admitted that the tree is in some sort about *to renew its youth*.

"During the early part of the first season, the new mould should be allowed to remain quite undisturbed; but towards the end of the year, the gardener or forester may cautiously look in, and he will observe the wonderful efforts towards the increase of leaves, and, by consequence, towards a fresh supply of sap, that the plant will even then have made; and after the second year, the renovating process will appear still more striking.

"These directions apply equally to both the thorn and the holly at Westquarter, with this difference, that, in consideration of the far greater exposure in which the latter is placed, I should not advise that the trench be opened nearer than within five feet of the stem; also, a greater number of large roots (to act as cables in supporting the tree), say five or six, should be left entire, running across the trench.

"The month of February or beginning of March, according to the season, before the ascending sap begins to stir, would of course be the best time to carry into effect the methods of resuscitation above detailed; and as Allanton House is at no great distance, I should have much pleasure in paying you a visit, and directing the execution myself.—With great esteem, I remain, dear Sir Thomas, your most faithful servant,

"H. STEUART."

Coppice and Fences.

Coppice or underwood is either natural or planted. Natural underwoods appear to be the remains of ancient forests, which are kept enclosed, and are felled periodically at long or short intervals, according to the purpose for which the stuff is to be applied. Planted underwoods are either willow bolts for the basket-maker, hoops for coopers, hop poles, poles for fencing and hurdle-making, stakes and headers for hedging, broom, hay-rake, and mop handles, spray for birch besoms, fagots for brickmakers and bakers, kindlers, and other firewood, and withes for binding fagots, &c.

Thriving and well-fenced and well-managed underwoods are considered more profitable than timber-woods. The first are very soon a source of income, and as such are subject to tithe, which has caused many acres of them in England to be allowed to grow up into woods, which are free from tithe. But timber and coppice may be united; the standard trees to stand thinly, and if kept pruned up, the undergrowth is not much hurt by their shade. Mixed underwoods are cut every five, seven, or ten years, unless they are entirely of oak, when they are allowed to stand longer, for the sake of having larger poles, together with the bark, which last is the principal part of the value of the fall. When such a fall is made, every superior-looking well-placed pole is left as a standard, if standards be wanting; these at last become fine trees, and are felled in their turn.

The most profitable underwood is that which has been planted, and each sort of tree kept by itself, having regard to the quality of the soil most suitable for each, if there be any difference. For instance, ash and Spanish chestnut should have the driest spots; oak and birch those which are more moist; alder and willow the moistest. All the sorts should be planted very closely together, because this not only increases the length and number but improves the form of the poles, circumstances which very much add to their value.

The ground should be prepared for underwood in the same manner as for timber-trees, either by the plough or spade. Wet land is usually laid into beds with narrow ditches between, the soil out of which serves to raise the beds, and give the roots more scope. Several wild shrubs introduce themselves among underwood, particularly hazel and hawthorn, neither of which are much objected to, as the first is a useful coppice plant, and the last is always in request about a farm.

Some of our ornamental shrubs arrive at the height of trees, and some of them produce excellent and beautiful timber; such are the cypress, holly, laburnum, and guelder rose. Large scantlings of the second and third are much prized for veneering.

The shrub usually employed for living fences is the hawthorn, which, by proper treatment, may be rendered a very effectual protection to fields. The shrubs should be planted when young, according to the required line, on the top of a dry bank; and, till they attain a sufficient size, the rows will require to be protected from cattle by palings. The way to cause the plants to increase in bulk, by throwing out lower branches to form a compact hedge, is to keep the ground free of weeds—a duty far too frequently neglected—and prune the outer struggling branches annually, when the sap is down. From neglect of these precautions, thorn hedges are frequently thin, scraggy, and almost useless in preventing the exit of sheep, and even cattle from enclosures. Besides weeding and pruning, thicken open spaces by inserting new plants when necessary.

Latterly, furze or whins have been employed with much advantage as fences, but this hardy native shrub will grow only where there is great freedom of air, and succeeds best in northern climates.

AGE AND SIZE OF TREES.

It has been mentioned in our article on VEGETABLE PHYSIOLOGY, that if a tree (of the exogenous kind) be cut transversely and examined, it will be found to consist of a number of cylinders enclosing one another like so many layers or concentric circles disposed round an axis; and that, as a circular layer is deposited every year, it is possible to ascertain the age of the tree by counting the number of the layers. M. Decandolle, one of the most celebrated botanists of modern times, has, as appears from a work on the subject, paid great attention to this method of ascertaining the age of trees. He observes, that the method of reckoning now alluded to is not liable to much error, but the inspection must be conducted with the greatest care; for the older circles become condensed into a mass, and their number can only be guessed at by measurement. "My plan," says he, "is as follows: When I have got a section of an old tree, on which I can see the circles, I place a sheet of paper upon it, extending from the centre to the circumference. On this paper I mark every circle, showing also the situation of the pith, the bark, the name of the tree, the country where it grew, and any other necessary observations. I also mark in a stronger manner the lines which indicate every *ten years*, and thus I measure their growth at *ten years'* intervals. Measuring from centre to circumference, gives me the circles; doubling this I have the diameter, and multiplying by six I have the circumference."

The learned professor then presents a table of the periods of increase in the diameter of various trees, an inspection of which proves that every tree, after having grown rapidly when young, seems at a certain age to take a regular march of growth, which may perhaps be accounted for by supposing that young trees have more room to expand in, are less pressed by the roots and branches of their neighbours, and may not have penetrated down to a hard, arid, or otherwise unfavourable soil; and also, that as trees advance in age, they still continue to form layers as thick as they previously did subsequently to the period of rapid growth. If such tables were multiplied to a sufficient extent, as we have no doubt they will be in course of time, they would form data from which, by ascertaining the circumference of a tree, its age might be known without having recourse to the destructive process of cutting deep into the growing timber. "If," says Decandolle, "one cannot get a transverse section of a trunk, then one must seek for old specimens of each kind, the date of whose planting is known, measure their circumference, deduce their average growth, and calculate from them the age of other trees of the same kind, always keeping in mind that young trees grow faster than old ones." Decandolle cites instances of trees whose ages have been ascertained according to the rules here laid down. Some of these we shall present to the reader, along with descriptions of other trees obtained from a variety of sources, particularly American publications.

A certain *Baobab tree* of Africa is considered by Humboldt as the oldest organic monument of our planet; and Adanson, a distinguished botanist, by ingenious calculations, has ascertained its age to be 5150 years. The method adopted by Adanson for finding its age, was by making a deep cut in the side of the trunk, and counting the concentric rings, by which he ascertained how much the tree had grown in three centuries; and having already learned the growth of young trees, he established his general law through the average growth. The enormous dimensions of the trunk of this tree bear a striking disproportion to the other parts. Examples of the species have been seen, which, with a trunk ninety feet in circumference, were only twelve feet in height. A still larger was seen by Mr. Golberry in the valley of the two Gagnacks, in Africa; it was thirty-four feet in diameter. The flower is of the same gigantic proportions as the tree. Such colossal masses of timber might be hollowed out into by no means straitened dwelling-houses.

One of the most celebrated trees described by travellers of recent times, is the *Great Dragon tree* of the island of Teneriffe. It derives its name of *dragon's-blood*, by which it is popularly known, from the circumstance of a liquor of a deep red colour like blood flowing from its hoary trunk during the dog-days. This exudation soon becomes dry and brittle by the action of the atmosphere, and is the true dragon's-blood of the apothecaries and other venders. The wonderful size and appearance of this tree excited the admiration of Humboldt, who thus describes it:—"We were told that the trunk of this tree, which is mentioned in some very ancient documents as marking the boundaries of a field, was as gigantic in the fifteenth century as it is at the present moment. Its height appeared to us to be about fifty or sixty feet; its circumference near the roots is forty-five feet. * * * The trunk is divided into a great number of branches, which rise in the form of a candelabrum, and are terminated by tufts of leaves, like the yucca which adorns the valley of Mexico. It still bears, every year, both leaves and fruit. Its aspect feelingly recalls to mind 'that eternal youth of nature' which is an inexhaustible source of motion and of life." This giant plant was laid prostrate by a tempest in 1822.

The fact here noticed by the learned traveller, that the tree annually bore leaves and fruit, affords indubitable proof of a very remarkable circumstance connected with the vegetable kingdom. In man and all other animals we find an organization and a process of life going on which are destined to cease at a certain period. But it is otherwise with trees. They appear to possess the power of growing on for ever without exhibiting any symptoms of decay, unless from accidental or extraneous causes. We shall quote the words of Decandolle on this point:—"As there is formed every year a ligneous deposit, and generally new organs, there is not among the vegetable creation place for that hardiness or rigidity, that obstruction of old and permanent organs, which constitute properly the *death of old age*, and, consequently, that being the case, trees can only die from accidental causes. Trees do not die from age in the true sense of the word; they have no fixed period of existence; and, consequently, some may be found that have arrived at an extraordinary age." But although a tree thus possesses in itself the elements of continual strength and youth, numerous causes step in to interrupt or destroy its existence. In corroboration of what we state, we need only allude to the facts, that soil is of limited depth—that, below the soil, there are usually hard strata, which the feelers of a plant cannot penetrate—that roots intercrossing encumber each other, and check vegetation—besides which, there are other destructive and obstructive causes which we need not occupy the reader's time by specifying. Consequently, although what the French philosopher says is quite true, that "some (trees) may be found that have arrived at an extraordinary age," yet, every circumstance considered, we are not to be surprised if the number found should prove exceedingly small, compared with the immense extent of the earth's surface which is covered with forest trees.

Cypresses of gigantic dimensions are met with in Mexico. At Atlexo there is one seventy-six feet in girth; and another at St. Maria del Tuli, in the province of Oaxaca, which is one hundred and eighteen feet in circumference! This is larger than the dragon tree of the Canaries, and all the baobabs of Africa. "But," says Humboldt, "on examining it narrowly, M. Anza observes, that what excites the admiration of travellers is not a single individual, but that three united trunks form the famous *Sabino of Santa Maria del Tuli*." The fact of the threefold nature of the stem seems to have escaped the notice of some writers; it is of importance in determining which is really the largest organic monument of our planet. There is another cypress at Chapultepec, in the same region, which is said to be one hundred and seventeen feet ten inches round, and the younger Decandolle considers it even older than the baobab of Adanson. If the measurement here given be correct, and the tree consists only of one stem, we are entitled to regard this Mexican cypress as the most gigantic and ancient tree hitherto discovered on the globe. Hunter says that in 1776 there existed in the garden of the palace of Grenada cypresses that were celebrated even in the time of the Moorish kings, and which were named *Cypressos de la Regna Sultana*, from a sultaness who was seen sitting under it with a lover, who was one of the Abencerrages. They are supposed to be eight or nine hundred years old. Strabo mentions a Persian cypress in girth as much as five men could span, and he believed it to be two thousand five hundred years old. But this must have been guess-work; at least we are not aware that he made the computation after the skilful manner of Adanson or Decandolle. Michaux, a Frenchman, has published a splendid work on the forest trees of the United States. He says that the largest stocks of the cypress are one hundred and twenty feet in height, and from twenty-five to forty feet in circumference, above the conical base, which at the surface of the earth is always three or four times as large as the continued diameter of the trunk. Cypresses are among the trees in the south of Europe which live to the most advanced age; and the custom of planting them in cemeteries and consecrated ground, ensures respect being paid to them, and thus affords botanists the means of measuring them.

Yews are believed to be the most ancient trees of Great Britain; and no doubt can exist that there are individuals of the species in England as old as the introduction of Christianity, and, there is every reason to believe, a very great deal older. It is the opinion of Decandolle, that of all European trees, the yew is that which attains the greatest age. "I have measured the deposits of one of seventy years; Œlhafen has measured one of one hundred and fifty years; and Viellard has measured one of two hundred and eighty years. These three measurements agree in proving that the yew grows a little more than one line annually in the first one hundred and fifty years, and less than a line from one hundred and fifty to two hundred and fifty. If for very aged yews we take the average of one line annually, it is probably an admission beyond the truth; and thus, in estimating the number of lines and years as equal, we make them younger than they really are." We think this reasoning very plausible, and point out to such of our readers as may have opportunities of seeing old yew trees, how easily they may ascertain their age.* The line here spoken of is one-tenth of an inch. The circumference may be taken just above the base of the tree; the third of this measurement gives the diameter, and every inch of diameter is equal to ten years. There are four measurements of venerable yews in England—those of the ancient Abbey of Fountains, near Ripon in Yorkshire, which yews were well known as early as 1155. Pennant says, that in 1770 they were 1214 lines in diameter, and, consequently, were more than twelve centuries old. Those of the churchyard of Crowhurst in Surrey, on Evelyn's authority, were 1287 lines in diameter. There are two remarkable yews still in the same cemetery, and if they be the same which Evelyn refers to, they must be fourteen centuries and a half old. The yew tree at Fortingal in Perthshire, mentioned by Pennant, in 1770, had a diameter of 2588 lines, and, consequently, we must reckon it at from twenty-five to twenty-six centuries old. The yew of Brabourn churchyard in Kent, has attained the age of 3000 years; but that at Hedsor in Bucks surpasses all others in magnitude and antiquity. It is in full health, and measures above twenty-seven feet in diameter; consequently, according to Decandolle's method of computation, this yew has reached the enormous age of 3240 years! In all likelihood, this is the most ancient specimen of European vegetation.

The elm attains a very large size, and has a very rapid growth, both in Europe and America; but the elm of the latter country has a much more majestic appearance than that of Europe. Michaux characterizes it as "the most magnificent vegetable of the temperate zone." A specimen mentioned by Decandolle, which grew near the town of Morges in Switzerland, measured seventeen feet seven inches in diameter, and was estimated at three hundred and thirty-five years of age. He informs us that it grew on an average three lines and a half yearly; but dividing its growth each century, it grew six lines annually the first, two and a half the second, and two and three-fourths the third; and this growth agrees with that of those elms planted by order of Sully, before the Chambers in France. Every one who has it in his power to ascertain the rate of growth of trees ought to do so, as he is thereby not only gratifying a rational curiosity, but conferring a benefit on science. Wherever the age of an elm or other tree is correctly known, its girth should be taken, and a plain statement of the species of tree, the nature of the soil where it grew, its diameter and age, transmitted to any journal, the special

* We are aware that at the British Association which met in 1836, a paper was read contradictory of Decandolle's computation regarding yew trees, and stating that he made the old trees too young, and the young trees too old. The experimenter asserted that the mean average of the number of lines which a tree increased in a year, was two, or one-fifth of an inch. But Decandolle is the highest authority, and we are inclined to abide by his opinion till further experiments have been made.

object of which is to take cognisance of the vegetable kingdom. We are certain that many of our readers have this in their power. Indeed, Decandolle earnestly solicits the attention of English botanists to the subject; for it is only by an extensive accumulation of individual facts that general laws can be established.

One of the most curious and beautiful of nature's productions is the Banian or Burr tree, the *Ficus Indica* of botanists. Each tree forms in itself a grove, composed of numerous stems connected together, some of which are of the size of a large tree. On the island of Nerbuddah, near Baroach, in Hindostan, there is still standing a celebrated banian, called the *Cubeer Burr*. The tradition of the natives is, that it is three thousand years old. It is supposed by some to be the same tree that was visited by Nearchus, one of Alexander the Great's officers. The large trunks of this tree amount in number to 350, the smaller ones exceed 3000, and each of these is constantly sending forth branches and hanging roots to form other trunks. The circumference of this remarkable plant is nearly 2000 feet. Milton, in his "Paradise Lost," has described one of these trees as that of whose leaves our first parents "made themselves aprons" after the fall.

———" Soon they chose
The fig-tree, not that kind for fruit renowned,
But such as at this day, to Indians known,
In Malabar or Decan, spreads her arms,
Branching so broad and long, that in the ground
The bending twigs take root, and daughters grow
About the mother-tree, a pillared shade
High over-arched, and echoing walks between."

The lime is the European tree which, in a given time, appears capable of acquiring the largest diameter. Decandolle has some observations on the rate of growth of this tree, which may prove useful. He says—"that which was planted at Fribourg in 1476, on occasion of the battle of Morat, has now a diameter of 13 feet 9 inches, which would give about two lines of annual diametric growth. This is about the rate of the increase of the growth of an oak, and therefore I suppose the tree had not found a favourable soil, and it would be nearer the truth to calculate the annual growth of the lime at four lines. There are in Europe a great number of limes of large size, and it would be interesting to have the circumference of those whose date is known. I shall mention for their size that of the Chateau of Chaillé, near Melles, in the department of the Deux Sèvres, which in 1804 measured 15 metres round (about 50 feet), and which I suppose was then five hundred and thirty-eight years old; that of Trons in the Grisons, already celebrated in 1424, which in 1798 measured 51 feet in circumference, and which I calculate to be five hundred and eighty-three years old; that of Depeham, near Norwich, which, in 1664, was 8½ yards in circumference; and that of Henstadt in Wurtemberg, which, in 1550, was so large as to have need of props, and which, in 1664, was 37 feet 4 inches in circumference. One must distinguish between the large and small leaved limes, as the former appear to grow faster than the latter." There appears to be a mistake in regard to the Depeham lime. We suspect it is the same mentioned by Sir Thomas Browne, which, he says, was 90 feet in height, and 48 feet round at a foot and a half from the ground. He also describes a poplar near Harling as of nearly the same dimensions. The largest now known in England grows in Moor Park, Herts.

The Oriental plane is one of those trees which attain the largest size, but the rate of its increase is not ascertained. In the valley of Bujukdére, about three leagues from Constantinople, there is a plane which calls to mind one which Pliny has celebrated. According to the Roman naturalist, there was a plane-tree in Lycia which had a hollow trunk capacious enough to accommodate the consul Licinius Mutianus and eighteen followers, who found within its ample cavity a retreat for the night. This living vegetable grotto was 75 feet in circumference, and the summit of the tree resembled a small forest. The plane at Constantinople is 150 feet round, and within it there is a cavity of 80 feet in circumference. This transcends the tree of Pliny. There are other very large oriental planes mentioned by Clark and others, and one of vast size was lately noticed by Mr. Quin in his voyage down the Danube. For the information of our readers, we may mention that, in the eastern states of the North American Union, the tree is called Button-wood, and in the western states Sycamore. Under the latter appellation, Mr. Flint, the distinguished geographer, styles it "the king of the western forests. It is the largest tree of our woods, and rises in the most graceful forms, with vast spreading lateral branches, covered with bark of a brilliant white. A tree of this kind near Marietta (Ohio) measured 15½ feet in diameter. We have seen one on the Big Miami (a river), which we thought still larger. Judge Tucker of Missouri cut off a section of a hollow trunk of a sycamore, and applied a roof to it, and fitted it up as a study. It was regularly cylindrical, and when furnished with a stove and other arrangements, made an ample and convenient apartment." But buildings of a more extensive description than the above have been constructed out of this tree. We learn that a hollow trunk of an enormous sycamore was fitted up with the requisite appendages, and made use of at Utica, in New York state, as a retail-shop; and it was afterwards carried to the city of New York for a show. We extract from the "New York Traveller" the following notice of such another extraordinary domicile, or in all likelihood the same as that made use of at Utica. It was exhibited in the saloon of the American Museum in New York. "A sycamore tree of most singular and extraordinary size has been brought to this city from the western part of this state. The interior is hollowed out, and will comfortably accommodate some forty or fifty persons. It is splendidly furnished as a sitting-room, and contains every article of elegance and usefulness. It has a handsome piano, sofas, glasses, and mirrors, of fit and becoming style, and is decorated with pictures and fancy articles." The reader is not to class this account with the many incredible trans-Atlantic stories which are imported into this country. We have no reason to doubt the fact; but it seems quite clear that the apartments must have been hollowed out of the tree turned lengthways, its diameter affording sufficient height for them.

There are still some trees of a very remarkable size or age which remain to be described, but we can only briefly notice the most celebrated of them. In the Garden of Olives at Jerusalem, there are now existing eight olives, which can be proved by historical documents to have existed anterior to the taking of Jerusalem by the Turks, and which, consequently, must be at least 800 years old. A writer in the "North American Review" remarks, that the largest oak, and indeed the largest tree he has seen in that country, is an oak about twenty-seven feet in circumference at the smallest part. Its age he computes at not less than 500 years, so that it must have been a majestic tree at the time when Columbus discovered the Western World. We wish he had told us its girth immediately above the base but it is quite clear that this oak must be a stupendous organic fabric.

In 1804, Decandolle saw at Gigean, near Montpelier, in France, an ivy, the trunk of which near the base was six feet round, and whose immensity he says, was truly astonishing. Another ivy, only forty-five years old, was only seven and a half inches round; so, taking it as a general type, the specimen at Gigean, in the year 1804, ought to have been of the age of 435 years. We have nowhere seen mentioned an ivy of such colossal dimensions. A writer in the "North American Review" mentions wild grape-vines of enormous size. He says that, while in the eastern states, and, we may add, in Europe, it "rarely grows larger than a stout walking-stick, in our western states it sometimes surpasses in diameter the body of a full-grown man. This fact we have verified by actual measurement."

England at one period possessed many noble and remarkable oak-trees, the remains of which are in some instances still to be seen, while in others they are only remembered by tradition. Close by the gate of the Water Walk, at Magdalen College, in Oxford, there grew an oak, which perhaps stood there a sapling when Alfred the Great founded the university; for this period only includes a space of nine hundred years, which is no great age for an oak. This tree, however, can almost produce historical evidence for the age assigned it. About five hundred years after the time of Alfred, William of Wainfleet expressly ordered his college to be founded near the Great Oak; "and an oak," says Gilpin, "could not, I think, be less than five hundred years of age to merit that title, together with the honour of fixing the site of a college." When the magnificence of Cardinal Wolsey erected the handsome tower which is so ornamental to Magdalen's, this tree might probably be in the meridian of its glory, or rather, perhaps, it had attained a green old age. At a subsequent era, in Charles II.'s time, this famed tree was much injured when the present walks were laid out. Its roots were disturbed, and from that period it declined fast, and became reduced by degrees to little more than a mere trunk. But the faithful records of history have handed down its ancient dimensions. Through a space of sixteen yards on every side from its trunk, it once flung its boughs, and under its magnificent pavilion could have been sheltered with ease three thousand men, though, in its decayed state, it could for many years do little more than shelter some luckless individual whom the driving shower had overtaken in his evening walk. In the summer of 1788, this magnificent ruin fell to the ground, alarming the college with its rushing sound. It then appeared how precariously it had stood for many years. Its grand tap-root was decayed, and it had hold of the earth only by two or three roots, of which none was more than a couple of inches in diameter. From a part of its ruins a chair has been made for the president of the college, which will long preserve its memory.

Near Worksop grew an oak, which, in respect both to its own dignity and that of its situation, deserves honourable mention. In point of grandeur, few trees equalled it. It overspread a space of ninety feet from the extremities of its opposite boughs. These dimensions will produce an area capable, on mathematical calculation, of covering a squadron of two hundred and thirty-five horse. The dignity of its station was equal to the dignity of the tree itself. It stood on a point where Yorkshire, Nottinghamshire, and Derbyshire, unite, and spread its shade over a portion of each. From the honourable station of thus fixing the boundaries of three large counties, it was equally respected through the domains of them all, and was known far and wide by the honourable distinction of the Shire Oak, by which appellation it was marked among cities, towns, and rivers, in all the larger maps of England.

In a glade in Hainhault Forest, in Essex, about a mile from Barkingside, stands an oak, which has been known through many centuries by the name of Fairlop. The tradition of the country traces it half way up the Christian era. It is still a noble tree, though it has now suffered greatly from the depredations of time. About a yard from the ground, where its rough fluted stem is thirty-six feet in circumference, it divides into eleven vast arms, yet not in the horizontal manner of an oak, but rather in that of a beech. Beneath its shade, which overspreads an area of three hundred feet in circuit, an annual fair was long held on the 2d of July, and no booth was suffered to be erected beyond the extent of its boughs.

Not far from Blandford, in Dorsetshire, once stood a tree, which five or six centuries ago was probably in its maturity, and known by the name of Damory's Oak. At the ground its circumference was sixty-eight feet, and seventeen feet above the ground its diameter was four yards. As this vast trunk decayed, it became hollow, forming a cavity, which was fifteen feet wide and seventeen feet high, capable of holding twenty men. During the civil wars, and till after the Restoration, this cave was regularly inhabited by an old man, who sold ale in it. In the violent storm in the year 1703, it suffered greatly, many of its noblest limbs having been torn from it. In the year 1765, this once magnificent production of nature was cut down and sold for fire-wood.

Queen Elizabeth has in more than one or two instances communicated her name to oak-trees of great size in England. Gilpin mentions one of those oaks which grew at Heveningham in Suffolk, of great dimensions, but in his time greatly decayed. In Elizabeth's time it was hollow, and from this circumstance the tree derives the honour of being handed down to posterity. That princess, who, from her earliest age, loved masculine amusements, used often, it is said, in her youth, to take her stand in this tree, and shoot the deer as they passed, and hence it acquired the name of Elizabeth's Oak. Sir Thomas Dick Lauder, in his notes to Gilpin, mentions another of these oaks of Queen Elizabeth, at Huntingfield, also in the county of Suffolk, measuring thirty-four feet in girth at five feet from the ground, and which, also, in the days of yore, afforded a station for the princess in the sports of the field. "Huntingfield," says Sir Thomas, "was, for a considerable period after the Norman conquest, the estate and residence of an eminent family of that name. It afterwards descended to the De la Poles, Earls of Suffolk, and, in the time of Queen Elizabeth, was the property of Henry Lord Hunsdon. Queen Elizabeth is said to have been entertained at the old mansion by Lord Hunsdon, and to have enjoyed the pleasures of the chase, in rural majesty. The approach to the house was over an arm of the river Blithe, which waters the park, and then through three great square courts. A gallery was carried along the whole length of the building, and, opening upon a balcony over the porch, gave an air of grandeur and variety to the front. The great hall was built round six straight massy oaks, which originally upheld the roof, as they grew; and upon these the foresters and yeomen of the guard used to hang their nets, cross-bows, hunting-poles, and other implements of the chase. This gives a most curious picture of the romantic notions of these olden times. In later years, the roots being decayed, the shafts were sawn off at the bottom, and the roof was supported either by irregular logs of wood or by masonry; and part of the long gallery, where the queen and her attendants used to divert themselves, was converted into a cheese chamber. Elizabeth is said to have been much pleased with the retirement of this park, filled with tall and massy timber trees, but particularly with the oak, which ever afterwards bore the appellation of the Queen's Oak. It stood about two bowshots from the old romantic hall; and tradition records that Elizabeth shot a buck, with her own hand, from this tree. The upper part of the main stem of the tree is now considerably shortened by age and accidents. The limbs, however, are bold and picturesque; and it still carries many boughs, and enough of foliage to constitute a considerable head. The trunk thickens as it rises, so that, at seven feet from the ground, it measures about thirty-three feet in circumference. Another oak, called the Duke's Walking-Stick, at the same place, is in girth, at the ground, twenty-one feet, and rises to the height of one hundred and eleven feet from the ground.

Among the trees deriving celebrity from historical events in England, one of the most considerable note was the oak in the New Forest in Hampshire, against which the arrow of Sir Walter Tyrrel glanced, which killed William Rufus, son of William the Conqueror, in the year 1100. This oak-tree, which was of exceedingly large proportions, survived till about the middle of the eighteenth century, at which period of its final decay, it was in all likelihood nine hundred years old—an interval of years embracing all that had occurred in the history of the country from the reign of Alfred the Great till that of George III. This exceedingly interesting and ancient tree at length going to utter decay, its stump was eradicated, and, to preserve the memory of its site, a monumental stone was erected upon it by the late Lord Delaware, with appropriate inscriptions.

The Skelton Oak is another of those trees which have been connected with historical transactions. This oak still survives, and stands about a mile and a half from Shrewsbury, at the spot where the Pool road diverges from that which leads to Owestry. Near this place was fought the famous battle, on the 21st of June, 1403, between Henry IV., king of England, and the forces of Harry Percy, son of the Earl of Northumberland, surnamed Hotspur, along with those of Owen Glendower. It is recorded by tradition that, prior to the engagement, this celebrated Welsh hero mounted the tree, now called the Skelton Oak, to make his observations. The tree, which has been thus in some degree associated with the transaction in which took place the death of Hotspur, is now hollow in its trunk, and can contain about a dozen people. It divides into two enormous limbs, both of which have been fractured. It is thirty-seven feet in circumference, at a foot and a half from the ground, and is otherwise proportionally large.

Scotland, though by no means a woody country, at one time possessed, and indeed still possesses, many fine large trees of various species, as oaks, elms, yews, firs, hawthorns, &c., some of which have been celebrated in the history of the country. Professor Walker of Edinburgh, in his catalogue of remarkable Scottish trees, mentions several very fine oaks. An oak at Lochwood, in Annandale, measured at six feet above the root, was fifteen feet girth, among a number of others of nearly the same size, standing not less than nine hundred feet above the level of the sea. An oak at Blarquosh, in the parish of Strathblane, in Stirlingshire, the spread of the branches of which was ninety feet in diameter, measures fifteen feet in girth at four feet from the ground. An oak in the Marquis of Tweeddale's grounds, at Yester, in Haddingtonshire, at one foot from the ground, measures about fifteen feet five inches; and at six feet, it is about fourteen. The tree called the King of the Wood, on the estate of Fernyhirst, near Jedburgh, is a beautiful tall straight oak of eighty feet in height. The girth of it is eighteen feet above the roots; and at fifteen feet, it is eleven feet six inches in circumference; and it goes on tapering gradually for nearly three-fourths of its height. And the Kepping or Trysting Tree, which grows near it, and which is much more picturesque in form, measures twenty-one feet above the roots; it speedily divides itself into two branches, which measure respectively eleven feet six inches, and fourteen feet. It is upwards of seventy feet high, and covers an area of ninety-two feet in diameter. These two trees are considered to be remnants of the great forest of Jedwood. An oak which stands near the middle of Inch Marin, in Loch Lomond, measured, in 1786, eighteen feet one inch in girth. This tree is remarkable for its fine expanded head.

But none of these trees have attained the celebrity of Wallace's Oaks, two trees of considerable antiquity, one in Stirlingshire, the other in Renfrewshire. The former which is now completely gone, in 1771 measured twenty-two feet in circumference in the trunk, and grew upon a little knoll in Torwood. From surrounding vestiges, it is believed that this oak originally mingled in the scene of Druidic worship, at a far remote period of our history. But its celebrity depended on events of a much later date. When that illustrious hero, William Wallace, roused the spirit of the Scotch nation to oppose the tyranny of Edward, he often chose the solitude of the Torwood as a place of rendezvous for his army. Here he concealed his numbers and his designs, sallying out suddenly on the enemy's garrisons, and retreating as suddenly when he feared to be overpowered. While his army lay in those woods, the oak which we are now commemorating was commonly his head-quarters. Here, it is said, the hero generally slept, the hollow trunk being capacious enough to afford shelter not only to himself but several of his associates. This tree was thence afterwards known as Wallace's Oak. There is another Wallace's Oak at Elderslie, in Renfrewshire, near the place where Wallace was born. It is a very noble tree, twenty-one feet in circumference at the ground. It is sixty-seven feet high, and its branches extend forty-five feet east, thirty-six west, thirty south, and twenty-five north, covering altogether nineteen English poles of ground. Tradition relates that Wallace and a large party of his followers hid themselves from the English among the branches of this tree, which was then in full leaf. It is a custom in Scotland to indent small portions of the wood of this famed tree in snuff-boxes, along with perhaps minute portions of a tree said to be planted by Queen Mary at Holyrood, and lately removed—of another tree which the same queen sat under near Crookston, while witnessing the battle of Langside—of the rafters of Alloway Kirk, celebrated by Burns—with pieces of various other trees and timbers either brought into notice in history, or some way connected with the popular literature and traditions of the country.

It is a very remarkable fact, that the trunks of large oak-trees are frequently dug out of the ground in Scotland, both in the mainland and islands, at places where there are now not only no trees of an ordinary size, but where, in the present day, trees will not grow. There is no way of accounting for this, but by supposing that the climate has very much changed since the period when all was one universal forest. Some very large masses of oak (says Sir Thomas Dick Lauder, in his notes to Gilpin's work) were brought up by the dredging-machine employed in deepening the line of the Caledonian Canal, in Loch Dochfour, from under sixteen feet of gravel which lay at the bottom of the lake. One of these fragments measured thirty feet round; and though it manifestly appeared to be only a small portion of the original tree, it was calculated to contain about two hundred and twenty cubic feet. It was black as ebony, and perfectly fresh and hard. Although there are fine thriving oaks in Scotland at this moment, yet few of them approach the dimensions of these fragments of the olden time.

The best elm we have recorded as of Scottish growth, was that in the parish of Roxburgh, in Teviotdale, called the Trysting-Tree, which was measured in the year 1796, and found to be thirty feet in girth. The ruins of this noble tree still remain at the Friars, near the old castle of Roxburgh. The most plausible tradition regarding the origin of the name of the Trysting-Tree is, that the lairds of Cessford and Fernyhirst, with a number of Scottish gentry, assembled there in 1547, to meet the Protector Somerset, during his rough courtship of the young Queen Mary, and to swear homage to the King of England. There can be no doubt that he was there; and this spot, which was near the old priory, was certainly a very likely place for such an assemblage. The Trysting-Tree was also famous, in later times, as the scene of much innocent pleasantry. After the Reformation, and until the present house of Fleurs was built, in 1718, the family of Roxburgh made an occasional residence of the remains of the religious house at Friars, which was then called East Roxburgh. The gardens belonging to it were kept up until the year 1780, when old Coles, who was butler to Duke John, ploughed them up, and destroyed some beautiful vestiges of antiquity. In these gardens there was a raised walk, called the Lover's Walk, between two rows of old elms, forming a vista, which terminated with the Trysting-Tree, whither the beaux and belles of these old times used to resort, to enjoy themselves, on a summer evening, and to eat the fruit, which was always sold during the absence of the family. Upon these occasions, the gentlemen were often made to walk blindfolded in the alley; and if any one failed to grope his way from one end of it to the other, without diverging from the grass into either border, he was immediately fined in a treat of fruit. What a picture would Watteau have made of so admirable a subject! Many a courtship was brought to a happy termination at this antiquated Vauxhall.

At Newbattle Abbey, the seat of the Marquis of Lothian, a few miles south from Edinburgh, there are some remarkably fine large trees, most probably planted by the monks prior to the Reformation. "Professor Walker measured a beech at this place in 1789; its trunk, where thickest, was seventeen feet in girth, and the span of the branches was eighty-nine feet. He thinks that it must have been planted between 1540 and 1560. It was blown down a short time before the year 1809. It contained upwards of one thousand measurable feet of timber (twenty loads, or twenty-five tons) and it is with reason reckoned among the largest beeches that have ever grown in Scotland. A beech at Taymouth, of a like size, and seemingly coeval with this, was blown down when it had reached above sixteen feet in girth. The large beech at Ormiston Hall, in Haddingtonshire, the bole of which we remember to have seen scooped artificially out into a shelter-house, was measured on the 10th of May, 1762, and found to be eighteen feet ten inches. We believe it was quite entire when it was destroyed by a high wind. A large beech near Oxenford Castle, in Edinburghshire, was measured on the 6th of June, 1763. At the height of three feet from the ground, it was nineteen feet six inches. This fine tree was then decaying. Professor Walker says that the beech was not copiously planted in Scotland till a little before the Revolution; and the trees planted about that period do not form, in many places, considerable timber, as at Inverary and other places. But the four trees last mentioned, which appear to be nearly contemporary, are of a much more remote era. They seem to have been planted singly, and merely as curious foreign trees, in the gardens of some eminent persons. From their dimensions and manner of growth, they may be presumed, at least, to have beech planted between 1540 and 1560, so that they may now be estimated at between two hundred and forty and two hundred and sixty years old. From the state of the Ormiston Hall and Newbottle trees, it may be concluded that the beech, if it meets with no accident, will grow with sound timber for at least two hundred and fifty years."

THE HORSE.

The Horse, well known as one of the most beautiful and useful of animals, is classified, according to the arrangements of zoologists, in the order Pachydermata, of which it constitutes a family—the *Equidæ*, along with the zebra, the ass, and several other animals. The horse, as a distinct species, differs from other members of the genus, not only in a few particulars of physical structure, but in its superior strength, spirit, and tractability. Of the absolutely natural character of the horse, however, mankind possess no certain account; for, in all the instances in which the animal is found in a wild state, the race appears to have been generally derived from a domesticated stock. The form and general qualifications of the animal are of a high order, and peculiarly susceptible of cultivation by art. The senses of smell and sight are remarkably acute, and the clearness of perception, excellence of memory, patient endurance, and gentleness, are not excelled in any other of the lower animals. The horse is altogether herbivorous, for which the structure of his teeth and lips is adapted; but he does not ruminate, and has only one stomach. His native country is believed to have been Tartary, whence the species has spread over the world, and separated into different varieties.

VARIETIES OF HORSES.

Horses exist in numerous varieties, distinguishable by size, strength, colour, and other qualifications, the result most likely of peculiarities of climate, food, and habits. The following is a brief notice of the leading varieties in which the animal is found:—

Horses in a State of Nature.

Horses are found in a state of nature, living as wild animals, in various parts of America, Asia, and Africa. In the vast plains of South America, immense troops of wild horses are to be found, which have all sprung from emancipated individuals taken to that country by the Spaniards. The geographical range of these herds extends from the shores of La Plata to Patagonia. They have increased in such astonishing rapidity, that they are to be met with in troops of many thousands. Naturally gentle in disposition, these wild horses never attack other animals, but always act upon the defensive. Their wide pastures satisfy their appetites, and, when the food of one district is exhausted, they have only to shift their stations to places where it is more abundant. They are seldom to be taken by surprise; but, if attacked, the assailant rarely comes off victorious, for the whole troop units in defence of their comrades, and frequently either tear their enemy to pieces or kick him to death. Wild horses usually retire to the confines of a forest to repose. One or more of their number are always awake to keep watch while the rest are asleep, and to warn their fellows of approaching danger, which is done by loud snorting or neighing; upon this signal they start to their feet, and either reconnoitre the enemy, or fly off with the swiftness of the wind, followed by the sentinel, and by the stallion who is patriarch of the herd.

In the desert tracts along the banks of the Don, in Russia, there are numerous troops of wild horses, which have sprung from emancipated progenitors. The Cossacks frequently take these, and breed from them, by crossing them with their domesticated horses, which are said to be thereby greatly improved. Pallas says they abound in the vicinity of the Palus Mæotis. These herds are the descendants of the Russian horses which were used at the siege of Azoph in 1696, when taken from the Turks by Peter the Great, who was compelled, from want of forage, to set at liberty nearly the whole horses belonging to his cavalry, to seek food for themselves. They are now quite wild, and associate in troops in the same manner as other wild horses. Those herds which have remained close to the alluvial and fertile banks of the river, are of a large size, owing to the rankness of their food; the ground in these situations is so extremely swampy that no solid edifice can be erected near the river, the whole surrounding country being little better than a morass. The herds which inhabit the higher mountain districts have all the appearance of the horses from which they sprung. It is supposed that the troops found in the plains of Great Tartary are descended from the same source as those of the banks of the Don and the Ukraine.

In South America there are no regular stables, the horses being either kept in pastures, which are fenced, or in what they call *corrals*, which consist of a circular enclosure of rough posts, driven into the ground so close, that a horse cannot pass through between them. In these, however, the mares and foals are never confined, but are allowed to graze about at freedom. The natives, however, usually keep one horse tied at the door of their hut, to be ready in case of immediate need, which is fed on a scanty meal of maize at night. If an additional horse is wanted, the *gaucho* (or native inhabitant of the plains) goes to the corral with his *lasso*, and fetches one which may have been only subdued the preceding day; or he will go to the plain where they are grazing at freedom, and bring one which he has backed for the first time; and when these horses have been once used, they are either put into the corral and fed with maize, or returned to the plain to feed at liberty. The lasso is a very simple contrivance, but of great power in the hands of the gaucho, who is accustomed to use it from his youngest years, or at least to see it done, and he puts it in practice as soon as he has sufficient strength to use it. Miers, in his Travels in Chili,* gives the following account of it:—

"The *lasso* is a missile weapon, used by every native of the United Provinces and Chili. It is a very strong plaited thong, of equal thickness, half an inch in diameter, and forty feet long, made of stripes of green hide, plaited like a whip-thong, and rendered supple by grease. It has at one end an iron ring, about an inch and a half in diameter, through which the thong is passed, and this forms a running noose. The gaucho, or native peon, is generally mounted on horseback when he uses the lasso; one end of the thong is affixed to his saddle-girth; the remainder he coils carefully in his left hand, leaving about twelve feet belonging to the noose end in a coil, and a half of which he holds in his right hand. He then swings this long noose horizontally round his head, the weight of the iron ring at the end of the noose assisting in giving to it, by a continued circular motion, a sufficient force to project it the whole length of the line."

It is sometimes necessary to break in a number of horses at once: in this event, they drive a whole herd of wild horses into the corral at one time. This scene was witnessed by Miers, who thus describes it:—"The corral was quite full of horses, most of which were young ones about two or three years old. The *copitar* (chief gaucho), mounted on a strong steady horse, rode into the corral, and threw his lasso over the neck of a young horse, and dragged him to the gate. For some time he was very unwilling to leave his comrades; but the moment he was forced out of the corral, his first idea was to gallop away; however, a timely jerk of the lasso checked him in the most effectual way. The peons now ran after him on foot, and threw a lasso over his fore-legs just above the fetlock, and, twitching it, they pulled his legs from under him so suddenly, that I really thought the fall he got had killed him. In one instant a gaucho was seated on his head, and with his long knife, and in a few seconds, cut off the whole of the horse's mane, while another cut the hair from the end of his tail. This, they told me, was a mark that the horse had been once mounted. They then put a piece of hide into his mouth, to serve for a bit, and a strong hide halter on his head. The gaucho who was to mount arranged his spurs, which were unusually long and sharp, and while two men held the horse by his ears, he put on the saddle, which he girthed extremely tight. He then caught hold of the horse's ear, and in an instant vaulted into the saddle, upon which the men who held the horse by the halter threw the end to the rider, and from that moment no one seemed to take any further notice of him. The horse instantly began to jump in a manner which made it very difficult for the rider to keep his seat, and quite different from the kick or plunge of our English horse: however, the gaucho's spurs soon set him going, and off he galloped, doing every thing in his power to throw his rider.

"Another horse was immediately brought from the corral: and so quick was the operation, that twelve gauchos were mounted in a space which I think hardly exceeded an hour. It was wonderful to see the different manner in which different horses behaved. Some would actually scream while the gauchos were girthing the saddle upon their backs; some would instantly lie down and roll upon it, while some would stand without being held, their legs stiff, and in unnatural positions; their necks half-bent towards their tails, and looking vicious and obstinate; and I could not help thinking that I would not have mounted one of those for any reward that could be offered me, for they were invariably the most difficult to subdue.

"It was now curious to look around and see the gauchos on the horizon, in different directions, trying to bring their horses back to the corral, which is the most difficult part of their work; for the poor creatures had been so scared there, that they were unwilling to return to the place. It was amusing to see the antics of the horses: they were jumping and dancing in different ways, while the right arm of the gauchos was seen flogging them. At last they brought the horses back, apparently subdued and broken in. The saddles and bridles were taken off, and the young horses trotted off towards the corral, neighing to one another."

There is a remarkable difference in the dispositions of the Asiatic and South American wild horses: those of the former country can never be properly tamed unless trained very young; if taken when adults, they frequently break out into violent fits of rage in after life, exhibiting every mark of natural wildness; while those of America can be brought to perfect obedience, and even rendered somewhat docile, within a few weeks, nay, sometimes days. It would be difficult to account for this opposition of temper, unless we can suppose that it is influenced by climate.

The Arabian Horse.

The Arabian Horse is considered to occupy the highest rank among the numerous cultivated varieties, and imbodies that qualification in its purest condition, known in England by the term *thorough-bred*. By the wandering tribes of Arabia, he has been skilfully subdued and domesticated, and exhibits, with great beauty of figure, spirit, docility, and intelligence. The pure Arabians are somewhat smaller than our race-horses, seldom exceeding fourteen hands two inches in height. Their heads are very beautiful, clean, and wide between the jaws; the forehead is broad and square; the face flat; the muzzle short and fine; the eyes prominent and brilliant; the ears small and handsome; the nostrils large and open; the skin of the head thin, through which may be distinctly traced the whole veins of the head. The body may, as a whole, be considered too light, and the breast rather narrow; but behind the arms, the chest generally swells out greatly, leaving ample room for the lungs to play. The shoulder is superior to that of any other breed; the scapulæ, or shoulder-blades, incline backwards, nearly in an angle of 45 degrees; the withers are high and arched; the neck beautifully curved, and the mane and tail long, thin, and flowing; the legs are fine, thin, and wiry, with the pasterns placed somewhat oblique, which has led some to suppose that the strength was thereby lessened, which is by no means the case; the bone is of uncommon density, and the prominent muscles of the fore-arm and thigh prove that the Arabian is fully equal to all that has been said of his physical powers.

The Arabs of the desert have made the breeding of horses their sole occupation for ages bygone; and, from their strict attention to certain rules, they may be justly regarded as the first breeders in the world. They take infinite trouble in grooming their steeds, and are extremely regular in their hours of feeding them morning and evening. They get but little drink, and that is supplied to them two or three times a day; they conceive that much water not only destroys their shape, but also affects their breathing. In spring they are pastured on dry aromatic herbage; and during the rest of the year they are fed on barley, with a small quantity of straw; and they are the hardiest horses in the world. The Arab trains his horse by kindness, and never on any occasion strikes it; the consequence is, that the animal shows a degree of affection and tractability in which most British horses are quite deficient. The Arab horse is employed only for riding, and possesses great fleetness.

The following interesting account of the hardihood of the Arabian is given by M. Chateaubriand, in his Travels in Greece—"They are never put under shelter, but left exposed to the most intense heat of the sun, tied by all four legs to stakes driven in the ground, so that they cannot stir. The saddle is now taken from their backs. They frequently drink but once, and have only one feed of barley in twenty-four hours. This rigid treatment, so far from wearing them out, gives them sobriety and speed. I have often admired an Arabian steed thus tied down to the burning sands, his hair loosely flowing, his head bowed between his legs to find a little shade, and stealing with his wild eye an oblique glance of his master. Release his legs from the shackles, spring upon his back, and he will 'paw in the valley, he will rejoice in his strength, he will swallow the ground in the fierceness of his rage;' and you recognise the original picture of Job."

The Arabs are exceedingly particular regarding the pedigree of their horses; and they have amongst them a breed which they declare has descended from a horse of King Solomon. It must not, however, be supposed that all the horses of that country are of the finer kinds; for the Arabs have three distinct breeds: the two inferior kinds, they say, were introduced from India and Greece. The superior kinds they call nobles; and they are never sold without a pedigree, which is more scrupulously attended to than with human beings in Europe.

British Race-Horse.

The British Race-Horse is a cultivated breed, originally sprung from the Arabian, and to which is traced the quality of being *thorough-bred*. The skins of race-horses are delicate, with short hair, usually tending to the bright brown or bay generally characteristic of the horses of the East, and sometimes the gray, prevalent likewise amongst the Arabs and Barbs. They are frequently chestnut, which may be looked upon as a mixture of the dun or tan colour of some of the races of Northern Europe with the finer brown or bay; and sometimes, though very rarely, they are of the bright black common to the great horses of the plains of Germany. They are of medium height, rarely exceeding fifteen hands. Their form is that which an almost exclusive attention to the property of speed has tended to produce. They have the broad forehead, the brilliant eyes, the delicate muzzle, the expanded nostrils, and the wide throat, characteristic of their eastern progenitors. Their light body is comparatively long, and suited to the extended stride. Their chest is deep, so as to give due space to the lungs, but comparatively narrow, preventing the fore extremities from being over-loaded, and the limbs from being thrown too far asunder in the gallop. Their shoulder is oblique, to give freedom of motion to the humerus, and their haunch is long and deep, beyond that of any other known race of horses, indicating the length of those bones of the hinder extremities on which the power of progression essentially depends. Their limbs are long and muscular to the knee and hock, and below, tendinous and delicate; and their pasterns being long and oblique, give elasticity to the limbs.

The pedigree of race-horses is always a matter of consequence to the breeder and purchaser of these animals, and is preserved with the same degree of care as the genealogy of many a noble family. By jockeys and others, therefore, a list or stud-book is kept of the sires and dams of their horses, which can be exhibited if required. The pedigree of many fine racers of the present day is traced through stud-books to the Darley Arabian, a horse purchased by a Mr. Darley at Aleppo, from which it was imported to England. One of its immediate descendants was the famous Flying Childers, bred by Mr. Childers of Carr-House. This beautiful racer is reputed to have been the fleetest runner ever known in England, or perhaps in the world. On one occasion, he ran round the course in Newmarket, which measures 3 miles, 6 furlongs, and 93 yards, in 6 minutes and 40 seconds.

Horse-racing, which, in the opinion of competent judges, is unnecessary, as far as keeping up serviceable breeds of horses is concerned, is usually spoken of as the *turf*, from its being performed on stretches of turf-ground at Newmarket, Epsom, and various other places. Among an idle and in many instances a profligate class of persons, this *sport*, as it is termed, affords scope for a most extensive system of fraud, betting, gambling, and general dissoluteness of behaviour; in a word, this cruel pastime may be described as a great canker lying at the root of society in England; and, countenanced by the high in rank, is at the present moment not the least effective of the many drags on social advancement. The framers and conservators of the laws of the turf, are the members of an association called the Jockey Club, whose principal betting-rooms are at Newmarket, and at the establishment of Mr. Tattersal in London. At these places of resort, noblemen, gentlemen, turf-speculators, sharpers, and jockeys of all shades meet to bet on the result of certain races; and there, also, they attend on certain settling days to pay the losses and receive the gains of their wagers. When we find so open a system of gambling largely supported, and rendered in appearance *respectable*, by the higher classes, need we feel surprised at the alleged degeneracy of the bulk of the lower orders? Horse-racing, with all its train of evils, may certainly be considered a disgrace of the age; and, as one of the relics of barbarism, along with cock-fighting, bull-baiting, and prize-fighting, we should rejoice to see it for ever abandoned.

Hunters—Saddle-Horses.

The Hunter is a combination of the thorough-bred race-horse and half-bred horses of greater strength and bone; but changes are continually taking place in its character. The older race of hunters has been giving place to one of lighter form and higher breeding, and even the thorough-bred horse is now employed by numerous sportsmen. In his improved state, the hunter may rank as a saddle-horse of the first class, combining strength with fleetness. The prime qualities of a hunter may be briefly summed up—head small, neck thin, crest firm and arched, a light mouth, broad chest, body short and compact, the hocks well bent, power behind to push him over difficulties, and broad well-made feet turned outward. He is prepared for his duties by physic, air, and exercise. To do him justice, the hunter should not work above three days a week; and, after a hard day's run, he ought certainly to have two or three days of rest. We cordially coincide in the following remarks on the cruelty of abusing this noble animal—"It is very conceivable, and does sometimes happen, that, entering as fully as his master into the sports of the day, the horse disdains to yield to fatigue, and voluntarily presses on, until nature is exhausted, and he falls, and dies; but much oftener the poor animal has intelligibly enough hinted his distress; unwilling to give in, yet painfully and falteringly holding on. The merciless rider, rather than give up one hour's enjoyment, tortures him with whip and spur, until he drops and expires. Although the hunter may be unwilling to relinquish the chase, he who 'is merciful to his beast' will soon recognise the symptoms of excessive and dangerous distress. To the drooping pace, and staggering gait, and heaving flank, and heavy bearing on hand, will be added a very peculiar noise. The inexperienced person will fancy it to be the beating of the heart; but that has almost ceased to beat, and the lungs are becoming gorged with blood. It is the convulsive motion of the muscles of the belly, called into violent action to assist in the laborious office of breathing. The man who proceeds a single mile after this, ought to suffer the punishment he is inflicting."—(*Library of Useful Knowledge.*)

The Charger or Cavalry Horse partakes of the qualities of the hunter—great strength and spirit, without which he would be unable to bear the toil of warfare in a rough country.

The proper kind of Saddle-Horse is only a variety of the hunter, possessing less or more *blood*, according to the nature of the work required of him, and the taste of the breeder. Of the great varieties of saddle-horses, there may be said to be a chain of connection, as respects spirit and form, from the racer to the cart-horse; and therefore the station which any individual occupies is almost undefinable. The saddle-horses of England are celebrated for their beauty and action; and nowhere are seen so many of elegant forms as in London. Latterly, the breeds have been tending to greater lightness, the state of the roads not now requiring the strength of limb which was at one time necessary.

Coach-Horses.

The better kind of Coach-Horses owe their origin to the Cleveland bay, and are principally bred in Yorkshire, Durham, and the southern districts of Northumberland, and some few have been produced in Lincolnshire. The coach-horse is produced by a cross of the Cleveland mare with a three-fourth or thorough-bred horse, which is possessed of sufficient substance and height. The produce of these is the coach-horse of the highest repute, and most likely to possess good action. His points are advantageously placed, with a deep and well-proportioned body, strong and clean bone under the knee, and his feet open, sound, and tough. He possesses a fine knee action, lifts his feet high, which gives an elegance to his paces and action: he carries his head well, and has a fine elevated crest. The full-sized coach-horse is, in fact, only an overgrown hunter, too large for that sport.

The carriage-horse, reduced to drawing stage-coaches, is generally used in a very disgraceful manner. Urged with a heavy draught to the height of his speed, and almost incessantly wrought, whipped unmercifully, and poorly groomed, his fate is often melancholy in the extreme. It ought to be recollected that, in proportion as the load or draught is increased, so is the animal's power of speed lessened; and therefore to make him both draw a heavy weight, and run also, is to put him beyond his natural powers, and his muscular energy suffers accordingly. We shall afterwards advert to the principles which ought to regulate both draught and speed.

The Hackney.

The term *Hackney*, in common use, is employed to denote a kind of horse fitted for general services, and is therefore understood to exclude the horses of the highest breeding, as the thorough-bred horse and hunter; and there is further associated with the idea of a hackney, an animal of moderate size, not exceeding fifteen hands, and possessing action, strength, and temper. Our present breed of hackneys have a considerable portion of racing blood in them, varying from a half to seven-eighths. The latter are too highly bred for the general purpose of a roadster, as their legs and feet are rather tender; and their long paces and straight-kneed action are ill-adapted for the road, being more fitted for cantering and running than the trot, which is the distinguishing characteristic of a good hackney. Indeed, they should never be permitted to go at any other pace than a trot, which is undoubtedly much better adapted for the road than cantering.

Nothing is more essential in a hackney than sound strong fore legs, and also well-formed hind ones; his feet must be quite sound and free from corns, to which hard-ridden horses are very liable; and he ought only to lift his fore legs moderately high. Some are of opinion that he cannot lift them too high, and conceive, while he is possessed of this quality, he never will come down. There is a medium, however, in this, as a horse that raises his fore legs too high in trotting is always disagreeable in his action, which greatly shakes and fatigues his rider; besides, he batters his hoofs to pieces in a few years. The principal thing to be attended to, is the manner in which the hackney puts his feet to the ground; for if his toes first touch the road, he is sure to be a stumbler. The foot should come flat down on the whole sole at once, otherwise the horse is not to be depended upon in his trotting. A hackney should be particularly even-tempered, and not given to starting. The thorough-bred hackney ought to possess two qualities, indispensable to the safety of the rider—he should never shy at any thing on the road, and his motion at a trot should be much more smooth than that of a half-bred horse.

The Cart-Horse.

The Cart-Horses of Great Britain are extremely variable in point of size as well as in shape, differing in almost every county. One principal character, however, is weight, to give more physical force in the draught. They should not be above sixteen hands high, with a light, well-shaped head and neck, short pointed ears, with brisk sparkling eyes; their chests should be full and deep, with large and strong shoulders, but rather low in front than otherwise. The back should be straight, and rather long, but not too much so, as this always impairs his general strength; the animal should stand wide on all his four legs, and considerably wider behind than before; he ought to have great pliability in the knee-joints, and be able to bend them well, which assist in producing a brisk and active step in walking, a quality of much consequence in a cart or wagon horse. The height to be desired in a draught-horse, however, will depend upon the purpose for which he is to be employed.

In the midland counties of England—Warwickshire, Derbyshire, Leicestershire, Lincolnshire, and Nottinghamshire, there is a very large breed called the great cart-horse. It was bred in the lowland rich alluvial pastures of the plains of these counties, from the Flemish and Dutch horses, with the larger English breed. Mr. Bakewell introduced horses, and also mares, from the Netherlands, and thus produced those fine animals with Belgic blood, both on the side of the sire and dam.

The very large horses of seventeen hands and upwards, are only useful for the purposes of brewers' drays, wagons, and the slop-carts of London. It is, however, doubted if they answer the better for their gigantic size; and all who have written on the subject consider that they are inferior in point of strength, on account of their bulk; for by the feeding which is required to increase their dimensions, little of muscular fibre is produced, the growth being principally in the cellular tissue and fat; and the additional quantity of food required to keep up their system must more than counterbalance any advantage to be reaped from their size. Latterly, considerable pains have been taken to improve the qualities of ordinary cart-horses, among which we include those required in agriculture. A breed called the Clydesdale is highly valued, for either cart or plough. Animals of the Clydesdale breed reach to a large size, and are not unfrequently to be met with sixteen and a half hands high. These animals are strong and hardy, but their heads are coarse, and they are rather flat on the sides and hinder quarters. The usual colour of these horses is gray or brown. This breed is supposed to have originated about one hundred and thirty years ago, between the common Scotch mare and the Flanders horse.

Ponies.

A horse beneath thirteen hands is called a pony, but this definition is not very strictly attended to, and the same thing may be said of the *galloway*. The old Scottish galloways, which took their name from the district of Galloway, in the south-western extremity of the country, are now nearly extinct. They were stout, compact animals, sure-footed, and of great endurance, and on these accounts invaluable in travelling over rugged and mountainous districts. The beauty and speed of the galloway were supposed to have arisen from the breed having been the produce of the Spanish jennets that escaped from the wreck of the Spanish armada, and these, crossed with our Scottish horses, gave rise to this esteemed breed. But we apprehend they were famous at a date long prior to that event, as this district is known to have supplied Edward I. with great numbers of horses. This breed seldom exceeded fourteen hands in height: their colour was generally bright bay or brown, with black legs, small head and neck, and their legs peculiarly deep and clean. A compact stout-built pony, of from thirteen to fourteen hands high, and possessing some of the qualifications of the Galloway, is called a *cob*, which is valuable as a steady pacer, at an easy rate.

The small ponies of the Highlands of Scotland and Shetland (usually called *shelties*) may almost be termed wild animals; for they go at large in herds on the hills and wastes, and are not shod till caught and put into training. They are docile and tractable, and being very sure-footed, are the best adapted for boys' riding. Of their remarkable sagacity in passing fords and dangerous morasses, numerous accounts have been given. The Rev. Mr. Hall, in his "Travels through Scotland," mentions, "When these animal come to any boggy piece of ground, they first put their nose to it, and then pat on it in a peculiar way with one of their fore feet; and from the sound and feeling of the ground, they know whether it will bear them. They do the same with ice, and determine in a minute whether they will proceed."

The Welsh pony is more handsomely formed than that of Shetland; has a small head, high withers, deep round body, and excellent feet. The Exmoor ponies are also very stout, hardy, and useful in the fatigues of rural sporting. The ponies of Dartmoor are likewise a hardy, sure-footed race, well adapted for riding in wild districts. The ponies of Norway and Sweden, which are of a dingy cream colour, and of which there are now occasional importations to Britain, are considerably larger than the Shetland or Welsh breeds, but also hardy and very docile.

REARING OF HORSES.

The breeding and rearing of horses are carried on professionally in England, chiefly in Yorkshire; but many private gentlemen and farmers also address themselves to it as a means of pecuniary profit and the improvement of their animal stock. We do not pretend here to offer any specific directions on this branch of our subject, it being one in which the public at large are not particularly interested, and a few observations seem all that is necessary.

The circumstance which the breeder of horses requires to keep most in mind, is, that the qualities, good or bad, of the animal are hereditary. Finely made horses produce finely made descendants, and *vice versa;* heavy cart-horses never produce animals possessing the qualities of racers. Thus, the bone, blood, and general make are directly transmissible; and, in the case of crossing, the produce is found to possess a proportional share of both sire and dam. Cross-breeding between extremely different horses is not found advantageous: it is a generally recognised principle, that the nearer the resemblance between the parents, so will the produce be more satisfactory. Mr. N. H. Smith, in his *Observations on Breeding for the Turf*, remarks, that "the stock of some mares will frequently partake most of the dam, and that of others most of the sire; and sometimes one foal will partake most of the mare, and the next perhaps most of the horse, &c. It also occasionally happens that the produce bears some resemblance to its grandsire, grandam, or other distant kindred; and although this does not perhaps often occur, so as to be very perceptible, yet, as their qualities must, in a lesser or greater degree, descend to their progeny, it has always had its due weight, and hence the value and partiality to blood, or ancestral excellences, transmitted through many generations." He further observes, however, "that he is disposed to attribute more in general to the dam than to the sire, inasmuch as he is decidedly of opinion that a good mare put to the worst thorough-bred horse would be much more likely to produce a runner, than a bad mare put to the most fashionable stallion in England; and therefore a person possessing good mares may bring any stallion into repute." The grand aim of the breeder must be the propagating of excellences and avoiding defects; but this is not to be accomplished, as respects important alterations, all at once; improvements in this, as in every thing else, being the work of time and a judicious experience. Breeding in

-in, as it is called, or between close relationships, is decidedly pernicious, and should by all means be avoided.

The season for mares is about February and March, but in some cases it continues later; and the term of gestation is generally over eleven months. The foal remains with the mother till weaned, which takes place earlier or later according to the quantity of milk, the strength of the animals, and the season of the year. On removal, it requires to be carefully attended to, and provided with soft nourishing diet.

The operation of cutting is seldom performed on thorough-bred colts, but with all others it is common. It is an operation which ought by all means to be left to the veterinary surgeon or skilful farrier. The best authorities recommend it to take place with young cart-horses when four or five months old, but if for carriage or light work, it may very properly be postponed till the animal is twelve months old. The use of the operation is to render the horse more submissive than if left in an entire state, and to devote him altogether to the work he is required to perform. The advantages, whatever they are, it may be supposed are in some measure lessened by the lowering of spirit. The practice, however, is universally recognised in England as one indispensable where great numbers of horses are congregated, and required to be kept in good condition.

Breaking, or reducing the young animal into obedience, is a most important point in the education of the horse. If previously accustomed to handling, the difficulty of breaking will be much lessened. Racing colts are now begun to be broken at one year old, and saddle colts at two years, and are finally and fully broken and trained, some at three, and few later than four years old. Breaking horses is a regular business, and is best left to the person who is well accustomed to it, provided he follow a judicious course of treatment. As in the training of children, gentleness yet firmness ought to be a prevailing principle of management. The chief apparatus of breaking is a powerful bridle or head tackle, with boots or pads strapped on the legs, to prevent them knocking against each other.

The young horse is to a certain extent trained before his back is mounted, all the preliminary part of the process of subduing being accomplished while he is led by the bitted tackle. His back is not to be mounted till he is evidently able to endure the load without injury to his figure; too early mounting is apt to make him hollow-backed for life. In putting on a saddle for the first time, great caution should be taken; let the girths be drawn loosely, the crupper smooth, and keep the stirrups from dangling. In short, the animal requires on this trying occasion to be treated with as much kindness as it is possible to employ.

Having, by the various means which are adopted, brought the animal into subjection, and in effect taught him that he must in future act the part of a dutiful servant to an indulgent but firm master, the next step is to teach him his paces. These are partly artificial. Commence with slow and regular walking, whenever he is inclined to bolt, bringing him back to the steady pace you desire. After he has been accustomed to slow paces on a methodic plan, go on to the slow trot, then the quick trot, and lastly the canter and gallop. By no means allow him to mix these paces, that is, half-canter and half-trot, which would be an ungainly hobble; but let him know that he must for the time being keep to one kind of pace. The skill of the breaker consists in enforcing these lessons, and teaching the animal to change readily and neatly from one pace to another, by little more intimation than a twitch of the rein. Lawrence recommends that "a graceful canter should be encouraged, commencing with the proper or off-leg foremost, and the nag accustomed to be pulled up from the canter to the trot without unseemly and unpleasant blundering. The lessons should not be too long or fatiguing, but the young animal kept in as cheerful and easy a state as possible." The first shoeing ought to be performed with great care, so as to alarm the animal as little as possible.*

The Teeth—Age.

The horse attains maturity at five years old, and he is in his prime till eight or nine. If no unfair play be used, his age may be judged of from his teeth, or, as it is called, *mark of mouth*. We shall give a short account of this part of the animal's economy.

At five years old, when the teeth have been fully developed, the horse possesses six teeth in the front of each jaw, called the incisors or *nippers*; it is with these teeth that he bites. At a short distance from each end of the row of incisors, and in each jaw, there is a solitary canine tooth; these canine teeth are technically named *tushes*. At a greater distance inward in each jaw, and on each side, there are six grinders—the whole apparatus being designed to bite or crop the herbage, to tear and to chew. At five and a half years old, the nippers are marked by a natural cavity formed in the substance between the outer and inner walls, and it is the presence or absence of these darkish marks that certifies the age of the animal. When the horse reaches six years, the marks in the two front nippers in the nether jaw are filled up, and the tushes are blunted. At seven years the two nippers next the middle ones are also filled up; at eight, the two outer ones are filled up also, and the tushes are round and shortened. The lower nipper teeth are now all smooth; the marks are gone; but in the teeth of the upper jaw marks remain a year or two longer. At eight years the disgraceful practice of *Bishoping*—a term given from the name of the inventor—is often resorted to, for the purpose of imitating the obliterated marks. An engraving tool is employed to cut the surface, and a hot iron is then applied to give a permanent dark stain. This infamous trick may impose on the ignorant; but a person skilled in horses can easily detect the imposition, from the stains being diffused around the marks, and other appearances.

As a horse, if well treated, remains in excellent working condition till twelve and even later, the disappearance of the marks on the teeth is often of little consequence. Some horses are as valuable to their owners at fifteen years as they are at eight; and for ordinary saddle-work, ten or twelve may be considered an age sufficiently young. It is important, however, that the teeth are capable of mastication; for if the animal is unable to chew his food properly, he cannot be kept in good condition, or fit for the performance of his duties. In consequence of the very general abuse of horses, few live till twenty-five years old, and the instances of any living till above thirty are rare.

Terms applied to Horses.

Horsemen employ terms to horses which are not strictly adhered to in ordinary language. A male horse left uncut is said to be an *entire horse*, to distinguish it from the *gelding*, or cut animal. A female horse is always spoken

* In connection with the breeding of horses, we may say a few words respecting *mules*, or the hybrid offspring of the horse and ass. The mule-proper is the produce of a male-ass and mare; when the parents are the horse and she-ass, the produce is called a *hinny*. The mule is the superior animal, partaking to a larger degree in the qualities of the horse; it is more robust, plump, and hardy, and better adapted for all the ordinary purposes of riding and draught. The hinny is more thinly made, has a longer head, and is altogether more like the ass than the horse. Mules of both kinds live to a very old age, and when properly trained, they are tractable and very serviceable animals. There are comparatively few mules in Britain; but in Spain, and some other countries of southern Europe, also in Spanish America, they are numerous, and are used in carriages of people of the highest rank. According to a well-known principle in natural economy, by which intermixture of kindred species is not allowed to go beyond a single step, and only for one generation, mules do not breed; and the stock requires to be kept up by a recurrence to the common parentage.

of as a *mare*. A young male horse is called a *colt*, and a young female a *filly*. *Thorough-bred*, as already noticed, is applied only to horses (we include mares, of course) whose pedigree can be traced to an Arabian origin, without stain or any common intermixture. When the pedigree of the racer is to a certain degree stained, the animal is called a *cocktail*. The term *blood* is of more loose signification, but what is generally understood by it is a horse which is thorough-bred, or of the blood of the Arabian, and consequently shows a fine spirit and action. A horse may be half-bred, three parts bred, and so on, according to his pedigree. The half-bred is produced from a racer and a common mare. Some of the best riding-horses are of this stamp. The term *welter horse* is applied to racers who are able to carry the highest weight.

Horses are measured by hands, four inches being reckoned to the hand; the measure is taken at the fore leg and shoulder. To all the more prominent parts of the body and members certain technical names are applied; for example, to take the fore extremities first, the *muzzle* includes the lips, mouth, and nostrils; the *withers* are the sharp protuberance over the shoulders between the back and neck; the breast is the *counter*; the *arm* is the upper part of the fore-leg, but enveloped in the muscle of the shoulder; beneath it is the *fore-arm*, which is the higher part of the visible leg, and extends downward to the *knee*; below the knee we have another stretch called the *shank*, which extends to the *pastern*, or, as we might call it, the ankle; the *fetlock* is behind the pastern; beneath are the feet. A few of the hinder extremities are named as follow: the *croup*, which extends from the loins to the root of the tail or rump; the *flank*, extending from the ribs to the haunches; and the *leg* or thigh, which reaches down to the *hock* or middle joint of the hind leg, corresponding to the knee in the fore-leg. The left side of a horse is called his *near* side; and his right the *off* side.

The greater number of British horses are of a dark colour, inclining to black or brown, but of innumerable shades. One kind of brown is called bay, and another the chestnut; a yellowish chestnut is termed the sorrel. The roan is a blending of red and whitish tones. The gray is a mixture of white and black hairs, and in old age becomes altogether white. The dark colours are the most esteemed for their physical qualities, and patches of white on the legs are considered defects or foul markings.

STABLE MANAGEMENT.

The horse, as has been already mentioned, possesses very delicate senses, and is nice in its habits, in which respect it differs very materially from black cattle. In a state of nature, the animal seems to be best adapted for a mild and genial climate, and to rejoice in freedom and space. When reduced to domestication, as it is with us, care should be taken to violate as little as possible its natural tastes and habits. Its delicacy of constitution, augmented in no small degree by an artificial mode of life, should warrant the best attentions of its keepers; and whatever be the nature of its work, it should be treated with kindness, regularly fed, and supplied with pure water, allowed a cleanly and well-ventilated habitation, and its body and limbs preserved free from dirt and all offensive matter that may cling to them. The leading features of management may be defined as follows:—

The Stable.

The stable varies in size, according to the number of horses kept. Of whatever dimensions, the situation should be dry and airy; if in any respect damp or fœtid, the animals will assuredly contract disease. When the stable is calculated to contain many horses, it is seldom regular in temperature, from the fluctuation of numbers in it at any one time. To avoid this defect, the best size, in ordinary circumstances, is that which will accommodate six or eight horses, leaving plenty of room to each.

A stable with a row of stalls only on one side, is better than one with double rows; if double, the space between should not be less than eight or ten feet wide. Sixteen feet is a proper width for a stable with a single row, six of the feet being allowed for the depth of the stalls; each stall should also be six feet wide, but commonly five and a half are only given. The floor of the stalls should be neatly paved, slope very little from head to feet, and be bounded by a gutter, with gratings to carry off all liquid refuse. The gangway, or space beyond the stalls, should be also paved in a neat manner; and care ought to be taken that rats are effectually excluded from the walls or any part of the flooring. The stalls should be lined with smooth wood. The stable should have only one door, and that not opposite a stall; it ought to be at least four and a half or five feet wide, and eight feet high. A pinchedness in any of these details is far from economical.

The inner walls of stables are often kept shamefully dirty. They ought by all means to be well whitewashed, at regular intervals, in order to extinguish vermin and wipe off impurities. The interior ought to be well lighted with windows, which should be kept clean, and never permitted to remain in a broken condition. A little carelessness in this respect may occasion the loss of a horse; for broken windows in stables are about as dangerous to the health of the inmates as broken windows in a dwelling-house.

When we say that the stable should be well lighted, we certainly oppose one of the most vulgar prejudices respecting horse management. In most instances, stables are kept as dark as dungeons, greatly to the injury and discomfort of the inmates. It is impossible to understand what can be rationally designed by keeping horses standing during their waking hours in the dark. Nature never intended any thing of the kind; and we say the practice should be abolished. Mr Stewart pleads as warmly as we do on this point. "A horse was never known to thrive better for being kept in a dark stable. The dealer may hide his horse in darkness: and perhaps he may believe that they fatten sooner there than in the light of day. But he might as well tell the truth at once, and say that he wants to keep them out of sight till they are ready for the market. When a horse is brought from a dark stable to the open air, he sees very indistinctly; he stares about him, and carries his head high, and he steps high. Dark stables may thus suit the purposes of dealers, but they are certainly not the most suitable for horses. They are said to injure the eyes. There is not perhaps an animal so liable to blindness as the horse. It cannot be said that darkness is the cause; but it is well known that the eyes suffer most frequently where there is no light. Whether a dark stable be pernicious to the eyes or not, it is always a bad stable. It has too many invisible holes and corners about it ever to be thoroughly cleaned. All these things considered, it is evident that the stable ought to be well lighted." The preferable plan of lighting is by skylights, made to open when required for the sake of improving the ventilation.

Hay-loft and Racks.

The hay-loft, or place of deposit for hay, ought not, as is usually the case, to be over the stable, but adjacent; and a chamber, level with the floor of the stable, is preferable. The reason for this is, that the hay may be preserved free from the breath of the animals and effluvia which rises from the stalls. Lawrence strongly opposes the use of hay-lofts over stables:—"According to the good old and present custom, it is the receptacle of all kinds of impurities as well as hay · the excrement of cats and mice, and exuviæ of spiders, and the accumulated and sacred dust of perhaps half a century. Add to these trifles the perpetually ascending clouds of steam from the stabling below, contaminating, drying, and exhausting the hay of its fragrance, and of every pure and beneficial quality. Hay should remain in the stack, in order to have it in its utmost fragrance and moisture of quality, to be cut often, and taken fresh to the horses, there being a clean and cool hay-room, near the stable, to contain small quantities. The gangway and walls of the stable should be perfectly clear of all encumbrances of chests, pails, brooms, shelves, saddles, or lumber of any kind, for which extra rooms are the proper place." In cases where haylofts are used, let them be kept as clean as possible, and allow no opening to the racks. The hay must be brought down in small quantities and placed in the racks.

Hay-racks of the best material and form are made of iron, the bars rounded, and two inches from each other. The rack need not traverse the whole breadth of the stall, because in such a plan rubbish collects in the corners. A size to hold from a half to a whole stone of hay, will be sufficient in most instances: and the form should be that of a convex or bulged grating from the wall, placed a little above the head of the horse. A rack of this or any other shape cannot be kept too clean; the bars should be daily rubbed, and all old bits of hay removed.

Mangers.

The manger, from which the corn and other kinds of food are eaten, is also best made of cast-iron, and need not be larger than a foot in length and breadth, and about nine inches deep. The old-fashioned wooden mangers, traversing the extremity of the stall, are absurdly large, and as they sometimes are splintered, they injure the animal when feeding or at rest. The form and dimensions of the manger, however, are of much less importance than being kept in a high state of cleanliness. All horses are nice feeders, but some are more fastidious than others, and will not partake of food from a foul manger, or one even which has been blown upon. Let the groom, therefore, keep his horse's manger as clean as he would do his own dish, and at all events do not allow it to get dusty or out of order.

The manger is only for dry food. Some attentive stable-keepers also provide a manger for water, and this seems to be highly judicious. Drinking from pails is a slovenly practice, independently of its being inefficacious. It is now allowed that horses, when stalled, should have a little fresh water beside them to drink, if they feel the desire to do so; and it may be doubted if any horse will drink whose nature does not need this refreshment. Be this as it may, a good plan is to have in one corner at the head of the stall, an iron manger, shaped like that for corn, and into which pure water can be made to flow from a pipe when the groom thinks proper. A waste pipe beneath should be provided to run off the water which is left, or which becomes impure from the dropping of particles of matter from the animal's mouth. A little consideration will point out how this very convenient arrangement can be accomplished.

Bedding.

The good horse sleeps in a lying posture, his legs being partly drawn under him, and his head remaining up. A horse that habitually sleeps standing, or will not lie down at night, is usually reckoned to be of little value; for it is indispensable to doing his duty during the day that he rests well at night. The preparation of a bed for the animal, ought to be one of the most pleasing parts of a stable-keeper's duty; and he should perform it well. The best bed is made of wheat-straw, but when that is dear, or cannot be got, the straw of oats may suit the purpose. The more even and less rumpled the litter, the better. The bed should be made level, or sloping slightly from the sides and head towards the centre, and be completely free of hard lumps. All ought to be smooth, clean, soft, and the depth of litter perhaps seven or eight inches.

Every morning the soiled litter is to be taken away to the dung-yard, and the clean portion separated and placed at the head of the stall, or in some other convenient situation, ready to be employed again at night. It is disgraceful niggardliness to bed horses with foul litter, or to stint them of what is required for their comfort, and seldom fails to bring its own punishment in the injured health and appearance of the animal.

Ventilation—Cleaning.

Ventilation, or a means for the provision of fresh air, is of the first importance in the economy of the stable. Small apertures at different places should be made in the walls, to allow the entrance of pure air, and the escape of such as has been vitiated. A better plan for the removal of the foul air, especially from stables in which a number of horses are kept, would consist in leading it away in a tube from the roof to the flue of a fire. (See our article VENTILATION.) Architects, generally, do not make any provision of this nature in stables, and as few stable-keepers think of instituting such an effectual process of ventilation, we can only here state, as a general principle, that means of some kind should be adopted to keep the atmosphere of the stable in an equable temperature, and as pure as possible, both night and day. We invite attention to the following observation on this point by an intelligent writer:—

"If the stable is close, the air will not only be hot, but foul. The breathing of every animal contaminates it: and when, in the course of the night, with every aperture, even the key-hole, stopped, it passes again and again through the lungs, the blood cannot undergo its proper and healthy change; digestion cannot be so perfectly performed, and all the functions of life are injured. Let the owner of the valuable horse think of his passing twenty or twenty-two out of the twenty-four hours in this debilitating atmosphere. Nature does wonders in enabling every animal to accommodate itself to the situation in which it is placed, and the horse that lives in the stable-oven suffers less from it than would scarcely be conceived possible; but he does not and cannot possess the power and the hardihood which he would acquire under other circumstances. The air of the improperly close stable is still further contaminated by the urine and dung, which rapidly ferment in the heat, and give out stimulating and unwholesome vapours. When a person first enters an ill-managed stable, and especially early in the morning, he is annoyed not only by the heat of the confined air, but by a pungent smell, resembling hartshorn; and can he wonder at the inflammation of the eyes, and the chronic cough, and the inflammation of the lungs, with which the animal, who has been shut up in this vitiated atmosphere all night, is often attacked, or if glanders and farcy should occasionally break out in such stables? It has been ascertained by chemical experiment, that the urine of the horse contains in it an exceedingly large quantity of hartshorn, and not only so, but that, influenced by the heat of a crowded stable, and possibly by other decompositions that are going forward at the same time, this ammoniacal vapour begins to be rapidly given out almost immediately after the urine is voided. When disease begins to appear among the inhabitants of these ill ventilated places, is it wonderful that it should rapidly spread among them, and that the plague-spot should be, as it were, placed on the door of such a stable?

When distemper appears in spring or in autumn, it is in very many cases to be traced first of all to such a pest-house. The horses belonging to a small establishment, and rationally treated, have it comparatively seldom, or have it lightly; but among the inmates of a crowded stable, it is sure to display itself, and there it is most of all fatal. The experience of every veterinary surgeon, and of every large proprietor of horses, will corroborate this statement."—(*Library of Useful Knowledge.*)

The more cleanly the stable is kept, the more easily will it be ventilated. Stables are in general kept in a most offensively foul condition. In the first place, they are often ill-paved, and the refuse of the animals getting imbedded in the interstices of the stones of the stall and gutter, keeps up a constant exhalation. Then there is no proper provision for disposing of the foul litter and urine. It is customary to rake out the used litter and other impurities to a dung-heap immediately outside the door, and there it steams and loses its value, besides being a nuisance to passengers. Instead of this bad economy, let all be raked or shovelled out to a dung-pit covered in from the outer atmosphere, so that every particle of the ammoniacal gases may be preserved. Into this pit, let a smooth channel from the stalls convey rapidly and effectually all liquid refuse. Any man who willingly allows the liquid manures of his stable to run to waste, may with great justice be said to be daily picking his own pocket. Should the gaseous odour be intense, and the quantity of litter in the heap incapable of absorbing it, add now and then a spadeful of earth or any absorbent material that will decompose.

The stable should be clean swept, brushed, and thoroughly ventilated, every morning, leaving impurities neither on the ground nor in the atmosphere. Good feeding and regular exercise may partly neutralize the effects of uncleanliness; but in the event of epidemical influenza, glanders, and other diseases, these effects become sadly manifest; and then, as Mr. Stewart humanely observes, "the proprietor begins to look about him. It is time for him to know that God has not given him absolute and unconditional control over his fellow tenants of the earth. Oppression has wide dominions, but there are limits which cannot be passed; and death reveals the operation of a wise and beneficent law."

Stable Furniture—Stablemen.

Every stable is to be provided with proper receptacles for hay and straw. The oats, peas, beans, bran, &c., should be kept in one large chest with divisions, or separate chests, and if possible be placed in an apartment separate from the stable. For small stables an adjoining room should be fitted up neatly for the accommodation of the corn chest, the saddles, and other apparatus; all saddles, bridles, and small articles being properly hung on hooks on the wall, or placed on other appropriate supports. A cupboard for combs, brushes, &c., will be an advantage. If the stable be not supplied with water in pipes, a well should be at hand.

Horses require to be under the charge of persons who understand the business of attending to them in all their varied wants. Some persons seem to imagine that any boy or lad will do for taking care of a horse. This is both inhumane and bad policy. Where only one horse is kept, a steady lad, under the directions of his master and instructed in the line of his duty, will often be found sufficient; but he requires constant looking after, for all young persons, and some old ones too, are disposed to play pranks with horses, and rob them of their food. The ordinary class of ostlers are not regularly instructed in the qualities and wants of the horse. All they know is empirical, and their prejudices are frequently absurd. Let all such persons, therefore, be estimated at their just value; and on committing your horse to any of them at an inn, see that he does his duty both as respects cleaning and feeding. A kind master always sees that his horse gets its proper measure of corn, and stands by till he eats it.

In stables in which two or more horses are kept, a regular groom should be employed; and this person should reside close by the stable, so as to be always at hand. The qualifications of a groom ought to be steadiness of conduct, promptitude in a case of difficulty, openness to advice or instructions, experience in well-managed stables, taste for cleanliness: and he should be as desirous of making his charge comfortable as he would be of his own person.

In large establishments, there are head and under-grooms, strappers, and stable-boys—the latter a kind of loose appendages to the concern, who act as drudges to the superior officers, and look forward to promotion. In establishments of moderate size, the groom and driver or coachman, are the only functionaries. It is the duty of the groom to attend to the horses in every particular, when in or about the stable, and when taking exercise. The duty of the driver is more particularly to keep the chaise or other vehicle clean, and also to clean the harness.

If all horses were good-tempered, or rendered docile by kind treatment, they might be advantageously left at liberty in their stalls; circumstances, however, require that they should be restrained; but this should be done with as little pain to them as possible. The halter or rein from the head gear should be led to a ring at the head of the stall, leaving the animal at liberty to lie down in an easy posture. The rein, whether of rope or chain, should not be tied to the ring. It should go through the ring, and drop down with a plummet at the extremity to keep it down, yet allowing the animal to pull it up or allow it to sink at pleasure. A shorter halter may be employed during the day than at night, so as to keep him from straggling backwards into the passage or gangway.

Some horses are most restive in restraint, and commit tricks to loosen themselves; and others, by awkwardness of movement, get *cast*, that is, benumbed or cramped, when lying; and it is necessary to employ skill and force to raise them to their feet. A soft bed and abundance of room are the best preventives for this kind of accident.

Grooming—Dressing.

The skins of horses are liable to become clogged with a scurf of dried perspiration, along with particles of dust and mud, which collect and lodge among the hairs. It is of great importance to remove these impurities by currying and brushing, for the sake of the health of the animal, independently of the value of the operation as respects the appearance of his coat. The degree to which this species of grooming is carried, will of course very much depend on circumstances; but, as a general rule, it should take place every morning before the horse is led forth to the labour of the day.

The grooming is commenced while the animal is in his stall, his wrapping-cloth, if he have one, being removed, and the restraining rein being lengthened, to allow his standing a little back into the gangway. If restive, his head must be tied up. All refuse having been previously removed, a little of his bedding may be drawn out for his hind-feet to stand upon. The first thing done is to curry him with a curry-comb—a flat iron instrument, with rows of short blunted teeth and a handle; by being drawn along the surface of the body and limbs, it rakes up the lumps of hair, and generally loosens and brings up all extraneous substances. The groom commences with the neck and shoulders; next he goes to the body, hinder quarters, belly, and legs, both sides being treated alike. The curry-comb must not in any case be used roughly, and with thin-skinned horses its application must be very gentle. If the horse be regularly groomed, and its work not dirty, a gentle scrubbing with the curry-comb will in most cases suffice. In performing the operation, a brush may be held in the other hand, with which to clear out the teeth when necessary. After the curry-comb has gone its rounds, apply the brush in turn, going over the whole surface with it, from head to heels, to remove all raised impurities, and to lay the coat smooth. Lately, a rough hair-glove has been introduced into use as an improvement upon the brush; and it certainly possesses the advantage of being more easily applied to nooks and corners than the brush. Should the horse be changing his coat, which he does twice a year, the curry-comb must not be used at all; a rubbing with a straw-wisp being perhaps sufficient.

After the currying and brushing, the groom proceeds to comb the fore-lock, mane, and tail, so as to make all the hairs lie straight. This finishes the grooming, but if the legs or feet be white, they will perhaps require washing with warm water and soap, to prevent the growth of a yellow appearance, and then dried with a wisp. We have only to add, that if horses are not groomed regularly in this manner, they will inevitably lose their health, or be troubled with parasitical animals lodging beneath the hairs; and never have a glossy and cheerful appearance. Some horses have a great repugnance to being groomed, but this generally arises from harsh treatment while they were young: if treated considerately, they will feel pleased with the friction, and grateful for the attention bestowed on them.

The cleaning of a horse after work is as necessary as the morning grooming. When a horse is brought to the stable in a state of perspiration, it should not be taken in to be at rest all at once, but be walked gently about till it becomes moderately cool. This allows the excitement of the blood-vessels and muscles to be allayed gradually, and prevents any sudden stoppage of the pores of the skin. To assist in drying and cooling down the animal, he may be scraped or rubbed with wisps. Wisping is preferable.

After the horse has been walked and wisped, his legs and feet should be washed with water and a brush or sponge, and also his belly, if it be dirty with sparks of mud; but after any such washing, every part should be thoroughly dried with a fresh wisp. Never leave a horse with wet legs or feet. In the country, it is not unusual to walk horses into a river to wash their legs—a practice most detrimental to their health, and which should not be allowed.

When the horse has been cleaned and dried, the cloth may be thrown over him, and tied to his stall. The cloth used in summer should be more light than that used for winter. It is customary for grooms to exercise horses with the stable-cloths wrapped round them, and then, perhaps, the next hour they are taken out saddled, and without any cloth at all. This seems an inconsistency. The use of cloths is to protect the animal's loins from cold, and is unnecessary in fine weather. If the horse has to stand still out of doors, and the weather be ungenial, his loins ought by all means to be protected by an oiled cloth, to keep out wet. The horse is very susceptible of injury by exposure of the loins; and it will be observed that, to shelter that part, cavalry soldiers wear a long riding-cloak, which falls loosely over the hinder part of the animal.

Trimming.

Nature gives the horse a beautiful flowing tail and mane, for the purpose of whisking off flies and for other uses; but mankind, in taking the creature under their protection, have, in many instances, and for no good reason as far as we are aware, deprived it of these graceful personal appendages. The most contemptible piece of this rash interference has been the docking of the tail, and causing it to cock up, thus leaving the rear of the animal exposed. The tail should be left flowing to a point, and only trimmed to a limited extent; and the same thing may be said of the mane. Nature has likewise given the animal long hairs on the legs independently of the fetlocks. These various appendages have likewise not been given unnecessarily; they answer as a kind of thatch to carry off the moisture which trickles down the legs, so as to keep the feet dry and the legs warm. These parts, therefore, should be trimmed sparingly, and the fouler the work, the more should be left on. Any trimming should be executed tastefully with a comb and pair of scissors. It is customary to clip away the long hairs about the ears and muzzle, but this also must be performed with great discretion. These hairs have their uses, those about the ears in particular, and harm may be done by their removal.

Management of the Feet.

When the horse has been stabled for the night, it will be the duty of the groom to see that the hoofs, above and below, have been cleaned, particles of sand removed from the crevices of the shoes, and the feet generally in a good condition. The feet have a tendency to harden and crack, and thus a good horse may become lame. The fore feet are most liable to this serious evil. To prevent hardness and soreness of feet, it is customary to stop them at night with a soft moist material, most commonly pieces of horse-dung, which is crammed into the sole. No special directions on this point can be given; for some thin-soled horses do not require stopping, and the hind feet are seldom in need of any thing of the kind. When the frog is liable to thrush, the feet require to be kept dry, and cleaned and attended to with peculiar care. To prevent over-dryness of hoofs, as well as to prevent the undue action of moisture, it is advisable to anoint the horny part of the feet with an ointment made of tar, fish-oil, and bees-wax, melted together in equal proportions; but this should not be done unless it is absolutely required. If well washed and kept clean, the feet will seldom require any of this kind of varnishing.

When at large in a wild state, horses, as may be supposed, go barefooted like all the other lower animals. The hoofs grow with a slight curve up in front, but this does not seem to impair their speed. If domesticated horses were always to walk on turf, and not be obliged to carry or draw a weight, their feet might remain unshod; but the circumstances of their condition make it necessary to protect the hoofs from tear and wear by means of shoes. Horse-shoes have been used of many different shapes and materials; but it is needless here to speak of any others than the iron shoes in common use. The shoe must be of weight conformable to the powers and uses of the animal, but exactly to suit the curve of the hoof, flat and of equal thickness, and be secured by nails to the hoof. The proper paring of the hoof before shoeing, and the shoeing itself, are matters to be left to the discretion of regular farriers. As a general principle, care must be taken not to drive the nails into any tender part, and the hoof should be as little broken as possible. A gentleman's horse should be shod at regular intervals, and a shoe never suffered to come off from too long usage.

Exercise.

Every horse ought to be exercised daily in the open air. The exercise should be in the early part of the day: when not exercised by work, he must be walked out and trotted on purpose. An authority already quoted observes:—"The horse that, with the usual stable feeding, stands idle for three or four days, as is the case in many establishments must suffer. He is disposed to fever, or to grease, or, most of all, to diseases of the foot; and if, after these three or four days of inactivity, he is ridden fast and far, is almost sure to have inflammation of the lungs or of the feet. A gentleman or tradesman's horse suffers a great deal more from idleness than he does from work. A stable-fed horse should have two hours' exercise every day, if he is to be kept free from disease. Nothing of extraordinary or even of ordinary labour can be effected on the road or in the field without sufficient and regular exercise. It is this alone which can give energy to the system, or develop the powers of any animal. In training the hunter and the race-horse, regular exercise is the most important of all considerations, however it may be forgotten in the usual management of the stable. The exercised horse will discharge his task, and sometimes a severe one, with ease and pleasure, while the idle and neglected one will be fatigued ere half his labour be accomplished, and if he be pushed a little too far, dangerous inflammation will ensue. How often, nevertheless, does it happen, that the horse which has stood inactive in the stable three or four days, is ridden or driven thirty or forty miles in the course of a single day? This rest is often purposely given to prepare for extra-exertion—to lay in a stock of strength for the performance of the task required of him; and then the owner is surprised and dissatisfied if the animal is fairly knocked up, or, possibly, becomes seriously ill. Nothing is so common or so preposterous as for a person to buy a horse from a dealer's stable, where he has been idly fattening for sale many a day, and immediately to give him a long run after the hounds, and complain bitterly, and think that he has been imposed upon, if the animal is exhausted before the end of the chase, or is compelled to be led home suffering from violent inflammation. Regular and gradually increasing exercise would have made the same horse appear a treasure to his owner. Exercise should be somewhat proportioned to the age of the horse. A young horse requires more than an old one. Nature has given to young animals of every kind a disposition to activity; but the exercise must not be violent. A great deal depends upon the manner in which it is given. To preserve the temper, and to promote health, it should be moderate, at least at the beginning and the termination. The rapid trot, or even the gallop, may be resorted to in the middle of the exercise, but the horse must be brought in cool. If the owner would seldom intrust his horse to boys, and would insist on the exercise being taken within sight or in the neighborhood of his residence, many an accident and irreparable injury would be avoided. It should be the owner's pleasure, and is his interest, personally to attend to all these things."—(*Lib. Use. Know.*)

Watering and Feeding.

A horse should be exercised a little after being watered. He should on no account be allowed to drink when heated, particularly if heated to the extent of perspiring. The only refreshment allowed in these circumstances is a rinsing of the mouth, and the muzzle may be washed and relieved of froth. When not permitted to take water of his own accord in the stall, let him be offered a pail three or four times a day; and after drinking copiously at either a pail or pond, he may be trotted or gently cantered, the motion being generative of heat, and at least prevents any chill.

Horses are fed on different materials in different countries; but principally on the various kinds of grasses and cereal grains. The Germans give them feeds of brown bread while on [illegible]; in India, rice and spices are employed for their [illegible]; in England, the chief articles of food are oats and hay, with inferior proportions of beans, peas, cut straw, and bran. The quantity and also the nature of the food will depend on the habits of the animal, and the work to which he is put. If the work be hard, he must be fed to a considerable extent on oats, which are more nutritious than most other articles in use; but if the work be light, a lighter diet of hay, with perhaps only a small quantity of oats, will suffice. The stomach of the horse being small, he cannot eat much at a time; and it is always preferable to feed him often, and at regular intervals, than to offer him large feeds at irregular periods. There is another reason for offering small feeds; the horse nauseates food which he has blown upon or previously touched, and will accordingly reject it if offered a second time, or allowed to stand beside him. For various reasons, therefore, it is better to give him only a little at a time, so as to leave none behind. If the animal be a poor feeder, or apt to waste his food, the more care must be taken in this respect.

Oats ought to be sound, old, and dry. If musty, reject them. In almost all cases it is preferable to have them bruised; for by this they are more easily digested and nourishing than if left whole. It is now customary to mix oats with chaff composed of the cuttings of clover or meadow hay, and the straw of wheat, oats, or barley. In some stables a machine is kept to cut these materials. The length of the cuttings should be about half an inch. Bruised oats have a tendency to scour the animal; but the infusion of chaff counteracts this quality.

Of hay, clover, and meadow hay, little need be said. They should be sound and sweet-flavoured, without any mustiness. The hay should, if possible, be a year old, and well saved for use in an adjacent stack. Some horses are fond of peas; but they require to be given with caution, as they are apt to swell in the stomach. Almost all horses are inordinately fond of carrots, which, when administered in small quantities do not purge the animal, and improve his coat. A respectable authority states, that "for agricultural and cart-horses, eight pounds of oats and two of beans should be added to every twenty pounds of chaff; and thirty-four or thirty-six pounds of the mixture will be sufficient for any moderate-sized horse [daily] with fair or even hard work." In this estimate, no hay is supposed to be given. When the horse is fed on the last two articles, hay and oats, four feeds, or nine or ten pounds of oats per day, will be a fair allowance, during winter, and in the case of moderate work; but, in summer, half the quantity, along with a proportion of green herbage, will suffice. Many gentlemen follow a general rule of allowing twelve pounds of oats per day to each riding-horse, and this is given in three or four meals. A pony, having but moderate work, will be well fed on six pounds of oats per day, with a fair proportion of hay. Latterly, sago has come into use as an article of horse diet; and we believe it is highly nutritive, and may be employed to a certain extent to supersede oats, or to be mixed with them. It should be partially softened by preparation.

Several serious diseases arise from improper feeding, particularly at intervals during hard labour; and on this point we refer to our observations on

THE DISEASES OF HORSES.

In consequence of the general mismanagement and ill treatment of horses, they are exposed to a number of formidable diseases. Those of most frequent occurrence are glanders, inflammation of the lungs, broken-wind, inflammation of the bowels, and certain illnesses of the feet and legs. Referring our readers to larger works on the Horse for full information on these diseases, and recommending all unskilled persons at once to hand over their horse to a veterinary surgeon when unwell, we propose only to give a few hints as to the best means of prevention. The institution of schools of veterinary surgery, at which the anatomy, peculiar nature, and diseases of horses are explained by men skilled in this important department of science, has been of great use in improving the qualities of horses, preserving their lives, and saving them from much needless distress.

Glanders.

This is a disease of the nose, in some measure resembling the effects of a cold. It is believed to be occasioned by breathing vitiated air, and takes the form of an irritation of the delicate membranes of the nostrils, accompanied by an offensive discharge. Glanders is highly infectious, and may be communicated hereditarily. When not removed in time, it will perhaps terminate in farcy, a disease of the veins, which causes swellings called farcy-buds. The preventive of either of these dangerous maladies, is cleanliness in the stable and pure ventilation.

Inflammation.

The more ordinary inflammation is that of the lungs, and is caused by sudden changes of temperature; it is in reality the grand disorder of the horse, and its effects are only paralleled by those of pulmonary consumption in the human species. Already we have spoken of the great impropriety of exposing horses, while heated, to cold draughts. Allowing them to stand any length of time in the open air, in cold or moist weather, is equally objectionable, and positively cruel. No gentleman having proper regard for the health of his horses, or for his own pocket, will permit his horses to stand waiting in the street at night; and many in London, rather than do so, make a practice of not employing their own carriage late in the evening, and procure a hackney-coach instead. Inflammation of the lungs, however, will arise from various causes besides cold, and these have engaged the most serious attention of veterinarians. Some time ago, the Highland Society of Scotland offered a premium for the best essay on the *inflammatory complaints generally* of farm-horses, and the prize was awarded to Mr. Matthew M. Milburn, Thorpfield, near Thirsk, Yorkshire, whose paper appeared in one of the numbers of the Quarterly Journal of Agriculture. Some of the parts of the essay appear to us so worthy of being made known to persons who have the management of horses, that we take the liberty of giving them publicly in our pages.

After showing that there is not any particular predisposition to disease in the breeds of horses usually employed in heavy draught, nor in the particular conformation of the animals, Mr. Milburn proceeds to say, that "The post-horse, and such as are required to perform fast work, are more liable to attacks of diseases of the brain, the nerves, and the lungs, simply because their work consists of rapid and powerful exertion; the farm-horse, the animal of long and steady exertion, to gripes, inflammation of the bowels, and stomach-staggers—results, as I shall presently show, of a management unsuited to the character of the labour we require from them. The stomach of the horse is remarkably small—smaller in proportion to his size, and the quantity of food he requires, than any other domestic animal. Nature intends for him a supply of nutritious food, and that *at short intervals;* wherein he materially differs from the ox, whose capacious stomach will contain food which will not be digested for hours. The post-horse, the hunter, and the carriage-horse, have food of the most nutritious description and the time during which they are worked is necessarily short, owing to the extreme exertion required; they return to their food; and although their appetite may for a time be impaired, and their stomach and bowels affected by the general debility of the system, yet they recover their tone as soon as the rest of the frame admits of their taking food. The farmer's horse, on the contrary, has food of a less nourishing nature; his rack is filled with straw, or at best with clover; the ploughman rises early, gives him a feed of corn, and leads him to his work, where he continues for seven, eight, and even nine hours, and his whole day's work is completed before he is allowed to eat. We do not find the ox, worked under similar circumstances, so affected in the stomach and bowels, simply because his capacious stomach, when filled, requires many hours to empty, while, as we have seen, it is different with the horse. Debilitated and hungry, the horse returns, and his rack is plentifully supplied, and a good feed of corn given him, and he is left to himself; he eats voraciously, half masticates his food, loads his debilitated stomach, and his digestive organs are weakened, and permanently injured. This course is repeated—a habit of voracity is acquired, and at no very remote period the food lodges and obstructs the pyloric orifice (the passage from the stomach to the bowels), fermentation ensues, gas is evolved, the stomach is distended, he grows sluggish and sleepy, drops his head upon his manger; or he is delirious, and evinces that the sympathy which exists between the stomach and the brain has excited the latter organ; he rolls, paws, and is seized with convulsions; at length he expires, and he has died of stomach-staggers. The half-masticated food has irritated the bowels, extra exertion of the muscles has been required to propel the fæces to the rectum, and cholic or cramp (spasms) of the bowels has followed, or a course of continued irritation, or of continued cholic, or both, has ended in inflammation of the bowels. I remember a beautiful farm-horse, which, owing to the distance of part of the farm to which he belonged from the buildings, was worked the long hours described, and finished his day's work before his bait. He was constantly subject to attacks of the gripes, which were subdued; but he died of stomach-staggers. The same stable, then so often subject to diseases, is now, by a change in the system, completely free from them. Another case, however occurred; a beautiful compact little mare was constantly afflicted by cholic; she eventually died of inflammation of the intestines.

"There are other parts of the management to which horses employed in agriculture are subject, which induce diseases of the bowels. For instance, a boy returning from work, with heated and sweating horses, to save himself trouble, allows them to drink copiously at some pool or stream he passes. Suddenly one or more of the horses exhibit symptoms of gripes; they suddenly lie down, roll about, look at their sides, rise up, seem relieved, and again speedily relapse; the sudden application of the cold water has produced spasms in the bowels, through which it has passed. This is neglected, or perhaps gin or whisky, aided by pepper, is administered as a remedy, and severe and general inflammation of the bowels is the result; this is mistaken for another attack, and again the poison is administered and the inflammation increased, and death follows. The horse of heavy work, too, is longer exposed to the inclemencies of the weather than the animal of light work. In the former, the rain is allowed to fall upon him for hours, and it is allowed *to dry upon his back;* the sympathy between the skin and the alimentary organs is known to every groom; obstructed perspiration, and consequent irritability, is conveyed from the one to the other, and disease is the consequence. It is true, the latter is also partly exposed to the rain, but for shorter periods, and the wisp and brush are liberally applied when he enters the stable; a determination of blood takes place to the skin, perspiration is excited, and disease thus prevented.

"Of the best means of preventing these diseases in farm-horses, we will now treat. We have attributed the peculiar liability to them in farm-horses to mismanagement, with the exception of certain instances of peculiar formation of the animals; and although the farmer must necessarily work his horses longer hours than the horse of rapid work is capable, there is no necessity for depriving the animal so long of food. No horse should work more than five or six hours without a bait. If we examine the history of the stables of large farmers, whose fields necessarily lie at a great distance from the buildings, and where they are worked long in consequence, and compare it with that of small farmers, under the contrary circumstances, we shall find a striking difference as respects the health of the animals. The case referred to above, strikingly illustrates the truth of this observation. But it may be asked, how is it possible to bait the animals so far from home? The difficulty seems to be in procuring food upon the spot; for if this is not done, the precaution will be neglected, and, at any rate, the land will be occupied by it. This, however, may be remedied. In the case, for instance, of a field intended for turnips, which has to be worked during the spring, a part of it, half an acre, or in proportion to the size of the field, may be sown with winter-tares, a few of which may be mown off, and given to the animals green, without carrying them from the field, interfering with any crop, or wasting any time in carrying the horses to a distance. If the field be intended for summer fallow, the spring tare will answer, and which may be used in the same manner, instead of allowing the poor animals greedily and indiscriminately to crop the leaves of the hedges at every turning, from the impulse of hunger. There is another easy way of baiting which some carters adopt, and which might be applied to the farmer's horse, especially when carting. It consists in securing a bag, containing corn, over the animal's mouth and nose, by a string, which passes over the poll, and is locally denominated a 'nose-bag,' or 'horse-poke,' and which should be removed when he has finished his feed. To prevent the effects of the wet upon the skin, an unexpensive glazed cloth may be thrown over the horse's back, and secured to the collar and traces. This may by some be considered very troublesome, but it will be found, that when it is once begun, it will be considered no more trouble than carrying the rest of the harness, and if disease is prevented, the trouble amounts to nothing. To counteract as much as possible any habits of greedy feeding which the horse may have acquired, his corn should be mixed with chopped straw or chopped clover, which will secure its proper mastication, and prevent many troublesome complaints, as well as render all the nutrition of the food available. These may be substituted by an admixture of clean chaff with corn, a plan which is pursued in a farm stable with which I am acquainted, and is found a useful practice. It would save the animals much time in eating, if all their food was chopped, and perhaps steamed; but on this subject we have not sufficient data to determine with accuracy."

The cure, it has been hinted, must generally be left to the veterinary practitioner, whose chief object should be to empty the stomach. In severe cases, an ounce of laudanum and a drachm of pounded ginger, in a quart of warm ale, may be used with probable success.

Broken-Windedness.

When the breathing of a horse is rapid and laborious, it is said to be *thick-winded*; and when it breathes irregularly, the inspiration taking one effort and the expiration two, it is called *broken-winded*. Inflammation of the lungs from cold is the cause of thick-windedness, the condition of these organs preventing the full action of the air-tubes. This complaint, if not removed, will most likely terminate in the broken-winded condition; but broken-windedness will take place without this premonitory symptom. The main cause of broken-windedness is sharp work after over-feeding—causing the animal to run while his stomach is full. The distended membrane presses upon the lungs, and causes a rupture in the air-cells, by which several cells are thrown into one. Thus the breathing is at once rendered irregular by imperfect muscular action in the parts.

This disease is almost invariably the result of sheer carelessness in the persons whose duty it is to superintend the feeding of the horse. The case stands as follows:—"Suppose a horse to be a gross feeder, and to have filled his stomach with straw and hay, and provender that occupies a great bulk, and contains little nourishment, the lungs are squeezed into a less than the natural compass. Let the horse be now suddenly and smartly exercised; more blood must be purified, and in the violent effort to accomplish this, some of the cells give way. Therefore we do not find broken-winded horses on the race-course, for although every exertion of speed is required from them, their food lies in small compass, and the stomach is not distended, and the lungs have room to play, and care is taken that their exertion shall be required when the stomach is nearly empty. Carriage and coach-horses are seldom broken-winded, unless they bring the disease to their work, for they too live principally on corn, and their work is regular, and care is taken that they shall not be fed immediately before their work. The farmer's horse is the broken-winded horse, because the food on which he is fed is bulky, and too often selected on account of its cheapness; because there is little regularity in the management of most of the farmer's stables, or the work of his teams; and because, after many an hour's fasting, the horses are often suffered to gorge themselves with this bulky food; and then, with the stomach pressing upon the lungs, and almost impeding ordinary respiration, they are put again to work, and sometimes to that which requires considerable exertion.

"This disease depends as much upon the cramped state of the lungs, from the pressure of an over-gorged stomach, in the ordinary state of the animal, as on the effects of over exertion. The agriculturist knows that many a horse becomes broken-winded in the straw-yard. There is little nutriment in the provender which he there finds; and to obtain enough for the support of life, he is compelled to keep the stomach constantly full, and pressing upon the lungs. Some have come up from grass broken-winded that went out perfectly sound.

"The cure of a broken-winded horse no one ever witnessed; yet much may be done in the way of palliation. The food of the animal should consist of much nutriment condensed into a small compass; the quantity of oats should be increased, and that of hay proportionably diminished; the bowels should be gently relaxed by the frequent use of mashes; the water should be given sparingly through the day, although at night the thirst of the animal should be fully satisfied; and exercise should never be taken when the stomach is full."—(*Lib. Use. Know.*)

Curb—Bog-Spavin—Bone-Spavin.

The hock-joint is particularly liable to derangement, so as to render the animal unsound. One of these affections is called *curb*, which arises from over-exertion of the ligaments, and takes the form of an enlargement a few inches beneath the joint of the hock. A more serious complaint of the hock is the *bog-spavin*, which takes place from over-exertion, and is an inflammation in the vesicles containing the lubricating material for the joint. This disease is almost incurable; and the poor animal is in general only fit for ordinary and moderate work all the rest of his life. The *bone-spavin* is a still more formidable disease. It is an affection of the bones of the hock-joint, caused by violent action, or any kind of shoeing which throws an undue strain on certain ligaments, and deranges the action of the bones. A bony deposit takes place, the joint is stiffened, and the consequence is a lameness or stiff motion in the hind legs. Blistering, as a counter-irritant, and rest, are the chief remedies prescribed for the complaint; but the best thing of all is not to overload the horse, or put him to any violent exertion, so as to prevent not only this but other similar complaints.

Physicking

Horses that are attended to with the greatest care occasionally get into a condition which requires physic, that is, purgative medicine; as, for example, when they have been too long on hard food and require a laxative, when they get into a heated state of body from constant work, when their bowels get overloaded or disordered, or when they are getting too fat. The most simple laxative is a *bran-mash*. Bran is put into a pail and softened with boiling water; when cooled sufficiently, it is given to the animal as the last feed at night, instead of corn or hay. About half a pailful is a dose. Horses used by commercial travellers or others during the whole week, and fed on corn, are indulged in a mash on Saturday night; and this, with the rest on Sunday, keeps them in good condition.

When a working-horse is lamed, or becomes sick, and must remain idle for a few days, he requires to be relieved by a dose of physic. Generally, this consists of from four to nine drachms of Barbadoes aloes, powdered and formed into a round moistened mass, fit to be swallowed. It requires to be administered by a skilful groom, who will push it over the throat adroitly without alarming the animal. Sometimes the powder is mixed with a little Castile soap. An hour or less after taking physic, a bran-mash should be given, and then the horse be gently exercised; on his return to the stable he may be offered a drink of water from which the chill is taken, or as warm as he will take it.

We should consider it imprudent to offer any further explanations of the materia medica of horses; and again recommend all unskilled or but partially instructed persons not to attempt doctoring their horses themselves, but to call in at once the advice of a veterinary surgeon.

ADVICE IN PURCHASING A HORSE.

The purchasing of a horse is ordinarily a matter of very serious difficulty, in consequence of the proverbial trickiness of dealers, and the many defective points in the animal's constitution which cannot be seen with all the care that may be bestowed. In offering any hints on this important particular, we must refer to the instructions of authorities whose testimony is worthy of confidence. Mr. Stewart has written a valuable little manual, entitled, "Advice to the Purchasers of Horses," which should be in the hands of all who have frequent occasion to make purchases. The following are a few of his admonitions:—

"In buying a horse, one of the chief requisites to be attended to, is the degree of nervous energy which the animal possesses; and it is the union of this energy with good conformation that makes many horses invaluable. Its absence or presence, however, is not likely to be discovered by the purchaser without a trial, and to avoid disappointment in this respect, it is therefore advisable to obtain one prior to purchase. The horse should be set to the work he will be called on to perform; and if he is intended for the saddle or single harness, he should have no companion on his trial, for many horses work well in company that are downright sluggards when alone.

"Some horses have an unpleasant way of going, or are difficult to manage, or have some vice which is only displayed when at work. These are so many more reasons for having a trial prior to striking a bargain. But if that cannot be obtained, some sort of conclusion regarding the animal's spirit may be drawn from his general appearance. The way he carries his head, his attention to surrounding objects, his gait, and the lively motion of his ears, may all or each be looked to as indicative of 'bottom' or willingness to work. It is only however, in a private stable, or in that of a respectable dealer, that these *criteria* can be depended upon; for in a market-place, the animal is too much excited by the cracking of whips, and the too frequent application of them, to be judged of as regards his temper. Neither must the buyer be thrown off his guard by the animation which horses display at an auction, or on coming out of the stable of a petty dealer; for it is a fact which cannot be too well made known, that there are many unprincipled dealers who make it their business, before showing a horse, to 'put some life in him,' that is, they torture him with the lash, till, between pain and fear, the poor animal is so much excited as to bound from side to side with his utmost agility, at the least sound or movement of the bystanders."

This writer continues, in relation to the head and other parts of the animal:—"The head, as being a part not at all contributing to progression, should in the saddle-horse be small, that it may be light—the nostrils expanded to admit plenty of air, and the space between the branches of the lower jaw, called the channel, should be wide, that there may be plenty of room for the head of the windpipe. In the draught-horse, a heavy head is not, as far as utility is concerned, an objection, for it enables him to throw some weight into the collar; and hence, excepting its ugliness, it is rather an advantage if he is used entirely for draught. But it makes the saddle-horse bear heavy on the hand of the rider, makes him liable to stumble, and, when placed at the end of a long neck, is apt to wear out the fore feet and legs by its great weight. The neck of the saddle-horse should be thin, not too much arched, and rather short than long, for the same reason that the head should be light: and, in the draught-horse, it may be thick, stallion-like, and sufficiently long to afford plenty of room for the collar, and for the same reason that the head may be large in this animal. The windpipe should be large, and standing well out from the neck, that the air may have an easy passage to and from the lungs. The horse used for both carrying and drawing should have a head and neck neither too light nor too heavy.

"That the saddle-horse may be safe, and have extensive action, it is necessary that the withers be high. This advantage is indicated by the horse standing well up before; and it is usual, in showing a horse, to exaggerate the height of the forehand, by making him stand with his fore feet on a somewhat elevated spot. A horse with low withers appears thick and cloddy about the shoulder. In the ass and mule, the withers are very low, and the shoulders very flat, and this is the reason why they are so unpleasant to ride, and why it is next to impossible to keep the saddle in its proper place without the aid of a crupper. High withers, however, are not essential to the racer or the draught-horse. The former does all his work by leaps, and that is performed best when the horse stands somewhat higher behind than before: neither are high withers necessary to the draught-horse; but in the roadster they are as important as the safety of the rider is, for a horse with a low forehand is easily thrown on his knees. In the draught-horse, this tendency towards the ground is obviated by the support the collar affords.

"The chest should be deep and wide in all horses, but especially so in one intended for quick work, in order that there may be plenty of room for those important organs, the lungs.

"The back should not be too long nor too short; for though length is favourable to an extended stride and rapid motion, yet it makes the horse weak, and unable either to draw or carry any considerable weight. On the other hand, if the back be too short, the horse's action must be confined; and short-backed horses, in general, make an unpleasant noise when trotting, by striking the shoe of the hind foot against the shoe of the fore one: and though they are in general very hardy, and capable of enduring much fatigue, and of living on but little food, yet a back of middling length is better by far than one immoderately short or long. The back should be nearly straight.

"In the saddle-horse, and where safety is desirable, the position of the fore leg is worthy of attention. It should be placed well forward, and descend perpendicularly to the ground, the toe being nearly in a line with the point of the shoulder. The pastern should neither be turned in nor out. When they are turned inwards, the horse is in general very liable to cut the fetlock-joint by striking the opposite foot against it. The draught-horse may be excused though he leans a little over his fore legs, but the saddle-horse will be apt to stumble if he does so."

Minute attention should be bestowed on the examination of the fore legs and feet; these, in fact, are the great trying points. If the feet be not round and full, so as to stand firmly and flatly on the ground, and if tender or thin in the hoofs, the animal is not to be trusted for saddle-work. Mr. Lawrence on this subject remarks—"The feet of saddle-horses, be they ever so sound and good in nature, detract greatly from the value of the nag, unless they stand even on the ground; since, if they deviate inward or outward, the horse will either knock or cut in the speed, that is to say, will strike and wound the opposite pasterns, either with his toe or his heel; and if he bend his knees much, and is a high goer, will cut the inside of the knee joint. Nature has been very favourable in the hinder hoofs, with which we have seldom much trouble; but there is, now and then, a most perilous defect in them; namely, when the horse is so formed in his hinder quarters, that he overreaches, and wounds his fore heels with the toes of his hind feet." The defect here spoken of will be observed to cause an unpleasant clattering noise in trotting.

The fore legs, from the knees downwards, should be clean made, sound and flexible at the joints. Bad usage knocks up a horse, or founders him; and his legs, being in a kind of benumbed state, will either wholly or partially refuse to perform their office. By ease and physicking the horse recovers; but his system has been shaken, and he is apt to come down. This is a fearful defect in a horse; for no one is for a moment safe on his back. Weakness in the fetlock-joint will also cause a horse to stumble and come down, and is therefore an equally serious defect. When the horse stumbles, so as to come down on his knees, the likelihood is that the knees are broken; and it is well known that wounds of this nature never heal over to resemble the original. The horse with broken knees is, in short, damaged for life, at least in as far as he is a marketable commodity. A good horse, however, may be thrown down on his knees by a bad rider, merely from his head not being held well up while running or quick trotting downhill over a hard road. Such a circumstance as this ought not in general to injure the character of a horse; but it is indisputable that it does so in the estimation of buyers.

Horses are sold either with or without warranty. At sales at repositories, the terms of warranty are generally announced in a public manner; but when the sale is private, no warranty is binding which is not expressed in writing in the receipt. The principle that a price above ten pounds warrants a horse sound, is not now recognised as binding. The warranty must be something different from a mere understanding or illusory custom. "When a horse," says Mr. Lawrence, "is simply warranted sound, that does not extend either to his qualifications or disposition; it merely guaranties that the animal, at the time of sale, is neither lame, blind, broken-winded, or in any respect diseased, or has any impending cause of unsoundness. Broken knees do not impede a sound warrant." We offer these hints on warranty with much diffidence for the rules on the subject are constantly altering by legal decisions.

THE DUTIES OF HORSES.

Draught.

The horse is equally willing to make himself useful as a beast of burden or draught; but his powers are best adapted for draught, and particularly on a level road. The formation of his body does not suit him for climbing or going up-hill with a load; and his strength is always exerted to greatest advantage when he can throw his centre of gravity forward as a makeweight. The amount of load which he can draw in a wheeled vehicle, depends on the arrangement of the load to the pull. The pulling point is across the shoulders, and the most advantageous method is to make the line of traction proceed *direct* from the shoulders to the load—in no shape bent or distracted from its course. The load should be placed lower than the line of the shoulders, thus making the line of traction go by a straight slope to the seat of resistance. The load should not be at a greater distance than will allow freedom of motion to the hind legs. If the load be placed too low, a part of the power will be uselessly spent in lifting it.

According to the calculations of James Watt, the weight which a horse can draw, called a *horse power*, is 1,980,000 lbs. raised one foot high per hour, or 33,000 lbs. raised one foot per minute. The weight is supposed to hang at the end of a rope passing over a freely moving pulley. This calculation is based on considerations more favourable than those which usually attend horse-labour. There are, in reality, no rules to guide the imposing of loads on horses; for every thing depends on the degree of friction on the wheels of the carriage, the nature of the road, and the strength of the animal in question. One thing is certain, that a horse always exerts his power better by himself than when yoked with others. The load which it requires four horses to draw unitedly, if divided, could be drawn with equal ease by three. The following observations in the Scotsman newspaper (June 1839), referring to the operations of Sir C. Stuart Menteith, deserve to be noticed:—

"From the experience this gentleman has had in the use of animal power upon common roads, he is of opinion that the most economical mode of employing horses in draught is to give every horse his own carriage, and that he should solely depend upon his own exertions in drawing the load, as otherwise it is well known that it is difficult to find either man or beast equally willing or capable to make the same exertion, or to have the same spirit or motion; and at the same time never to exceed six miles on one stage, and to be performed twice daily. In a stage of three miles and a half, Sir C. Stuart Menteith employs wagons weighing eighteen cwt., in which horses draw three tons. The road is in general upon a declivity of one foot of fall for every eight sixteen, or eighteen feet, with several ascents of one foot in every thirty feet, up which a horse draws the load of three tons, and a wagon of eighteen cwt.; but in order to facilitate the ascent, a continuous line of sandstone railroad is first laid down, upon which a plate of iron, six inches wide, by a quarter of an inch thick, is fixed down. In order to enable a horse to bring a load of three tons down any rate of descent, a friction-break has been employed, similar to the one in common use in Belgium, from which Sir C. Stuart Menteith derived this important application. The break is a strong plank, fixed to the back of a cart or wagon, which, by means of a screw, the carter presses against the two hind wheels of the machine, so as to give a sufficiency of friction to retard the too rapid descent of the carriage. This plan has been employed with great success by Mr. Croal coach proprietor in Edinburgh, from the suggestion of Sir C. Stuart Menteith, who has now used it more than fourteen years upon his coal-wagons. The mode adopted by Mr. Croal is to fix a lying axle to the plank pressing upon the hind wheels of a coach, and which is turned by an upright shaft, with a bevel wheel connecting the two shafts, and turned by a winch by the hand of the coach-guard, without moving from his seat. Were this break applied to every coach, the lives and limbs of thousands would be preserved, as the guard would be able to stop horses when running away with a carriage—as it is thought the treble, as it were, of the weight of a coach is to be drawn, if the two hind wheels are prevented from revolving by the break. This kind of break enables a coachman to drive with perfect security down a descent of any length, and at any rate of speed. If the employment of horse wagons, weighing from twelve to thirteen cwt., were adopted in conveying coal through the streets of London, one horse would do the work of two; at present, four immense horses draw three chaldrons of coal, or four tons one cwt., in a wagon weighing two tons; so that the shaft-horse is obliged to draw a weight of six tons in turning out of one street into another, which is the greatest cruelty to which a poor animal can be subjected."

The larger the size of wheels in a vehicle, within a reasonable proportion, so is the friction in overcoming obstacles on the road less, and so is the draught more easy to the horses. The benefits of large wheels, however, have often been completely lost by not making them run fairly in an upright position. The custom has been to make them *dished* or bevelled outward from the axle, and to cause the axle to lean downward at each extremity to accommodate this peculiar shape. It is of importance to understand that a wheel always runs best when its tire is of equal diameter, when the spokes are at right angles to the axle, and when the axle projects straight out. This is exemplified in the trundling of a hoop: a hoop which is perfectly upright and even on the rim, requires less force to send it forward and keep it moving than if it were bevelled, and inclined to go round in a circle. For the sake of convenience, wheels may be a little dished, though now that the roads are good, that is scarcely necessary.

The power of draught of a horse depends on the rate at which he is compelled to proceed. He exerts his power to most advantage at a fair pull, when moving at the rate of from two and a half to three miles per hour. If he go at a greater speed, he is less able to draw. As a general rule, if the speed be doubled, the load should be halved; and if the speed be twice doubled, the load should be quartered; yet this will only hold as correct for short distances. Much work may be procured from a horse if he be impelled only for short stages. A horse in a stage-coach, running only five miles at a time and then resting for a few hours, will last at least four times longer than another horse of equal power which runs ten miles at a time. This is well understood by all stage-coach proprietors, and short stages have now almost everywhere superseded long ones. Such a fact should also be known to all private travellers. Whether employed in a gig, chaise, or for riding, the horse on a journey should take his day's work in two distinct stages; one in the morning, and another in the afternoon, when rested and refreshened. He should also, to remain in good condition, have a rest during the whole of Sunday. In journeying with light loads, a distance of from twenty to twenty-five miles is considered a sufficient day's task.

Riding.

The art of riding or equitation forms a regular branch of instruction, and is seldom well performed by those who have not been regularly taught. It is not to be supposed that any thing we can say can supersede the instructions of the riding-school; but it may be of use to offer a few hints on the subject from the best authorities.

Riding should be performed in that manner which is least calculated to oppress the horse and fatigue the rider, and which will be most secure for both parties. The first principle in horsemanship is, that the horse and his rider should act and react on each other, as if governed by one common feeling. To attain this end, the rider must acquire the knack of balancing himself properly on the animal, and establishing the means of making himself understood through certain movements of hand and body. A good horseman will act according to the following directions, given in Walker's Manly Exercises:—"The place of the rider's seat is that part of the saddle into which the rider's body would naturally slide were he to ride without stirrups. This seat is to be preserved only by a proper balance of the body, and its adaptation to even the most violent counteractions of the horse. In relation to the thighs, the rider, sitting in the middle of the saddle, must rest chiefly upon their division, vulgarly called the fork, and very slightly upon the hips The thighs, turned inward, must rest flat upon the sides of the saddle, without grasping; for the rider's weight gives sufficient hold, and the pressure of the thighs on the saddle would only lift him above it. The knees must be stretched down and kept back, so as to place the thighs several degrees short of a perpendicular; but no gripe must be made with them, unless there be danger of losing all other hold. If the thighs are upon their inner or flat side of the saddle, both the legs and the feet will be turned as they ought to be. Thus turned, they must be on a line parallel to that of the rider's body, and hang near the horse's sides, but must not touch; yet they may give an additional hold to the seat, when necessary, and the calves must act in support of the aids of the hands. The heels are to be sunk, and the toes to be raised, and as near the horse as the heels, which prevents the heel touching the horse. As to the body, the head must be firm, yet free; the shoulders thrown back and kept square, so that no pull of the bridle may bring them forward. The chest must be advanced, and the small of the back bent a little forward. The upper parts of the arms must hang perpendicularly from the shoulders, the lower parts at right angles with the upper, so as to form a horizontal line from the elbow to the little finger. The elbows must be lightly closed to the hips, and, without stiffness, kept steady, or they destroy the hand. The wrist must be rounded a little outwards. The hands should be about three inches from the body, and from the pommel of the saddle, and from four to six inches apart; the thumbs and knuckles pointing towards each other, and the finger-nails towards the body. When the rider is in the proper position on horseback without stirrups, his nose, breast, knee, and instep, are nearly in a line; and with stirrups, his nose, breast, knee, and toe, are in a line. The man and the horse throughout are to be of a piece. When the horse is at liberty, or disunited, as it is termed, the rider sits at his ease; and, as he collects and unites his horse, so he collects and unites himself. There must, however, be no stiffness of manner more than in sitting on a chair; for it is ease and elegance which distinguish the gentleman."

Riding, to one accustomed to it, is best performed with a curb and snaffle bridle; the curb, however, being only employed to bring the animal up by pressure on the mouth, when occasion requires. As some horses have a much more delicate mouth than others, the nature of the bridle must depend on circumstances. In holding the reins, a union of firmness, gentleness, and lightness, is the essential requisite. The foregoing authority alludes to the manner in which the reins are to operate on the mouth of the animal:—"The hand being connected with the reins, the reins to the bit, the bit operat ing in the curb on the bars, and in the snaffle on the lips, the rider cannot move the hand, and scarcely even a finger, without the horse's mouth being more or less affected. This is called the *correspondence*. If, moreover, the hand be held steady, as the horse advances in the trot, the fingers will feel, by the contraction of the reins, a slight tug, occasioned by the cadence of every step; and this tug, by means of the correspondence, is reciprocally felt in the horse's mouth. This is called the *appuy*. While this relation is preserved between the hand and mouth, the horse is in perfect obedience to the rider, and the hand directs him, in any position or action, with such ease, that the horse seems to work by the will of the rider rather than by the power of his hand. This is called the *support*. Now, the correspondence or effective communication between the hand and mouth—the appuy, or strength of the operation in the mouth; the support, or aid, the hand gives in the position or action, are always maintained in the *manège* and all united paces. Without these, a horse is under no immediate control, as in the extended gallop or at full speed, where it may require a hundred yards to pull before we can stop him. The degree of correspondence, appuy, and support, depends, in horses otherwise similar, on the relative situation of the hand. The act of raising the rider's hand increases his power; and this, raising the horse's head, diminishes his power. The depressing of the rider's hand, on the contrary, diminishes his power; and this, depressing the horse's head, increases his power. On these depend the unitedness or disunitedness in the action of the horse."

Much may be done to animate a horse, either in riding or drawing, by addressing a cheerful word to him, instead of the lashing and scolding with which he is too frequently visited. If a horse requires correction or urging by the whip, he should only be touched lightly behind the girth and saddle, never on any account on the head or in a fore part of the body. Some carters strike their horses with sticks over the head and legs, and yell to them like savages—two practices equally detestable, which we should be glad to see abolished. We have also seen riders so lost to humanity, as to whip their horses when restive over the head and ears. Should a rider find that his horse designs to baffle him, he must be pressed by the legs, urged lightly with the spur, and kept in his proper track, but not drawn up with the curb, or terrified by abuse.

The most common pace in road-riding is the trot, which in effect is a rapid walk, and most difficult for a rider to perform with address and a small degree of fatigue to himself. In slow trotting, the body should adhere to the saddle, and when it becomes fast or rough, the body may be raised at the proper moments to ease the jolting. This rising of the body, however, is to be a result of the horse's action, not an effort of the rider. The proper method is to rise and fall with the leading foot, the body rising from the seat when the leading foot is elevated, and falling when the foot sinks. Unskilful riders make an unnecessary effort by trying to rise and fall in the saddle.

In the course of either slow or fast riding, the horse may trouble his rider by plunging, shying, or restiveness. If he kick and plunge, sit upright, hold on by the legs, and do not vex him by any lashing; when let alone, he is not long in coming out of his freak. When he shies, or flies to one side, as if afraid of something, press him on the side to which he is flying, keep up his head, and bring him into his track. Pressing both legs against his sides will generally keep him from running backward. When he becomes restive, that is, turns round, and has a disinclination to go in the way he is required, the rider must keep him in his track by dint of pressure, a touch of the spur, and the hand. If he has been accustomed to spurs, and finds that your heels are not provided with these appendages, your case is very hopeless. We must allow Walker to point out the course to be pursued with a restive horse. If he persists in turning round, the rider must continue "to attack his unguarded side, turn him two or three times, and let the heel and spur, if necessary, assist the hand, before he can arm or defend himself against it. If he still refuse to go the right way, the rider must take care that he go no other, and immediately change his attack, turning him about and reining him backward, which the horse is easily compelled to do when he sets himself against going forward. In these contests, the rider must be collected, and have an eye to the surrounding objects; for restive horses try their utmost to place their riders in awkward situations, by sidling to other horses, carriages, the foot-pavement, the houses, &c. In this case, the rider, instead of pulling him from the wall, must bend his head to it, by which his side next the wall is rendered concave, and his utmost endeavours to do injury are prevented. The instant, therefore, that the rider perceives his horse sidling to any object, he must turn his head to that object, and back him from it. There are some horses who set themselves like stocks, setting all endeavours to move them at defiance. There, happily, their defence can in no way endanger the rider. It must, however, be converted to punishment. Let them stand, make no attempt to move them, and in a short space—frequently less than a minute—they will move of themselves."

The same author recommends the rider to remain perfectly cool in all these awkward circumstances. "When passion," he observes, "possesses the rider, it prevents that concord and unity taking place which ever should subsist between the rider and his horse. He should always be disposed to amity, and never suffer the most obstinate resistance of the horse to put him out of temper. If the contest does not demand his utmost exertion of strength, he should be able to hum a tune, or converse with the same composure and indifference as though his horse were all obedience. By these means, the instant a horse finds himself foiled, he desists, having no provocation to contend farther, and is abashed at his own weakness. It is the absence of passion which, added to cool observation, makes the English the best riders and drivers in the world."

Neither in the above section nor elsewhere have we said any thing of the accoutrements of the horse, as all articles of this kind must be left to the taste of the party concerned. The harness made by all saddlers is now both handsome and commodious, and so well calculated for the comfort of the animals, that it would be superfluous to say any thing respecting it, further than to recommend its always being kept clean and glossy, and that it nowhere galls or presses unduly on the animal's body. A properly bred and carefully treated horse is proud of his harness as well as his coat being kept in good condition; and these, like other points in the economy of this highly useful animal, we press on the attention of all whose duty includes the care of horses.

In concluding this comprehensive treatise, which aspires only to be a manual for horse management in ordinary circumstances, we have much pleasure in referring for full information on the subject to a variety of excellent treatises of recent date: among others—"The Horse," in the "Farmers' Series—Library of Useful Knowledge," which we have occasionally quoted; "Stable Management," and "Advice to the Purchasers of Horses," by Mr. Stewart (Blackwood and Sons), two volumes, which can be recommended for their great practical utility; also, Walker's "Manly Exercises" (W. S. Orr and Co., London), for instructions in Equitation.

CATTLE AND DAIRY HUSBANDRY.

Next to the horse, the cow is justly valued as the most useful animal which man has been able to domesticate and retain permanently in his service. The ox tribe, of which it is the female, belongs to the order *Ruminantia*, in the class *Mammalia*, these terms implying that the animals ruminate or chew their food a second time, and have mammæ or teats with which they suckle their young. In the ox tribe there are different genera and species, all more or less differing from each other; and of the domesticated ox, the varieties from the effect of cultivation are now very numerous. The ox, in one or other of its genera, and for the sake of its labour as a beast of draught, its flesh, or the milk of its female, has been domesticated and carefully reared from the earliest times, in some countries having been raised to the rank of a divinity, or at least held as an object of extreme veneration.

The domesticated species of oxen common to Britain and adjacent parts of Europe, is, in all its varieties, materially altered from its wild parentage. Influenced by climate, peculiar feeding, and training in a state of subjection, its bony structure is diminished in bulk and power, its ferocity tamed, and its tractability greatly improved. Our observations in the present sheet will refer chiefly to the cow, on which very great changes have been effected by domestication; the most remarkable of these alterations has been in the capacity for giving milk. In a wild state, the udder is small, and shrinks into an insignificant compass when the duty of suckling is over; but when domesticated for the sake of its milk, and that liquid is drawn copiously from it by artificial means, the lacteal or milk-secreting vessels enlarge, and the udder expands, so as to become a prominent feature in the animal. In this manner, by constant exercise, the economy of the cultivated species of cows has been permanently altered, and rendered suitable to the demands which are constantly made on it. Yet it is important to remark, that those milk-yielding powers are not equal in the different varieties or breeds of cows. Some breeds, from the influence of circumstances which it is here unnecessary to inquire into, give a large quantity of milk, but of a thin or poor quality, while others yield less milk, but of a good or rich quality. Whether, then, the cow-keeper wish *quantity* or *quality*, is the question for him to solve in making a selection of stock. In general, near large towns where the demand for milk is considerable, the object of dairymen is to keep cows which will give a large quantity of milk, no matter of what sort. Private families in the country are usually more regardful of the quality of the article they wish a little milk which is good, some fine cream, and perhaps, also, some sweet butter and cheese, and on that account are more careful in the choice of their cows. The following is a list of breeds which may aid the selection of cows in these different respects.

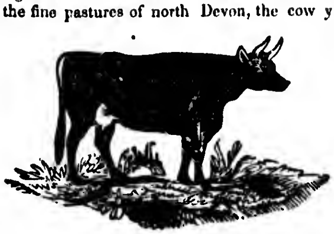
BREEDS OF CATTLE.

The breeds of cattle throughout the United Kingdom vary in different districts from the small hardy varieties of the north Highlands, to the bulky and handsome breeds of the southern parts of England. It has been customary to classify the whole according to the comparative length of the horns—as the long-horned, short-horned, middle-horned, crumpled-horned, and hornless or polled breeds. Besides these, there are many intermixed breeds. The middle-horned cows, which are found in the north of Devon, the east of Sussex, Herefordshire, and Gloucestershire are among the most valuable and beautiful varieties of the animal.

The intelligent author of the work on Cattle, published by the Society for the Diffusion of Useful Knowledge, thus describes what ought to be the proper form and shape of cattle:—"Whatever be the breed, there are certain conformations which are indispensable to the thriving valuable ox or cow. If there is one part of the frame the form of which, more than of any other, renders the animal valuable, it is the chest. There must be room enough for the heart to beat and the lungs to play, or sufficient blood for the purposes of nutriment and strength will not be circulated; nor will it thoroughly undergo that vital change which is essential to the proper discharge of every function. We look, therefore, first of all, to the wide and deep girth about the heart and lungs. We must have both: the proportion in which the one or the other may preponderate, will depend on the service we require from the animal; we can excuse a slight degree of flatness of the sides, for he will be lighter in the forehand, and more active; but the grazier must have width as well as depth. And not only about the heart and lungs, but over the whole of the ribs, must we have both length and roundness; the *hooped* as well as the deep barrel is essential; there must be room for the capacious paunch, room for the materials from which the blood is to be provided. The beast should also be ribbed home; there should be little space between the ribs and the hips. This seems to be indispensable in the ox, as it regards a good healthy constitution and a propensity to fatten; but a largeness and drooping of the belly, notwithstanding that the symmetry of the animal is not improved, are considered advantageous in the cow, because room is thus left for the udder; and if these qualities are accompanied by swelling milk veins, her value in the dairy is generally increased. This roundness and depth of the barrel, however, are most advantageous in proportion as found behind the point of the elbow more than between the shoulders and legs; or low down between the legs rather than upwards towards the withers: for the heaviness before, and the comparative bulk of the coarser parts of the animal, are thus diminished, which is always a very great consideration. The loins should be wide. Of this there can be no doubt, for they are the prime parts; they should seem to extend far along the back, and although the belly should not hang down, the flanks should be round and deep. Of the hips it is superfluous to say that, without being ragged, they should be large; round rather than wide, and presenting, when handled, plenty of muscle and fat. The thighs should be full and long, close together when viewed from behind, and the farther down they continue close the better. The legs may occasionally vary in length according to the destination of the animal; but shortness is a good general rule, for there is an almost inseparable connection between length of leg and lightness of carcass, and shortness of leg and propensity to fatten. The bones of the leg (and they are taken as a sample of the bony structure of the frame generally), should be small, but not too small—small enough for the well-known accompaniment, a propensity to fatten—small enough to please the consumer; but not so small as to indicate delicacy of constitution and liability to disease. Lastly, the hide—the most important thing of all—should be thin, but not so thin as to indicate that the animal can endure no hardship; movable, mellow, but not too loose, and particularly well covered with fine and soft hair."

Of the various breeds and cross-breeds of cows now in use, there are a few which enjoy the best reputation. We may name, for example, the *Old Yorkshire Stock*, a cross between the Teeswater and Holderness breed; the *Long-horned* or *Lancashire breed*, the *Short-horned* or *Dutch breed*, the *Middle-horned breeds of Devonshire, Sussex*, and *Hereford*, the *Ayrshire breed*, the *Alderney breed*, &c. Some of these merit particular attention. We should first point to the

Devonshire Cow.—The Devonshire is a handsome breed of cattle, well set upon their legs, straight along the back, small muzzle, generally red in colour, and both as oxen and cows, they feed well at an early age. The cow is much smaller than the bull, but roomy for breeding, and is distinguished for her clear round eye and general loveliness and neatness of features. Fed on the fine pastures of north Devon, the cow yields a



Devonshire Cow.

rich quality of milk, and in reasonable abundance. The north Devon breed prevails in some parts of Somersetshire, and has been introduced into other quarters of the country, but is not considered suitable in situations greatly differing from its native country as respects climate and herbage.

Herefordshire Cow.—The Hereford breed of cattle is larger than that of north Devon. It is broad across the

Hereford Cow.

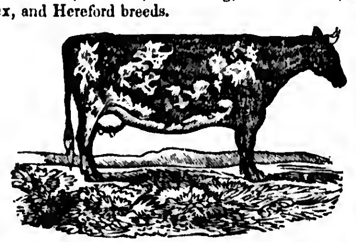
hind quarters, narrow at the surloin, neck and head well proportioned, horns of a medium size, turned up at the points, colour deep red, but with face and some other parts generally white, and countenance cheerful and sagacious. This cow is reckoned among the best in England as respects the production of milk, and when too old for that purpose, it fattens to a greater weight than the north Devons.

The *Galloway breed* of cattle is well known for various valuable qualities, and easily distinguished by the want of horns. It is broad across the back, with a very slight curve between the head and quarters, broad at the loins, the whole body having a fine round appearance. The head is of a moderate size, with large rough ears, chest deep, legs short, and clean in the neck. The prevailing colour is black, those of this colour being thought the most hardy, although this varies. This breed is highly esteemed, as there is no other kind which arrives at maturity so soon, and their flesh is of the finest quality. The milk is very fine, but is not obtained in very large quantities. Great numbers of this breed are sent annually to Smithfield market; and it is remarkable that they are generally in as good condition after the journey as before. The Suffolk dun, also a hornless breed, is supposed to be a variety of the Galloway, from their general resemblance.

The *Ayrshire breed*, which is considered the most valuable in Scotland, is of the small sized and middle horned race: its origin is unknown, as it has been long

Ayrshire Bull.

settled in the county from which it derives its name. In modern times, the breed has been improved by judicious selection, coupling, and general treatment. The common characteristics of this excellent variety of cows are thus described by Mr. Aiton in his "Survey of Ayrshire:"—"Head small, rather long and narrow at the muzzle; eye small, smart, and lively; horns small, crooked, and set at considerable distances from each other; neck long, rather slender, tapering towards the head, with no loose skin below; shoulders thin; fore quarters light; hind quarters large; back straight, broad behind, the joints rather loose and open; carcass deep; legs small, short, with firm joints; udder capacious, stretching forward; the milk veins large and prominent; teats short, all pointing outwards." The Ayrshire cow is very docile, feeds well, is easily managed, and, as a dairy cow, is equal to any other. It is inferior, however, for feeding, to the Devon, Sussex, and Hereford breeds.



Ayrshire Cow.

Many of the Ayrshire dairy cows, when properly fed will yield from 6 to 8 gallons per day during a part of the summer. The quantity varies much during the year, from 1½ to 6 gallons, or more; and the highest average of the milk yielded by this breed is 1000 gallons per annum. It is only some of the finest cows that will yield such a quantity as this, and from 500 to 750 gallons may be calculated as the most general yearly produce. Every 2¼ gallons of milk will afford 1 pound of butter, of 16 ounces to the pound, or 8 gallons will give 3 pounds. About 26 gallons of milk will give a stone of cheese, 14 pounds to the stone, and a good milch cow will thus yield 36 stones annually, which, at 10s. per stone, is £18 per annum for this article alone.

The *Short-horned* or Dutch breed is considered of great value, both for milking and feeding. There are many varieties of it, known by the names of the counties where they have been raised. The best of these varieties are large in the carcass, well proportioned, broad across the loins, chine full, legs short, head small but handsome, neck deep, but in keeping with the size of the body, colour generally red and white mixed, or what is called flecked, hide thin. The flesh of this breed is thick, close grained, retaining the juices well; and from this circumstance is in request for victualling ships going on long voyages.

Regarding the milking qualities of this breed, Mr. Dickson, an eminent cattle-dealer, who has had the most extensive experience throughout the whole country, says —"It has been frequently asserted that the short-horned cows are bad milkers; indeed, that no sort of cattle are so deficient in milk. But this deficiency of milk does not proceed from the circumstance of the cows being of the short-horned kind. Had the flesh been neglected as much as the milk by the eminent breeders, and the property of giving milk as much cherished as the development of flesh, the short-horned cows would have been deep milkers. Indeed, it is not to be doubted that, where the general secreting powers of the animal system have been increased, the power of secreting milk will be increased with the power of secreting fat; all that seems requisite is to encourage the power of that secretion which is most wanted for the time. It would be to desire an impossibility to desire the full development of flesh, fat, and milk, at the same time; but there is no absurdity in desiring a large secretion of flesh and fat at one time, and a large secretion of milk at another, from the same cow. Accordingly, this is the very character which has been acquired by short-horned cows. They will yield from six to sixteen quarts a day throughout the season; and they are such constant milkers, that they seldom remain dry above six weeks or two months before the time of calving. I know a Scotch breeder who had a short-horned cow which gave fifteen quarts a day during the flush of the grass in the summer, and never went dry for two seasons. A cross between a Galloway cow and a short-horned bull in Berwickshire yielded twenty pints a day during the best of the season, and she had to be milked five times a day to keep her easy." We have thus considered it our duty to give the opinion of Mr. Dixon regarding the value of the short-horned breed of cows as a dairy stock, seeing that the demand for short-horned bulls has of late years been great in many of the counties of both England and Scotland. It seems, however, a well-confirmed opinion, that the breed which of all others appears to be gaining ground throughout the United Kingdom for abundant produce on ordinary pasture, is the Ayrshire kyloe, which is described as without a parallel under a similar soil, climate, and relative circumstances, either for the dairy, or feeding for the shambles. But the ever-variable circumstances in climate, soil, shelter, and the quality and quantity of the pasturage, as well as the winter feeding and general treatment, will always have an effect upon the stock.

The *Improved Kerry* is an Irish breed, of rather diminutive size, hardy, and which can subsist on scanty pasture. This renders them exceedingly well adapted for hilly pastures, and for cottagers who may not have the best food to offer their stock Their milk and butter are rich in quality, and for their size they are good milkers. They are quiet enough when let alone, but if the least irritated, no fence can contain them. The Irish cows have improved very much of late years, in consequence of crossing; and they are now in many respects thought equal to the breeds of either England or Scotland.

The *Long-horned* or Lancashire is distinguished by the length of its horns, the thickness of its hide, and the large size of its hoofs. It is far from being a handsome animal; nor is it held in very general estimation either for milking or feeding.

Highland breeds.—The cattle of the Highlands of Scotland are of small bulk, and very hardy. The most esteemed are those belonging to the Western Highlands and Isles, called the Argyleshire breed, and frequently *kyloes*. It is thought that this breed might be much improved by judicious crossing, as was seen in the case of the Ayrshire kyloe, formerly mentioned. This breed is rather handsome in appearance; the horns are long and upright, head large, neck short and deep, legs of a good length, and the beef is in general estimation. The cattle of the Highlands and Isles are bred on an extensive scale of farming for the purpose of sending to the southern markets. Small in size at first, they increase in bulk as they are transferred to a more genial climate and richer pasturage as they proceed southward, till, by annual stages, they reach the neighbourhood of London, when they are large and heavy. The breeds may therefore be considered more an object of culture for the shambles than the dairy.

The *Alderney breed* of cattle is awkwardly shaped, with short bent horns, and light red, dun, or fawn-coloured skins. The appetite of the cow is voracious, and it yields little milk, but that is of an exceedingly rich quality, and the animal is on that account preferred by families who do not regard the expense of keep.

Remarks on Breeds.

We have thus briefly treated of some ot the many breeds of cattle considered valuable as dairy stock in Britain; but we pretend not to give any decided opinion as to which is best. The merits of each kind have been vigorously contested by their respective advocates, and it would be extremely difficult to decide between them. Upon the form and qualifications of a perfect cow, it ought to be observed, that whatever breed is selected, there is a wide difference between the form of one meant for fattening and that intended for the dairy. The first should resemble the ox as nearly as possible; while the latter should be long and thin on the head, with a brisk quiet eye, lank in the neck, narrow across the shoulders, but broad at the haunches; and there should be no tendency to become fat. The udder should be large and full looking, but not protruding too far behind; the teats all pointing out and downwards, equal in size, and rather long and tapering. A cow with a high backbone, large head, small udder, and showing an inclination to become fat, will be found to be a bad milker. This description applies to all breeds; and of course the difference between a cow for fattening and one for yielding milk will be comparative.

Mr. Aiton mentions the following as the most important qualities of the dairy cow:—"Tameness and docility of temper greatly enhance its value. One that is quiet and contented feeds at ease, does not break over fences, or hurt herself or other cattle, will always yield more milk than those who are of a turbulent disposition. To render them docile, they ought to be gently treated, frequently handled when young, and never struck or frightened. Some degree of hardiness, however, a sound constitution, and a moderate degree of life and spirits, are qualities to be wished for in a milch cow, and what those of Ayrshire generally possess. Some have thought that a cow living on a small quantity of food was a valuable quality, but that will depend on the quantity of milk given by the cow that eats little compared with those that eat much. If the cow that eats little gives as much milk as the one that eats more, it certainly is a valuable quality; but of this I entertain doubts, which forty years' experience and observation have served to confirm. Speculative writers affirm that some cows will fatten as well, and yield as much milk, when fed on coarse as others will do on rich food. Cows that have been reared and fed on coarse pasture will yield some milk of a good quality, and from which the best butter may be extracted; while a cow that has been reared and fed on much better pasture, would, if turned on that which is bad, give scarcely any milk. But if a cow that has been accustomed to feed on bad pasture be put on that which is better, she will greatly increase in milk, and fatten much faster. If two cows of the same age and condition, and which have been reared and fed on food of equal quality, are put, the one on bad food, and the other on that which is good, the latter will yield four times the milk, and fatten four times faster than the former. A cow need not always be fed on green clover, cabbages, and cauliflower; but she will neither fatten nor yield milk if she gets no better fare than rushes, bent, and sage grass."

A writer in the "Farmer's Magazine," a few years ago, presented the following doggrel lines, as combining what are popularly considered the good points of a cow, such as is common among the short-horned breed of Yorkshire:—

"She's long in her face, she's fine in her horn,
She'll quickly get fat without cake or corn;
She's clean in her jaws, and full in her chine,
She's heavy in flank, and wide in her loin.

"She's broad in her ribs, and long in her rump,
A straight and flat back, without e'er a hump;
She's wide in her hips, and calm in her eyes,
She's fine in her shoulders, and thin in her thighs.

"She's light in her neck, and small in her tail,
She's wide in her breast, and good at the pail,
She's fine in her bone, and silky of skin—
She's a grazier's without, and a butcher's within."

To ensure the perpetuation of valuable qualities in cows, it is necessary to breed from good bulls of a similar variety to the cows. The heifer or young cow, if properly pastured, should begin to breed at two years, or not beyond two and a half years old. The cow is at her prime at from four to six years, and declines into old age at ten or eleven years, when it is customary to fatten her for market. Dairymen, in selecting cows, prefer those which have had their third or fourth calf when they have attained their fifth or sixth year. The bull is in his prime at three years, and should not be used after eight or nine years old.

GENERAL MANAGEMENT OF COWS.

Calving.

The cow goes with young nine calendar months, or 270 days; but this length of time is liable to variation, from the effect of circumstances. A calf is most likely to survive and be healthy which has gone exactly the nine months. Cows come into season at different periods of the year, in which state they remain for a few days, after which the affection ceases, but it afterwards returns in three or four weeks. The farmer watches these periods, and permits the company of the bull at such a time as will produce the young at a time of the year when grass is plentiful for the nourishment of the mother. This should be an advanced period of spring, for the cow will require nourishing diet some time before she drops her calf as well as afterwards.

A cow may be kept in milk up to the time of her calving, by daily taking a quantity from her; but this is most injurious to the fœtus, and the excitement of the new upon the old milk is apt to produce local inflammation. In towns, where dairymen care nothing for the calf, and must have milk at all risks, cows are often maltreated by being milked to the last; but no one who conducts a dairy on proper principles will be guilty of this inhumanity. The best plan is to allow the cow to go gradually dry, and not milk her at all for six or eight weeks before calving. This will keep her in a reasonably good condition, and save extra food, which it is not advantageous to give on a luxuriant scale, because high feeding at this period may induce inflammation and fever at calving.

No animal is so liable to abortion as the cow: it takes place at uncertain periods during the pregnancy; sometimes it occurs from fright, teazing by other cattle in the field, or over-high condition; but also not unfrequently from some bad habit acquired by the animal. It has been found that the habit is infectious; and when once it has got among a parcel of cows, it can be banished only with the greatest difficulty. In all cases the aborted fœtus should be buried deep and far from the cow pasture; the cow physicked, and its parts washed with chloride of lime; the cow-house thoroughly lime-washed and otherwise purified; and lastly, the cow fattened and sent to market.

If in a state of health, no difficulty will occur at the parturition; but should the case be otherwise, we prefer leaving the cow-keeper to ask assistance from a person of practical skill, or veterinary surgeon, than to offer any speculative advices on the subject. With respect to the treatment after calving, we beg to quote the following directions from the volume on Cattle, "Library of Useful Knowledge:"—"Parturition having been accomplished, the cow should be left quietly with the calf; the licking and cleaning of which, and the eating of the placenta, if it is soon discharged, will employ and amuse her. It is a cruel thing to separate the mother from the young so soon; the cow will pine, and will be deprived of that medicine which nature designed for her in the moisture which hangs about the calf, and even in the placenta itself; and the calf will lose that gentle friction and motion which help to give it the immediate use of all its limbs, and which, in the language of Mr. Berry, 'increases the languid circulation of the blood, and produces a genial warmth in the half-exhausted and chilled little animal.' A warm mash should be put before her, and warm gruel, or water from which some of the coldness has been taken off. Two or three hours afterwards, it will be prudent to give an aperient drink, consisting of a pound of Epsom salts and two drachms of ginger. This may tend to prevent milk fever and garget in the udder. Attention should likewise be paid to the state of the udder. If the teats are sore, and the bag generally hard and tender, she should be gently but carefully milked three or four times every day. The natural and the effectual preventative of this, however, is to let the calf suck her at least three times in the day if it is tied up in the cow-house, or to run with her in the pasture, and take the teat when it pleases. The tendency to inflammation of the udder is much diminished by the calf frequently sucking; or should the cow be feverish, nothing sooths or quiets her so much as the presence of the little one." For instructions respecting the condition and diseases of cows at and after calving, we must refer to the valuable work above quoted.

Treatment of the Calf.—If the calf be a male, and is to be pastured and fattened for market, or to be bred as a working ox, it should be cut between the first and third months; if deferred later, the operation is dangerous.

Whether calves are kept for veal or for stock, they are begun to be fed in the same manner, by sucking milk from a dish. As they naturally seek for the teat when their nose is put to the dish, the fingers of the attendant may be put into their mouth when in the milk, and this will set them going in the art of artificial sucking. "The milk" (says the author of "Clerical Economics"), "should be given to them sparingly at first, to render their appetite more keen, and prevent them from loathing at their food. For the first two weeks they should be fed on the milk first drawn from the cow, locally termed the *forebroads*, which abounds with serum: and as they grow up, the quantity of milk is gradually increased to as much as the calves can be made to drink. After the first two or three weeks, by all means give them plenty of milk, warm from their mother; and let it be that which is last drawn from the cow, locally termed *afterings*, which are much richer. Keep abundance of dry litter under them. Have them in a place that is well aired, and of a uniform temperature, neither too hot nor too cold; let the apartment be quite dark, excepting when the door is opened to give them food. If they enjoy the light, they become too sportive, and will not fatten. Take care they are fastened to the wall, in such a way, by 'swivels,' that they cannot hang themselves. Never let them make their escape at the door, or, by their running and jumping, they will do more injury to themselves in three minutes than a week's feeding will make up. Don't keep them till they become too old, because, when they begin to grow to the bone, they require more milk than the manse can generally produce; and whenever they cease to advance in the fattening process, they begin to recede, and the milk for a week or two is lost. They should be kept from four to seven weeks, according as milk may be abundant and rich. If a calf be kept long, during the last two or three weeks it will require the richest part of the milk of at least two or three cows to bring it to the highest pitch of fatness. When the milk begins to fall short of the calf's appetite, some mix eggs and others peas-meal into their food; others try infusions of hay, oil-cake, and linseed; but none of these additions are approved of by those who feed calves to the greatest perfection. Meal is understood to darken the flesh, web, and lights of the animal; but sago has of late years been almost, from the first two or three weeks, boiled and mixed in its liquid state with the milk, and to great advantage. Begin with a saucerful of it or so, and gradually increase the quantity. Calves are very fond of chalk, and they also feel the want of salt. If a calf happens to be dropt about the middle of summer, when the processes of butter and cheese making wont admit of their being fattened to perfection, they are sometimes, even at the manse, brought sparingly forward for two or three months on whey and skimmed milk; and in November, when veal is very high priced, they are fattened at considerable cost, and sold so as to yield a great return, owing both to their weight and the high markets at that season of scarcity. A calf well managed, in ordinary seasons and prices, should yield, when sold, six or seven shillings for every week it is old."

Cow-house—Cleaning.

The cow-house should be airy, and well ventilated; of moderate temperature, and kept very clean. The stalls for the cows should be paved with small stones, slope gently towards the foot, where there should be a clear run of a gutter to carry off the urine to a pit outside. The stalls must be daily scraped and swept, and all refuse carried out to the dung-heap. In general, far too little litter is allowed. The cow should have plenty of straw bedding, kept in a cleanly condition; and this, when soiled, is to be mixed with the dung for manure. The only fastening for the cow should be a chain to go round the neck, with the other end round an upright post, but easily movable up and down, and allowing room for the animal shifting its position. The feeding manger or stone trough is on the ground, and ought to be kept free of all impurities; for though the cow is not so nice as the horse, it has a disinclination for food not fresh and cleanly.

Except in dairies of a high order, it is customary to keep cows in a shamefully unclean condition. The floor of their habitation is filthy, the walls ragged and full of vermin, and the hides of the animals dusty or barkened with dirt. Persons who keep ' are not aware of the loss they incur from allowing .n to live in this uncleanly state. Some people seem to think that they do quite enough for their cows if they give them food and shelter; but besides this, they require to be kept very cleanly, though seldom indulged in that luxury. The cow should be curried daily like the horse: its hide should be freed from all impurities, and relieved from every thing that causes uneasiness. When you see a cow rubbing itself against a post, you may depend on it that the animal is ill kept, and requires a good scrubbing. Irritation of the skin from impurities also causes them to lick themselves, a habit which is injurious, for the hairs taken into the stomach form a compact round mass, which may destroy the animal. If well curried, any danger from this catastrophe is avoided, the health is generally improved, and this improves the quality of the milk, besides increasing the quantity. A cottager might easily make two or three shillings more of his cow weekly by attention to this point; and if he at the same time took pains to preserve all the liquid refuse of the cow-house, he might double that amount. How strange to reflect, that many decent and well-meaning, but ignorant and rather lazily-disposed people, are suffering a loss of four or five shillings weekly from no other cause than this! It is long, however, before old habits are eradicated, and new and better ones introduced.

Feeding.

The cow requires to be supplied with an abundance of food, not to make her fat, which is not desirable, but to keep up a regular secretion of milk in the system. The feeding must be regular, from early morning to night, and pure water must also be offered at proper intervals, if the cow has not the liberty of going to the water herself.

Regarding the nature of the food of cows, although soiling, or artificial feeding in the house, is at all times economical, there can be no doubt that the best milk and butter are produced by cows fed on natural pasture; and although the quantity of milk is not so great, yet the butter has a sweet taste, never to be discovered in the produce of soiled cows. It was formerly the case in Scotland, and the practice is still continued in some parts, to put the cows out to grass in spring, in such an emaciated state that a considerable part of the best season was gone before they yielded the quantity of milk they would otherwise have done. On well-enclosed farms, it is the custom of many to keep their cows out both night and day, from May till the end of October, so long as a full bite can be obtained; and some bring them into the house twice a-day to be milked. In moorish and unenclosed districts, they are put under the charge of a herd through the day, and are brought into the byres during the night. Soiling, or feeding entirely in the house or court-yard, is but seldom practised, except by some farmers in arable districts. Although complete soiling is only occasionally resorted to, yet a considerable quantity of rich green food is served out to the dairy stock in their stalls at night, and in the heat of the day, by such farmers as bring their cows into the house at these times. This mode of feeding is more especially followed when the pasture begins to fail; the second crops of clover and tares, cabbages, coleworts and other garden produce, are all given to the cows in the house at this period. It is upon this system that the whole perfection of the Flemish husbandry is founded, and it could be put in practice, with the most beneficial results, in many other countries. In Holland, the cows, when fed in the house, have their drink of water invariably mixed with oil-cake, rye, or oat-meal. Dairy cows are allowed to be much injured by being denied a due supply of salt, which is said to improve the quality and increase the quantity of the milk. In the best managed dairies in Scotland, when the cows are taken in for the winter, they are never put out to the fields until spring, when the grass has risen so much as to afford a full bite. In the moorish districts, however, they are put out to the fields for some hours every day when the weather will permit. In these districts, the winter food is turnips with marsh meadow hay, occasionally straw and boiled chaff.

In the richer districts, turnips and straw are given and occasionally some clover hay in spring, or when the cows have calved. Upon this subject nothing need be added, but that the quantity and quality of the milk will be in proportion to the nourishment in the food. White turnips afford a good quantity of milk, but they impart a very disagreeable taste, which may be removed, however, by steaming or boiling the turnips, or by putting a small quantity of dissolved saltpetre into the milk when new drawn. The quality of the milk depends a great deal on the cow, influenced, however, by the food she eats. Linseed, peas, and oat-meal, produce rich milk; and a mixture of bran and grains has been recommended as food in winter. Brewers' grains are said to produce a large quantity of milk, but very thin, the quality being somewhat similar to that sold in large towns, yielding neither good cream nor butter. It has been found of some importance to feed cows frequently—three or four times a-day in summer, and five or six in winter, and to give them no more at a time than they can eat cleanly.

What has been stated regarding the feeding of cows applies principally to those kept on dairy farms. In establishments for the supplying of large towns with milk, the method of feeding is somewhat different; there the practice is to feed them chiefly on distillers' wash, brewers' grains, and every sort of liquid stuff that will produce a large quantity of milk, without reference to its quality. The Edinburgh cow-keepers begin to feed with grain, dreg, and bran mixed together, at five o'clock in the morning, feed again at one o'clock afternoon, and a third time at seven or eight o'clock in the evening; grass in summer, and turnips and potatoes in winter, being given in the two intervals. The grass is laid upon the straw, in order to impart to it a certain flavour, and make it palatable; it is eaten after the grass; and in winter, straw or hay is given after the turnips. Part of the turnips and potatoes are boiled, particularly when there is a scarcity of grains.

The following is mentioned in the "Farmer's Magazine," vol. xv., as an improved mode of feeding milch cows, near Farnham, in Surrey:—"Go to the cow-stall at six o'clock in the morning, winter and summer: give each cow half a bushel of the mangel-wurzel, carrots, turnips, or potatoes, cut; at seven o'clock, the hour the dairy-maid comes to milk them, give each some hay, and let them feed till they are *all* milked. If any cow refuses hay, give her something she will eat, such as grains, carrots, &c., during the time she is milking, as it is *absolutely necessary* the cow should feed whilst milking. As soon as the woman has finished milking in the morning, turn the cows into the airing ground, and let there be plenty of *fresh water* in the troughs; at nine o'clock, give each cow three gallons of the mixture (as under—to eight gallons of grains add four gallons of bran or pollard); when they have eaten that, put some hay into the cribs; at twelve o'clock give each three gallons of the mixture as before. If any cow looks for more, give her another gallon. On the contrary, if she will not eat what you give her, take it out of the manger, for never, at one time, let a cow have more than she will eat up *clean*. Mind you keep your mangers clean, that they do not get sour. At two o'clock, give each cow half a bushel of carrots, mangel-wurzel, or turnips; look the turnips, &c., over well, before you give them to the cows, as one rotten turnip, &c., will give a bad taste to the milk, and most likely spoil a whole dairy of butter. At four o'clock, put the cows into the stall to be milked; feed them on hay as you did at milking-time in the morning, keeping in mind that the cow, whilst milking, must feed on something. At six o'clock, give each cow three gallons of the mixture as before. Rack them up at eight o'clock. Twice a week put into each cow's feed at noon a quart of malt-dust." The writer of these directions adds, that the daily expense of subsisting each cow on the above feed would be about two shillings.

Milking.

Cows are milked twice or thrice a-day, according to circumstances. If twice, morning and night; if thrice, morning, noon, and night. They should not go too long unmilked, for, independently of the uneasiness to the poor animal, it is severely injurious.

The act of milking is one which requires great caution; for if not carefully and properly done, the quantity of the milk will be diminished, and the quality inferior, the milk which comes last out of the udder being always the richest. It should, therefore, be thoroughly drawn from the cows until not a drop more can be obtained, both to ensure a continuance of the usual supply of milk, and also to get the richest which the cows afford. Cows should be soothed by mild usage, especially when young; for to a person whom they dislike, they never give their milk freely. The teats should be always clean washed before milking, and when tender, they ought to be fomented with warm water. The milking and management of the cow should, in these circumstances, be only intrusted to servants of character, on whom the utmost reliance can be placed. In the southern and midland counties of England, it is a common practice to employ men to milk the cows, an operation which seems better fitted for females, who are likely to do the work in a more gentle and cleanly manner, which is of essential importance.

The writer in the "Farmer's Magazine," above quoted, gives the following explicit directions to the dairy-maid in regard to milking:—"Go to the cow-stall at seven o'clock; take with you *cold water* and a sponge, and wash each cow's udder clean before milking; dowse the udder well with *cold* water, winter and summer, as it braces and repels heats. Keep your hands and arms clean. Milk each cow as dry as you can, morning and evening, and when you have milked each cow as you *suppose* dry, begin again with the cow you first milked and drip them each; for the principal reason of cows failing in their milk is, from negligence in not milking the cow dry, *particularly* at the time the calf is taken from the cow. Suffer no one to milk a cow but yourself, and have no gossiping in the stall. Every Saturday night give in an exact account of the quantity of milk each cow has given in the week."

THE DAIRY.

The dairy should be cool, airy, dry, and free from vermin of all kinds. To prevent the intrusion of flies, the windows or ventilators ought to be covered with a fine wire gauze. The floor should be laid with smooth glazed tiles, and also the lower part of the walls; the benches on which the milk pans are to be placed are feet when made of stone or slate, and about thirty inches broad. The ceiling should be at least eight feet from the floor, and finished in every respect like that of an ordinary dwelling-house. A slate roof is preferable to one of tile, as it tends to keep the temperature more equable. Cleanliness is of the most essential consequence in dairy management, and, if not strictly looked after, may cause considerable loss. It is this which has raised the produce of the dairies of Holland so much in public estimation. Every article in which milk is placed, more especially when made of wood, ought to be washed in boiling water, and a little soda or lime dissolved in it. If milk should happen to sour in any dish, the acid thus generated will injure any which may be afterwards put into it; but if washed with water in which an alkali has been dissolved, the acid will be destroyed.

The utensils of a dairy are very numerous. The principal are milk-pails, shallow coolers for holding the milk, sieves for straining it through after it is taken from the cow, dishes for skimming the cream, churns for making the butter, scales, weights, &c. For making cheese, there are likewise ladders, vats, tubs, curd-breakers, and presses; and various other articles will be required, which it is almost impossible to enumerate. In form, these vessels, with a few exceptions, are alike throughout Great Britain; and even in other countries there is little variation. The majority of them are made of wood; but in some of the best dairies in England and Scotland, it is now the practice to have the coolers made of cast-iron, wood lined with tin in the inside, or glazed earthenware. Maple is the wood generally used in England for the manufacture of these dishes; both from its lightness, and being easily cut, it can be finished in a neater style. In Holland, the milk dishes are very commonly made of brass; and certainly brass or iron is to be preferred to wood, because the dishes made from either of these materials are more durable, and can be easier cleaned. It has been objected to earthenware vessels, that, being glazed with lead, the acid of the milk acting upon the glaze forms a very noxious poison. This, however, is scarcely correct; it would require a much stronger acid than that of milk to decompose the glaze; and in some parts of England lead has been long used, and never objected to. Zinc pans are now coming into use, and they can be safely recommended for their cool and cleanly qualities, besides being economical. We have seen it stated that cream rises best in zinc pans.

Cheese-presses are usually made of stone of various weights, according to the size of the cheese. Granite is preferred for this purpose, on account of its great weight. A lever was a method long practised, one end of which being placed in a hole in the wall, the sinker acted as a fulcrum, and one or two unhewn stones hung on the end of the pole produced the pressure. Another kind of press consisted of a stone weight placed upon the sinker, which was raised and depressed either by a block and tackle or a screw. The kind most commonly used at present is a lever with a double wheel, which occupies little space, is easily worked, and allows of the weight being better regulated than by a stone placed upon the sinker.

Churning is now, in all large dairy establishments, performed by machinery, worked either by horse or water power, or attached to a thrashing-machine, if there is one near the dairy. Churns vary in size from ten to fifty, and even one hundred gallons, according to the size of the establishment. The plunge-churn, which has the appearance of a barrel placed on its end, is that most commonly used—the plunge being worked by a lever connected with a shaft and crank, moved by a wheel outside. The common hand-churns are of various forms, either upright with a plunge, or horizontal with arms inside, which are turned by an iron handle. A churn formed like a cradle is much used in Canada, and has been strongly recommended for adoption in this country. It is rocked regularly by a child sitting astride, who may thus be usefully employed while amusing himself. Great care should be taken to wash churns thoroughly with boiling water, both immediately after they have been used, and before they are again to be put into operation; and those churns which admit of being easily cleaned are always to be recommended, even although they should not be so elegant in construction.

DAIRY PRODUCE.

Milk.

Milk consists of three materials blended together, called in science the butteraceous, lactic, and serous kinds of matter, which can be separated by artificial means, so as to form *butter*, the milk called *butter-milk*, and *serum* or whey. The whey is little else than water, slightly saline, and is generally the chief ingredient in the milk. When taken from the cow, milk should be removed to the dairy or milk-house, and after being sieved, placed in shallow pans, to throw up the butteraceous matter termed cream, which, being lightest, floats on the top.

The following observations on milk and its management, made by Dr. Anderson, in his "Recreations," are worthy of the consideration of cow-keepers:—

"Of the milk drawn from any cow at one time, that part which comes off at the first is always thinner, and of a much worse quality for making butter, than that afterwards obtained; and this richness continues to increase progressively to the very last drop that can be obtained from the udder.

"If milk be put into a dish and allowed to stand still, it throws up cream; the portion of cream rising first to the surface is richer in quality and greater in quantity than that which rises in a second equal space of time; and the cream which rises in the second interval of time is greater in quantity and richer in quality than that which rises in a third equal space of time; that of the third is greater than that of the fourth, and so of the rest; the cream that rises continuing progressively to decrease in quantity and to decline in quality so long as any rises to the surface.

"Thick milk always throws up a much smaller proportion of the cream which it actually contains than milk that is thinner; but the cream is of a richer quality; and if water be added to that thick milk, it will afford a considerably greater quantity of cream, and consequently more butter than it would have done if allowed to remain pure; but its quality is, at the same time, greatly debased.

"Milk which is put into a bucket or other proper vessel, and carried in it to a considerable distance, so as to be much agitated, and in part cooled before it be put into the milk-pans to settle for cream, never throws up so much or so rich cream as if the same milk had been put into the milk-pans directly after it was milked.

"From these fundamental facts, the reflecting dairyist will derive many important practical rules. Some of these we shall enumerate, and leave the rest to be discovered. Cows should be milked as near the dairy as possible, in order to prevent the necessity of carrying and cooling the milk before it is put into the creaming dishes. Every cow's milk should be kept separate, till the peculiar properties of each are so well known as to admit of their being classed, when those that are most nearly allied may be mixed together. When it is intended to make butter of a very fine quality, reject entirely the milk of all those cows which yield cream of a bad quality, and also keep the milk that is first drawn from the cow at each milking entirely separate from that which is last obtained, as the quality of the butter must otherwise be greatly debased, without materially augmenting its quantity. For the same purpose, take only the cream that is first separated from the first drawn milk. Butter of the very best quality can only be economically made in those dairies where cheese is also made; because in them the best part of each cow's milk can be set apart for throwing up cream, the best part of this cream can be taken in order to be made into butter, and the remainder, or all the rest of the milk and cream of the dairy, can be turned into cheese. The spontaneous separation of cream, and the production of butter, are never effected but in consequence of the production of acid in the milk. Hence it is, that where the whole milk is set apart for the separation of cream, and the whole of the cream is separated, the milk must necessarily have turned sour before it is made into cheese; and no very excellent cheese can be made from milk which has once attained that state."

We now pass on to a consideration of the most valuable ingredient in the dairy produce—

Butter.

Butter is made of cream, freed from its milky and serous properties. This is effected by churning. Some imagine that no butter can be good except such as is made from fresh cream; but this is a mistake, as cream requires to have a little acidity before the butter will form. The length of time which the cream should stand before churning has never been clearly ascertained; from three to seven days, however, may be considered as the proper period. A more important matter than the length of time which cream requires to stand, is the degree of temperature at which the cream will turn into butter. This has been ascertained from experiment to be from 45 to 75 degrees of Fahrenheit. In Holland, when the cream is too cold, hot water is put into the churn to raise the temperature to 70 or 75 degrees. The best quality of butter is obtained at a temperature of 51 degrees, according to experiments performed by Mr. Pooler; and the greatest quantity at a temperature of 46 degrees. During the process of churning, the agitation will increase the heat to about five degrees more than it was when the cream was put into the churn. Mr. Pooler is of opinion, that the greater quantity of butter is obtained by the increased heat causing more milk to remain amongst the butter; and this, of course, must decrease its quality.

In some of the dairies in the neighbourhood of Edinburgh, and in all those near Glasgow, the butter is made by churning the cream and the milk together. This is done in order to obtain the buttermilk, the demand for which is always great in large cities. When the milk and cream are to be churned together, the milk is kept in the coolers for from twelve to twenty-four hours, and then poured into a milk-tub. It remains here until required for churning; and will, during this time, have coagulated. If a certain quantity of milk is put into the milk-tub, and has coagulated before any more has creamed, the coagulated milk must in no way be disturbed, or, if the two quantities are mixed together, too much fermentation may be the consequence. The milk is not churned till it has become acid; and when once coagulation has taken place, it should be churned as early as convenient. If the milk has not fermented before churning, the buttermilk will keep for a much longer time, will have an agreeable taste, and will bear to be mixed with a little water. When the milk has fermented before being churned, the buttermilk will never be so good, nor will it keep for such a length of time as the former.

The operation of churning, whether it be of cream alone, or cream and milk, is performed in the same manner. The milk requires more time than cream to complete the process, from two to three hours being considered necessary, while cream alone may be effectually churned in an hour and a half. It is necessary that the operation should be slow in warm weather; for if done too hastily, the butter will be soft and white. If the cream is at too high a temperature, the churn should be cooled with cold spring water, to reduce it to the proper degree of heat. In winter, again, the operation of churning should be done as quickly as possible, the action being regular; and the churn should be warmed, to raise the temperature of the milk or cream. The air which is generated in the churn should be allowed to escape, or it will impede the process by the froth which it creates.

After the churning is performed, the butter should be washed in cold spring water, with a little salt in it, two or three times, to extract all the milk which may be lodging about the mass. It is said by some that the butter retains its sweetness much longer when no water is used; and others affirm that the washing improves the flavour. The extraction of the milk from butter will reduce its weight; but it appears from the experiments of Mr. Pooler upon the temperature of the cream, that the less milk which is in the butter its quality is proportionably improved. Kneading and beating the butter too much render it tough and gluey. After the milk has been carefully extracted, if the butter is to be salted, it should be mixed with the finest salt, in the proportion of ten ounces to the stone of fourteen pounds, more or less, according to the time the butter is to be preserved. The butter and salt should be well mixed together with the hand; and in Ireland it is customary to add a little saltpetre. A compound of one part sugar, one part nitre, and two parts of the best Spanish salt, finely powdered together, has been highly recommended for preserving butter. It is used in the proportion of one ounce to the pound: and it is said to give a flavour to the butter which no other kind ever acquires.

For making butter casks or kegs, the wood of the lime-tree is highly recommended, as containing no acid; and after it the white oak and the ash. When wood contains acid, it acts powerfully upon the salt in the butter, converting it into brine. Fir has also been recommended for making casks; and, indeed, any wood will answer if boiled for a few hours, for by this process the pyrolignous acid will be entirely taken out.

In salting, the butter should never be put into the firkins in layers; but the surface should be left every day rough and unbroken, so as to unite better with that of the succeeding churning. The quality may likewise be better preserved by covering it over with a clean linen cloth dipped in pickle, and placing it in a cool situation.

Buttermilk.

This is the liquid which remains in the churn after removing the butter. If skimmed milk has been employed for churning, the buttermilk is thin, poor, and easily sours; but if from the churning of the entire milk, the buttermilk is more thick and rich, and is considered by many a delicious beverage. Good buttermilk is at all events exceedingly wholesome and nutritious. In Ireland, it is largely used at meals with potatoes; in Scotland, it is more frequently employed as a relish with oatmeal porridge; and for this purpose large quantities are brought to Edinburgh, Glasgow, and other towns, from the adjoining rural districts. In England, the buttermilk of farmers is usually employed in feeding pigs.

Corstorphine Cream.

This is a preparation of milk, which derives its name from Corstorphine, a village three miles west from Edinburgh, where it was once made in perfection. It consists of the curd of soured or *lappered* milk, from which the whey is poured, along with fresh cream and a little sugar. In former times it was a favourite supper dish in Edinburgh, but is now altogether out of use.

Devonshire Clouted Cream.

This is a preparation of the rich milk of Devonshire, and may be said to be a kind of half-formed butter, such is the solidness of its consistency. In Vancouver's "Survey of Devonshire," the following is described as the mode of preparing this delicious article:—"The milk is put into tin or earthen pans, holding about ten or twelve quarts each. The evening's meal is placed the following morning, and the morning's milk is placed in the afternoon, upon a broad iron plate heated by a small furnace, or otherwise over stoves, where, exposed to a gentle fire, they remain until after the whole body of cream is supposed to have formed upon the surface; which being gently removed by the edge of a spoon or ladle, small air-bubbles will begin to rise, that denote the approach of a boiling heat, when the pans must be removed from off the heated plate or stoves. The cream remains upon the milk in this state until quite cold, when it may be removed into a churn, or, as is more frequently the case, into an open vessel, and then moved by the hand with a stick about a foot long, at the end of which is fixed a sort of peel from four to six inches in diameter, and with which about twelve pounds of butter may be separated from the buttermilk at a time—the butter in both cases being found to separate much more freely, and sooner to coagulate into a mass, than in the ordinary way, when churned from raw cream that may have been several days in gathering; and at the same time will answer a more valuable purpose in preserving, which should be first salted in the usual way, then placed in convenient-sized egg-shaped earthen crocks, and always kept covered with a pickle, made strong enough to float and buoy up about half out of the brine a new-laid egg. This cream, before churning, is the celebrated clouted cream of Devon."

Cheese.

Cheese may be made from cream alone, or from the whole milk; the object in either case being in the first place to separate the serum from the other materials. This is effected by curdling the cream or milk, by the infusion of an acid, the refuse being the serum or whey, which is of scarcely any value. No acidulous substance is found so suitable for curdling milk as *rennet*, which is formed of the gastric juice of a calf that has been fed on milk. Some persons preserve the maws or stomach bags of calves with the curd contained in them; others employ the stomach bags alone, putting a few handfuls of salt into and around them. They are then rolled up, and hung in a warm place to dry, and are kept for some time before they are used. The stomach is never made use of in Gloucestershire until it is a twelvemonth old; for, if used before this, it is said to swell the cheese, making it full of *eyes* or holes. The usual way of preparing the rennet in England, is to add to every six skins or stomachs two gallons of brine, and two lemons, which take away any unpleasant taste, and give the rennet an agreeable flavour. A large quantity is made at a time; and it is never used until it has stood at least two months. A method of preparing rennet, recommended by the late Mr. Marshall, is as follows:—

"Take the maw of a newly-killed calf, and clean it of its contents, salt the bag, and put it into an earthen jar for three or four days, till it forms a pickle; then take it from the jar, and hang it up to dry; after which it is to be replaced in the jar, the covering of which should be pierced with a few holes to admit the air; and allowed to remain in the jar for twelve months. When wanted for use, a handful each of leaves of sweet briar, dog rose, and bramble, with three or four handfuls of salt, are to be boiled together for a quarter of an hour, when the liquid is to be strained off, and allowed to cool. The maw is then to be put into the liquid, together with a lemon stuck round with cloves; and the longer it remains in the liquid, the stronger and better will the rennet be; half a pint of the liquid is sufficient to turn fifty gallons of milk." As almost every dairy county in England has its own particular method of steeping and salting the maws and preparing the rennet, we shall only give the method pursued in Ayrshire, the most important dairy district in Scotland. The stomach of the calf is examined, and all impurities such as straw, removed from the curdled milk. Two handfuls of salt are then put into and around the bag, which is hung in a warm place to dry thoroughly. It is seldom used before it is a year old, and even a longer period is thought to improve it. When wanted to prepare rennet, the bag is cut into small pieces, and put into a jar, with a handful or two of salt, and a quantity of boiled soft water, cooled down to about sixty-five degrees, or new whey taken off the curd is put into the jar. The quantity of water or whey will vary according to the quality of the yirning; and if it is that of a new-dropped calf, three English pints will be enough; but if fed for four or five weeks, two quarts will be about the quantity required. This is allowed to stand in the jar for two or three days, and is then strained off, and another pint of water placed upon the maw, which, after standing three days, is added to the first infusion. If any impurities appear in the liquid, it should be carefully strained through a sieve, and the whole can be bottled and used as wanted. A glassful of whisky is sometimes put into each bottle; but this is not common. The liquid thus prepared may be used either immediately, or kept months if required, and a table-spoonful will coagulate thirty gallons of milk in the course of ten minutes; whereas the English rennet requires nearly three hours for this purpose.

Dunlop Cheese.—Dunlop cheese has of late come into very general repute; and although nowhere so well made as in the parish of Ayrshire, from which it derives its name, it is now manufactured in Galloway, in the counties of Renfrew, Lanark, and Ayr, and is extending to others. The cheeses are made of various sizes, from a quarter to half a hundred weight; and the process of making them is as follows:—Sweet milk for Dunlop cheese is composed of all the milk as it is yielded by the cows without having the cream separated from it. When so many cows are kept upon a farm that a cheese can be made every time they are milked, the milk is passed through a seive into the vat, and formed into a curd by the rennet. But when the cows are not so numerous as to afford milk sufficient to form a cheese at each milking, it is put into the coolers about six or eight inches deep. At the next milking the cream is skimmed off, and without being heated, the milk is put into the curd-vat along with that just drawn from the cows. The milk is then raised to a temperature above blood heat, or in summer to 90 degrees, and in winter 95 degrees. If coagulated much warmer, the curd becomes too adhesive; some of the butteraceous matter is lost in the whey, and the cheese will be found dry, tough, and tasteless. If too cold, on the other hand, the curd, which is then soft, does not part readily with the serum, and the cheese is so wanting in firmness that it is difficult to get it to keep together. Even after the utmost care has been taken to extract the whey and give solidity to the cheese, holes, which in provincial language are termed *eyes*, whey-drops, and springs, frequently break out, and render the cheese either rancid or insipid.

It is not enough that the milk be brought to a right temperature when the rennet is applied, but the milk must be kept neither too hot nor too cold from the time it is taken from the cow. The temperature of the milk-house ought to be kept as equal as possible, never rising above 55 nor sinking below 50 degrees. In operations so critical as those of the dairy, where any material alteration in the temperature will affect the quality of the cheese, this ought at all times to be ascertained. Instead of this, the general practice is for the dairy maid merely to pass her fingers through the milk, than which nothing can be more uncertain. A thermometer ought not only to be in every milk-house, but also in every byre, as extremes of heat or cold, or sudden changes in the temperature, have a great effect upon the secretion of milk.

About a table-spoonful of the liquid rennet is considered sufficient for 100 quarts of milk, and the curd is formed by it in twelve or fifteen minutes; but in some dairies, the curd does not appear in less than forty-five or sixty minutes, although double the quantity of rennet is used. This must be owing either to a want of strength in the rennet, or from some peculiarity in the herbage upon which the cows have been fed. The curd, when formed, should be broken with the skimming-dish or the hand as soon as possible, but without pressing as the least violence has been found to make it come off white, and thus weaken the quality of the cheese. The whey may be run off by lifting the tub gently on its edge, and allowing it to flow into a vessel placed beside the tub. The curd should then be allowed to stand until the whey had gathered in another part, and this is also poured off.

When quite freed from the whey and the curd has acquired a little consistency, it is cut with the cheese-knife, gently at first, and more minutely as it hardens, after which it is put into the drainer, a square vessel with small holes in the bottom, and a cover to fit inside. The lid is placed upon the curd, with a cloth thrown over it, and pressure is applied according to the quantity of curd; and in this state it is allowed to stand for about half an hour. It is then cut into pieces about two inches square; the whey is again discharged, and double the former weight is placed upon it. This process of cutting it smaller every half hour, and increasing the weight until the pressure is 100 lbs., is continued for three or four hours. It is then cut very small, and thoroughly salted; thirteen ounces of salt to twenty-four pounds English of the curd being sufficient.

A clean cheese-cloth, rinsed in warm water and wrung out, being then placed in the chessel, the curd is put in, and half a hundredweight laid on it for an hour. It is then put under a press of two hundredweight, where it remains during an hour and a half, after which it is taken out, and a fresh cloth placed in the chessel. The cheese is then placed upside down, and laid, with increased weight under the press, letting it remain three or four hours in the press at a time, and at each shifting get a clean dry cloth. Some have shortened the process of pressing by placing the cheese, when it comes from the press for the first time, into water heated to about 95 or 100 degrees, where it remains till the water becomes milk-warm. The cheese is then dried well, and again placed under the press.

When ultimately taken from the press the cheeses are generally exposed for about a week to a considerable degree of drought, turned over every twenty-four hours, and rubbed with a dry cloth. They are then removed to the store-room, which should be in a cool exposure between damp and dry, without the sun being allowed to shine on them, or a great current of air admitted—this gradual mode of ripening being found essential to prevent the fermenting and swelling of the cheese and cracking of the rind. The mode of sweating cheeses, after they come from the press, and before they are laid up to dry, although common in England, is not approved of nor practised in Ayrshire. Yet Dunlop cheeses do not crack in the skin except when the milk has begun to acidify before being coagulated, or when they are exposed to too much drought at first. Whey springs, or eyes, are seldom seen in the cheeses of Ayrshire. Cheese, like butter, is sometimes coloured with an infusion of annato, but the practice is far from being common. The Dunlop or Ayrshire cheeses have not so high a flavour and spicy taste as some of the English, owing, perhaps, to the inferiority of the pasture, and to the greater pains taken in the English dairies to give the cheese an acrid taste.

Cheshire Cheese.—It has been remarked, that although good imitations of the cheese made in the English counties have been produced elsewhere, yet in no trial has a cheese possessing the true Cheshire flavour been made. This is attributed to the abundance of the saline particles in the earth, resulting from the numerous salt springs in that county. Cheshire is almost entirely a dairy county, its arable husbandry being neither extensive nor of a superior character. It is said to possess thirty-two thousand dairy cows; the quantity of cheese made annually is estimated at eleven thousand five hundred tons, and the average quantity afforded by each cow at three hundred pounds. In making the cheese, the practice followed is to set the evening's milk apart till the following morning, when the cream is skimmed off, and two or three gallons put into a brass pan, which is immediately placed in hot water and rendered scalding hot. Half of the milk thus heated is poured upon the night's milk, and the other half mixed with the cream, which is rendered thinner by the mixture. This is done by the dairy-woman while the other servants are milking the cows; and the morning's milk being immediately added to that of the previous, evening the whole mass is set together for cheese. The rennet and colouring being then put into the tub, the whole is well stirred, and a wooden cover put over the tub, with a linen cloth thrown over it. It in general requires an hour and a half before the milk curdles; and if the cream should rise to the surface in this time, the whole must be again well stirred, which is done every time the cream rises, until coagulation takes place.

When the curd is formed, if it be firm, it is cut with the cheese-knife, and then cut across, making the incisions about an inch distant from each other. The curd is then broken by the dairy-woman, until every part of it is made as small as possible, about forty minutes being generally spent in this process, when the curd is left about half an hour to subside, covered over with a cloth. After this, the curd is put in a favourable position in the tub to drain, and a weight of about sixty pounds put upon it, in order to press out the whey, which is drained to the lower side of the tub and laded out. When well drained, the curd is turned upside down, and pressed as before. It is cut into pieces of about nine inches square, which are piled one above another, and pressed both with the hand and the weight, so long as the whey continues to flow.

These pieces are then cut into three parts of about the same size, which are broken very small, and salted at the rate of three handfuls to each. They are then put into a cheese-vat, furnished with a coarse cheese cloth. The curd is heaped in the vat in a conical shape the cone being covered with a cloth, to prevent any curd from falling off. As soon as the curd adheres together, a weight of about sixty pounds is put upon it, and several iron skewers are stuck through it by holes in the sides of the vat. These holes are made in order to allow any whey remaining in the curd to escape. The weight and skewers are then removed, and the curd is broken as small as possible, half way down the vat. The pressing and skewering are again repeated, and a clean cloth is put over the upper part of the curd, which is then taken out of the vat, and put into it again upside down, and broken half way down as before. When no more whey can be extracted, the curd is turned in the vat, and rinsed in warm whey. The curd is still kept above the edge of the vat, being bound round with strong tape to keep it in a proper shape. The cheese is next put into the press, which has generally the power of fourteen or sixteen hundredweight, and is then well skewered with strong wires, eighteen or twenty inches long, and sharp at the points. The vat is furnished with holes on the sides to receive the skewers; and after being about half an hour in the press, the cheese is again turned, and supplied with a clean cloth. It is turned again and again several times for forty-eight hours, each time supplied with a clean cloth, and is then put mid-deep into salt, its top covered with salt, where it remains for three days, its position being reversed each day. When taken out of the vat, it is put into a wooden hoop or girth of the same breadth as the thickness of the cheese, and is placed on the salting bench, where it stands about eight days, being well salted during that time. The cheese is then washed in lukewarm water, and after being wiped, is placed on the drying bench, where it remains about seven days; it is then again washed and dried as before, and rubbed all over with sweet butter. After this, it is placed in the warmest part of the cheese-room, and rubbed each day with sweet butter for the first seven days.

These cheeses vary in size, being in some dairies nearly a hundred and forty pounds in weight. The quantity of salt made use of during the process is uncertain; three pounds to a cheese of sixty pounds is thought to be about the amount; but much of this is lost in the salting house. Whether the cheese acquires much saltness during the steeping and rubbing, is uncertain, though much salt is expended in these operations.

Gloucester Cheese.—The double Gloucester cheese, which is held in such high repute, is almost wholly made in the vale of Berkley in Gloucestershire. Its excellence is said to depend much upon the quality of the land, and the great attention which is paid to the management of the dairies. The quantity of cheese made in this vale annually, is about one thousand two hundred tons, and each cow is estimated to yield three hundred and fifty pounds. It is usually made in the months of May, June, and July, and the process of manufacturing is as follows:—

When the curd is considered firm enough for breaking, it is cut gently and slowly into squares of about an inch; and after standing, to allow the whey to gather, it is again cut at this time into larger pieces than before, and slowly at first. This cutting is gradually quickened, the incisions being made near to each other. The lumps of curd are lifted with the skimming spoon in one hand, and cut with a knife in the other hand, while suspended. The curd is now allowed to settle about a quarter of an hour, when the whey is taken from it by being poured through a fine hair sieve, the dairymaid, at the same time, cutting the curd so that all the whey may escape. The curd is then pressed down with the hand into vats, covered with large cheese-cloths of fine canvas, and placed in the press for half an hour. It is then put into a mill, which crumbles it to small pieces, thus saving the labour of squeezing and rubbing with the hands; and this operation is thought a great improvement in the making of cheese.

The whey is next completely extracted, and the curd put as compactly as possible into the vat, heaped above the vat just so far that it can be pressed down to a level with the edge. A cheese-cloth is then spread over the vat and a little hot water thrown over the cloth, which has a tendency to harden the outside of the cheese, and prevent it from cracking. The curd is next turned out of the vat into the cloth, and the inside of the vat being washed in whey, the inverted curd with the cloth is returned to the vat. The cloth is then folded over, and the vat put into the press for two hours, when it is taken out, and dry cloths applied through the course of the day. It is then replaced in the press until salted, which is generally performed about twenty-four hours after it is made. In salting, the cheese is rubbed with finely powdered salt; and this is thought to make the cheese smoother and more solid than when the salting process is performed upon the curd. The cheese is after this returned to the vat, and put under the press, in which more than one are placed, the newest one at the bottom, and the oldest on the top. The salting is repeated three times, twenty-four hours being allowed to intervene between each; and the cheese is finally taken from the press to the cheese-room in the course of five days. In the cheese-room it is turned over every day for a month, when it is cleaned of all scurf, and rubbed over with a woollen cloth, dipped in a paint made of Indian red or Spanish brown and small beer. As soon as the paint is dry, the cheese is rubbed once a week with a cloth.

The quantity of salt employed is about three and a half pounds; and one pound of annato is sufficient to colour half a ton of cheese.

The true characteristics of double Gloucester consist in its great richness, together with the mildness of its flavour. The single Gloucester differs in no respect in the making from the double sort, except that it is thinner; the weight of each seldom exceeding twelve pounds, while the double is generally about twenty-two pounds. This cheese is sometimes made less rich by being mixed with skimmed milk.

Stilton Cheese.—This cheese is made by putting the night's cream, without any portion of skimmed milk, into the next morning's milk; but those who wish to make it very fine, add still more cream; and thus its richness depends upon the quantity of cream made use of. Butter is also said sometimes to be used in its manufacture. The rennet is then added without any colouring; and when the curd has formed, it is taken out without being broken, and put whole into a sieve or drainer. In the drainer it is pressed with weights until all the whey is extracted, and when dry, put into a hooped chessel. The outer coat being salted, it is then put into the press, and when sufficiently firm, it is taken out of the chessel, and bound tightly in a cloth. This cloth is changed every day until the cheese is quite dry, when it is removed; and the cheese requires no further care except occasional brushing and turning. The Stilton cheese, although small, not weighing more than twelve pounds, requires two years to bring to full maturity.

Parmesan Cheese.—This famous cheese is manufactured in that part of Italy which lies between Cremona and Lodi, comprising the richest portion of the Milanese territory. The cows are kept in the house nearly all the year round, and fed in summer with cut grass from the rich irrigated meadows of the country. Some of the cheeses are so large as to contain nearly 180 lbs. and the milk of 100 cows is required to produce one of this size. This cheese is made from the milk of the evening, which is skimmed in the morning and at noon, and the milk of the morning, which is also skimmed at noon. These two milks are put together into a large copper caldron, which is hung on the arm of a lever, and can be taken off and put on the fire at pleasure. The milk is heated in this vessel to about 120 degrees, and then removed from the fire and kept quiet until all internal motion has ceased.

The rennet is then added, and in an hour the curd will have formed, when it is again put on the fire and heated to a temperature of 145 degrees. While heating, the mass is briskly stirred, till the curd separates in small pieces, when part of the whey is run off, and a little saffron added to colour the cheese. When the curd is sufficiently broken, nearly the whole of the whey is taken out, and two pailfuls of cold water are thrown in. The temperature is thus reduced so far as to allow the dairymen to collect the curd, by passing a cloth under it and gathering up the corners. It is now pressed into a frame of wood, placed on a solid platform, with a heavy weight on the top. In the course of the night the curd cools, parts with the whey, and assumes a firm consistence. The next day one side is rubbed with salt, and the succeeding day the cheese is turned, and the other side rubbed in the same manner, this alternate salting being continued for forty days. After this, the outer surface of the cheese is pared off, the fresh surface rubbed with linseed oil, the convex side is coloured red, and the cheese is fit for sale.

It appears that this highly esteemed cheese is altogether made from skimmed milk, and yet all the pores are filled with an oily substance. This seems too rich to be imparted by the butteraceous matter of milk which has been deprived of its cream, and it is generally supposed that some portion of oil is mixed with the curd. This, however, has not been ascertained to be the case.*

Swiss Cheese.—The finest cheese made in Switzerland is that of Gruyere, in the canton of Friburg. It is rich in quality, and generally flavoured with a powdered dry herb, the *Melilotus officinalis*. The cheeses weigh from forty to sixty pounds each, and are exported in large quantities.

Mr. Laing, in his work, "Notes of a traveller," thus alludes to the primitive dairy operations of the small pastoral farmers in Switzerland:—"Each parish has its *alp*, that is, its common pasture for the cows of the parish, and each inhabitant is entitled to a cow's grazing, from June to October, on this common pasture. Few, however, have cows in sufficient number to repay the labour of attending them at the summer grazing in the alps. The properties are too small, in general, to keep more than five or six cows all winter; and few can keep more than three. Yet these small proprietors contrive to send cheese to market as large as our Cheshire dairy-farmers with their dairy stocks of forty or fifty cows; and, as the price of Gruyere cheeses shows, incomparably better in quality. Each parish in Switzerland hires a man, generally from the district of Gruyere in the canton of Friburg, to take care of the herd, and make the cheese; and if the man comes from Gruyere, all that he makes is called Gruyere cheese, although made far enough from Gruyere. One cheeseman, one pressman or assistant, and one cowherd, are considered necessary for every forty cows. The owners of the cows get credit, each of them, in a book daily, for the quantity of milk given by each cow. The cheeseman and his assistants milk the cows, put the milk altogether, and make cheese of it; and at the end of the season each owner receives the weight of cheese proportionable to the quantity of milk his cows have delivered. By this co-operative plan, instead of the small-sized, unmarketable cheeses only, which each could produce out of his three or four cows' milk, he has the same weight in large marketable cheese superior in quality, because made by people who attend to no other business. The cheeseman and his assistants are paid so much per head of the cows, in money or in cheese, or sometimes they hire the cows, and pay the owners in money or cheese. In October, the cows are brought home, and the home grass-lands having been mown for hay twice during the summer, the winter food is provided, and a very small area of land keeps a cow, when the home grass has not been burdened with summer grazing. The pasture in these alps, or summer grazings, is abundant and rich. In some of the upper valleys, inhabited winter as well as summer, but in which the corn-crops are secondary, and dairy produce the main object—as, for instance, Grindewald—a man with a house suitably situated is permanently established for receiving the milk of the neighbourhood. Each family takes care of and milks its own cow or cows, keeps the milk wanted for family use, and sends the rest of it daily to the cheeseman, who gives each family credit for the milk delivered each day; and the cheese made during the season is divided, or very usually the cheese is marketed, and the money divided; and in this way cheeses of great weight are manufactured, although no one cow-owner has milk enough to make one of marketable size. I went one warm forenoon, while ascending the Rhigi, into one of these dairy houses. From the want of dairymaids or females about the place, and the appearance of the cow-man and his boys, I thought it prudent to sit down on the bench outside of the smoky dwelling room, and to ask for a bowl of milk there. It was brought me in a remarkably clean wooden bowl, and I had some curiosity, when, clean or dirty, my milk was swallowed, to see where it came from. The man took me to a separate wooden building; and instead of the disgusting dirt and sluttishness I had expected, I found the most unpretending cleanliness in this rough milk room; nothing was in it but the wooden vessels belonging to the dairy, but these were of unexceptionable nicety; and all those holding the milk were standing in a broad rill of water led from the neighbouring burn, and rippling through the centre of the room, and prevented, by a little side sluice, from running too full, and mingling with the milk. This burn running through gave a freshness and cleanliness to every article; although the whole was of rude construction, and evidently for use, not show. The cows were stabled, I found, at some distance from the milk-house, that the effluvia of their breath and dung might not taint the milk. Cheese is almost the only agricultural product of Switzerland that is exported; and it is manufactured by these small farmers certainly as well, with as much intelligence, cleanliness, and advantage, as by large farmers."

Whey.

Whey, or the thin watery serum of milk, is of a pale-greenish hue, and saline in taste, and forms an agreeable beverage when cool. Some dairy-farmers in England are in the habit of extracting a little butter from it; but with careful management, this practice would be quite unnecessary, as it is only when the milk has been coagulated too hot that any quantity of butter will remain in this liquid. In Scotland, the whey is used as food by the farmers and their families in making oatmeal porridge and a saving of nearly one-third of meal is effected when the porridge is made of whey instead of water. By boiling, what is called float whey is obtained, which, when mixed with a little sweet milk, is thought little inferior to curd. Whey is also very valuable in feeding swine; and it is estimated that the whey of three or four cows will, in the course of one season, with little additional food, fatten a pig to the weight of twelve or fourteen stones.

LONDON DAIRY MANAGEMENT.

The quantity of fresh milk annually consumed in the British metropolis was lately calculated to be 39,420,000 quarts, costing £985,500, and being the produce of 12,000 cows, kept principally in large dairy establishments in all parts of the environs. The milk is generally of the best kind when drawn from the animals; but, between the dairy and the consumer, it passes through several hands, each of whom takes a profit upon it, and increases the quantity of saleable liquid by large infusions of water, chalk, &c. In the condition it usually reaches the public, it is shamefully adulterated. The charge of deteriorating the quality of the article is seldom made upon the cow-keepers, whose establishments are, for the most part, models of good management. As it may be interesting to our readers to have some account of these large dairies, we present the following particulars:—

The two largest dairy establishments are those of Mr. Flight (known as Laycock's dairy) and of Messrs. Rhodes. Flight's is one of the curiosities of London; it covers fourteen acres of ground, surrounded by a high wall, and

* For our information upon the manufacture of cheese in the English counties, we have been indebted to the British Husbandry; and the different county reports; and for the account of the Parmesan cheese, principally to the Journal de Physique.

including buildings for the different purposes required. In the cow-house there are upwards of 400 cows, the whole of which are fed in stalls. The food is very properly varied; at one time they have mangel worzel; then they have turnips, carrots, cabbages, and clover; and when fattening for market, they are fed on oil-cake and other articles. All are curried daily. Adjoining the cow-house is an hospital for unwell cows, or cows which are calving. The milk-house is kept beautifully clean, being scouered daily with hot water.

With respect to Rhodes's dairy, which is situated at Islington, Mr. Loudon, in his "Encyclopædia of Agriculture," has condensed the following description of its extent and mode of management from various publications: "The number of cows kept by the present Messrs. Rhodes exceeds, on an average of the year, four hundred: at one time these individuals are said to have had upwards of a thousand cows in their different establishments. The surface on which the buildings are placed is a slope of two or three acres, facing the east; and its inclination is about one inch in six feet. The sheds run in the direction of the slope; as well for the natural drainage of the gutters, and the more easily scraping, sweeping, and wheeling out of the manure, as for supplying water for drinking to small cast-iron troughs, which are fixed in the walls, at the heads of the cattle, in such a manner as that the one trough may be supplied from the other throughout the whole length of the shed. The sheds are twenty-four feet wide; the side walls about eight feet high; the roof of tiles, with rising shutters for ventilation, and with panes of glass, glazed into cast-iron skeleton tiles, for light. The floor is nearly flat, with a gutter along the centre; and a row of stalls, each seven feet and a half wide, and adapted for two cows, runs along the sides. The cows are fastened by chains and rings, which rings run on upright iron rods, in the corners of the stalls; the common mode being departed from only in having iron rods instead of wooden posts. A trough or manger, formed of stone, slate, or cement, of the ordinary size of those used for horses, and with its upper surface about eighteen inches from the ground, is fixed at the head of each stall. Four sheds are placed parallel and close to each other, and in the party walls are openings, about a foot in breadth and four feet high, opposite each cow. The bottom of these openings is about nine inches higher than the upper surface of the troughs, and is formed by the upper surface of the one-foot-square cast-iron cisterns, which contain the water for drinking. Each cistern serves two cows, which, of course, are in different sheds, but adjoining and opposite each other. All these troughs are supplied from one large cistern by pipes, in a manner which can be so readily conceived that we shall not stop to offer a description. Each of these troughs has a wooden cover, which is put on during the time the cows are eating their grains, to prevent their drinking at the same time, and dropping grains in the water. At the upper end, and at one corner of this quadruple range of sheds, is the dairy, which consists of three rooms of about twelve feet square: the outer or measuring-room; the middle or scalding-room, with a fire-place and a boiler; and the inner or milk and butter-room, separated by a passage from the last. At the lower end of the range is a square yard, surrounded by sheds; one for fattening the cows when they have ceased to give milk, and the others for store and breeding pigs. The pigs are kept for the purpose of consuming the casual stock of skim milk which occasionally remains on hand, owing to the fluctuations in the demand. This milk is kept in a well, walled with brick laid in cement, about six feet in diameter, and twelve feet deep. The milk becomes sour there in a very short time; and, as is well known, is found most nourishing to the pigs when given in that state. Breeding swine are found most profitable, the sucking pigs being sold for roasting. Beyond this yard is a deep and wide pit or pond, into which the dung is emptied from a platform of boards projecting into it. The only remaining building wanted to complete the dairy establishment is a house or pit for containing the exhausted malt (grains), on which the cows are chiefly fed. Messrs. Rhodes have a building or pit of this description at some distance, where they have a smaller establishment. There are a stack-yard, sheds, and pits for roots, straw, and hay, a place for cutting hay into chaff, cart-sheds, stables, a counting-house, and other buildings and places common to all such establishments, which it is not necessary to describe.

"The cows in Rhodes's dairy are purchased newly calved in the cow market held in Islington every Monday. They are kept as long as they continue to give not less than two gallons of milk a day, and are then fattened on oil-cake, grains, and cut clover hay, for the butcher. The short-horned breed is preferred, partly for the usual reason of being more abundant milkers than the long horns, partly because the shortness of their horns allows them to be placed closer together, and partly because this breed is more frequently brought to market than any other. The Ayrshire breed has been tried to the number of 150 at a time, and highly approved of, as affording a very rich cream, as fattening in a very short time when they have left off giving milk, and as producing a beef which sold much higher than that of the short horns. The difficulty, however, in procuring this breed was found so great, that Mr. Rhodes was obliged to leave it off. The length of time during which a cow treated as in this establishment, continues to give milk, varies from six months to the almost incredible period of two years. We were assured of there being at this moment several cows among the 390 which we saw, that had stood in their places even more than two years, and continued to give upwards of one gallon of milk daily.

"The treatment of the cows in Rhodes's dairy differs from that in most other establishments. The cows are never untied during the whole period that they remain in the house. In most other establishments, if not in all, stall-fed cows or cattle are let out at least once a day to drink; but these animals have clear water continually before them. They are kept very clean, and the sheds are so remarkably well ventilated, by means of the openings in the roofs, that the air seemed to us purer than that of any cow-house we had ever before examined; probably from its direct perpendicular entrance through the roof, this, in moderate weather, being certainly far preferable to its horizontal entrance through the side walls.

"The principal food of the cows in Rhodes's dairy, as in all the other London establishments, consists of grains; that is, malt after it has been used by the brewer or the distiller. As the brewing seasons are chiefly autumn and spring, a stock of grains is laid in at these seasons sufficient for the rest of the year. The grains are generally laid in pits bottomed and lined with brickwork set in cement, from ten to twenty feet deep, about twelve or sixteen feet wide, and of any convenient length. The grains are firmly trodden down by men, the heaps being finished like hay-ricks, or ridges in which potatoes are laid up for the winter, and covered with from six to nine inches of moist earth or mud, to keep out the rain and frost in winter, and the heat in summer. As a cow consumes about a bushel of grains a day, it is easy to calculate the quantity required to be laid in. The grains are warm, smoking, and in a state of fermentation when put in, and they continue fit for use for several years, becoming somewhat sour, but they are, it is said, as much relished by the cows as when fresh. It is common to keep grains two or three years; but in this establishment they have been kept nine years, and found perfectly good. The exclusion of the air almost prevents the increase of the fermentation and consequent decomposition. What is called distiller's wash, which is the remainder after distillation of a decoction of ground malt and meal, is also given to cows, but more frequently to such as are fattening than to those in milk. The present price of brewers' grains is fourpence halfpenny per bushel; of distillers' grains, on account of the meal they contain, ninepence a bushel; of wash, thirty-six gallons for sixpence.

"Salt is given to the cows in Rhodes's dairy at the rate of two ounces each cow a day. It is mixed with the grains, which are supplied before milking, about three o'clock in the morning; and in the afternoon, about two o'clock, just before milking. Of green food or roots, portions are supplied alternately with the grains; and in winter, when tares or green grass cannot be procured, after the turnips, potatoes, or mangel-wurzel have been eaten, a portion of dry hay is given.

"The produce of this dairy is almost entirely milk and cream for private families and for public hospitals and other institutions. A number of the public establishments are supplied directly from the dairy by contract; but private families are principally supplied by milk-dealers: these have what are called milk-walks; that is, a certain number of customers, whom they call upon with supplies twice a day; and they are thus enabled to ascertain the average of what their customers consume, and to contract with Messrs. Rhodes for this average. The latter calculate the number of cows sufficient to give the dealer the supply wanted, and this number the dealer undertakes to milk twice a day, namely, at three o'clock in the morning and at three in the afternoon. The milk is measured to the dealer, and should he have milked more than his quantity, it remains with the dairyman; but should the cows have been deficient in the quantity, it is made good from the milk of other cows, milked on account of the contracts of the establishment. As the supply of the cows and the demand of the dealers are continually varying, it often happens that considerable quantities of milk remain on the dairyman's hands, frequently, we are told, as much as sixty or seventy gallons a day. This quantity is placed in shallow earthen vessels, to throw up the cream in the usual manner; this cream is churned, and the butter sold." The skimmed milk, it is added, as well as the butter-milk, are, as is usual in English dairies, given to the pigs.

GENERAL MANAGEMENT OF CATTLE.

Diseases.

Cattle are subject to various diseases, the result of improper treatment, or of causes connected with climate which it is difficult to avert. By attention to feeding, housing and cleaning, as already noticed, much may be done to prevent some of the more fatal distempers. Cattle that have passed their lives, both day and night, in the open air, are generally so hardy that they are not injured by a wetting of the skin, and are liable to few of the complaints of dairy or stall-fed animals. Cows, being compelled to lead an artificial mode of life, are the most delicate in every respect, and require the most careful treatment. They should not be left out all night, and when they return from the field wet, it is always a safe and humane plan to dry them with a wisp of straw. The diseases to which they are most liable are of an inflammatory kind, and for these the veterinary surgeon prescribes bleeding, and perhaps some medicines to be taken internally. Leaving cow-keepers to seek the advice of these professional men, or at least of persons possessing practical skill, we need here only allude to three chief disorders for the sake of general information. The first we shall mention is

The Hove.

The hove, or blown, in cattle is a swelling in the paunch, caused generally by eating wet grass or clover in warm weather. The substance ferments, and the membrane becomes distended by the creation of air or gas, which cannot find the means of escape; and if not taken off artificially, the animal will be suffocated. Mr Loudon, in his "Encyclopædia of Agriculture," mentions the following methods of relief from this fatal distension:—

"There are three modes of relieving the complaint, which may be adverted to according to the degree of distension and length of time it has existed. These are internal medicines; the introduction of a *probang* of some kind into the paunch by the throat; and the puncturing it by the sides. Dr. Whyatt, of Edinburgh, is said to have cured eighteen out of twenty hoved cows, by giving a pint of gin to each. Oil, by condensing the air, has been successfully tried. Any other substance, also that has a strong power of absorbing air may be advantageously given. Common salt and water, made strongly saline, is a usual country remedy. New milk, with a proportion of tar equal to one-sixth of the milk, is highly spoken of. A strong solution of prepared ammonia in water often brings off a great quantity of air, and relieves the animal. Any of these internal remedies may be made use of when the disease has recently taken place, and is not in a violent degree; but when otherwise, the introduction of an instrument is proper, and is now very generally resorted to. The one principally in use is a species of probang, invented by Dr. Munroe, of Edinburgh. Another, consisting of a cane of six feet in length, and of considerable diameter, having a bulbous knob of wood, has been invented by Eager, which is a more simple machine, but hardly so efficacious. It is probable that, in cases of emergency, even the larger end of a common cart-whip, dexterously used, might answer the end. But by far the best instrument for relieving hoven cattle, as well as for clystering them, is Read's enema apparatus, which is alike applicable to horses, cattle, and dogs. It consists of a syringe, to which tubes of different kinds are applied, according to the purpose and the kind of animal to be operated upon. There is a long flexible tube for giving an enema to horses and cattle, and a smaller one for dogs. To relieve hoven bullocks effectually, it is necessary not only to free the stomach from an accumulation of gas, but from the fermenting pultaceous mixture which generates it: for this purpose a tube is applied to the extremity of the syringe, and then passed into the animal's stomach through the mouth, and being put in action, the offending matter is discharged by a side opening. When the same operation is performed on sheep, a smaller tube is made use of. The characteristic excellency of Read's instrument is, that there is no limit to the quantity of fluid that may be injected or extracted. The same syringe is used for extracting poison from the stomach of man, for smoking insects, extinguishing fires, and syringing fruit trees. The introduction of any of these instruments may be effected by the help of an assistant, who should hold the horn of the animal by one hand, and the dividing cartilage of the nose with the other; while the operator himself, taking the tongue in his left hand, employs his right in skilfully and carefully introducing the instrument; the assistant bringing the head and neck into such an attitude as to make the passage nearly straight, which will greatly facilitate the operation. But when no instruments can be procured, or as cases may occur when, indeed, it is not advisable to try them, as when the disease has existed a considerable time, or the animal has become outrageous, or the stomach so much distended with air that there is danger of immediate suffocation or bursting, in these instances the puncture of the maw must be instantly performed, which is called *paunching*. This may be done with the greatest ease, midway between the ilium or haunch-bone and the last rib of the left side, to which the paunch is cline: a sharp penknife is frequently used; and persons in veterinary practice should always keep a long trocar, which will be found much the more efficacious, and by far the most safe, as it permits the air escaping certainly and quickly, at the same time that it prevents its entrance into the cavity of the abdomen, which would occasion an equal distension. As soon as the air is perfectly evacuated, and the paunch resumes its office, the trocar may be removed; and in whatever way it is done, the wound should be carefully closed with sticking-plaster or other adhesive matter. It is necessary to observe, that this operation is so safe, that whenever a medical assistant cannot be obtained, no person should hesitate a moment about doing it himself. After relief has been afforded by means of either the probang or the paunching, a stimulant drink may be very properly given: half a pint of common gin, or one ounce of spirit of hartshorn in a pint of ale, or two ounces of spirit of turpentine in ale, may any of them be used as an assistant stimulus. When, also, the cud is again chewed, still some relaxation of the digestive organs may remain; at first, therefore, feed sparingly, and give, for a few mornings, a tonic."

The apparatus mentioned above, with directions for use, may now be had from the principal makers of or dealers in agricultural implements. The cane tube, to employ in emergencies, no cow keeper should be without.

Epidemic Murrain.

The malignant epidemic, generally called murrain, is a species of catarrh, affecting the respiratory organs, and is most frequent in damp climates or ill-drained parts of the country. The writer of the work on cattle, already quoted from (Lib. Use. Know.), thus speaks of its nature and remedies:—"There are few diseases that assume, in its earlier or later stages, a greater variety of form; but, disarmed somewhat of its virulence in modern times, or at least not having appeared in all its terrors for some years past, it will generally be distinguished by some or the greater part of the following symptoms:—

"There will be cough, frequent and painful, and in many cases for a week or more before there is any other marked symptom. The farmer may not always be aware of this, but he will find it out if he inquires about it; and he will be fully aware of the importance of the fact before we have done with this division of our subject.

"After a few days, some heaving of the flanks will be added to the cough; the pulse will be small, hard, frequent, and sometimes irregular; the mouth hot; the root of the horn cold; the fæces sometimes hard and black, at others liquid and black, and then very fœtid. Presently afterwards, that of which we have to speak again and again, is observed—extreme tenderness along the spine, and particularly over the loins.

"The cough becomes more frequent and convulsive, and a brown or bloody matter runs from the nostrils and mouth; the eyes are swelled and weeping; the patient grinds his teeth; there is frequent spasmodic contraction about the nostrils; and the animal rarely lies down, or, if he does, rises again immediately.

The eyes soon afterwards become unusually dull; the pulse remains small, but it has become feeble; the respiration is quicker; the flanks are tucked up; the tenderness on the loins is removed; insensibility is stealing over the frame; and the fæces are more loaded with mucus, and more fœtid. The patient moans and lows, and grinds his teeth almost incessantly; the head is agitated by a convulsive motion; blood begins to mingle with the fæces; the breath, and even the perspiration becomes offensive; and the beast staggers as he walks.

"Tumours and boils now, or often earlier, appear on various parts. If they are to come forward, the sooner they rise the better, for much depends on what becomes of them. If the animal has sufficient strength for them to go through the usual process of suppuration, although the sloughing and the stench may be greater than could be thought possible, the beast will have a chance to recover; but if there is not energy to bring them forward —if they become stationary—and, most assuredly, if they recede and disappear, the patient will die.

"The treatment of this disease is most unsatisfactory. If the farmer could be brought to attend more to this cough in cattle, if, here, he had recognised the violent and increasing cough and, although he had not dreamed of murrain, had bled and physicked the beast on account of the cough, the disease would probably have been arrested, or at least its virulence would have abated.

"The early stage even of murrain is one of fever, and the treatment should correspond with this—bleeding. Physic should be cautiously yet not timorously resorted to. For sedative medicines there will rarely be room, except the cough should continue. Small doses of purgative medicine, with more of the aromatic than we generally add, will be serviceable, effecting the present purpose, and not hastening or increasing the debility which generally is at hand; but if the bowels are sufficiently open, or diarrhœa should threaten, and yet symptoms of fever should be apparent, no purgatives must be given, but the sedatives should be mingled with some vegetable tonic. The peculiar fœtid diarrhœa must be met with astringents, mingled also with vegetable tonics. In combating the pustular and sloughing gangrenous stage, the chloride of lime will be the best external application; while a little of it administered with the other medicines inwardly, may possibly lessen the tendency to general decomposition. The external application of it should not be confined to the ulcerated parts alone, but it should be plentifully sprinkled over and about the beast; and the infected animal should be immediately removed from the sound ones."

Red-Water.

This disease, indicated at first by the redness of the urine, is properly inflammation of the kidneys, and arises from an undue determination of blood to these parts of the animal. The cause of this local inflammation is generally connected with the nature of the food. In many instances, it is found to have arisen from the cattle eating plants of a noxious quality, and which, as it appears, are not confined to any particular species of soil. When in its aggravated form, the disease becomes what is called *black-Water*. On the slightest indication of the early stages of the distemper, the cattle ought to be immediately shifted to different pastures, or housed and stall-fed for a short period; and if this simple precaution prove unavailing in restoring health, each animal affected should be copiously, and if necessary frequently, bled; and let that active treatment be followed up by purgatives, so as to clear out and restore a proper tone to the bowels. Should these means fail, let a skilled practitioner be consulted. On no account listen to the absurd advices of superstitious and ignorant people either on this or any other disease of cow or bullock. In every quarter of the country, there are persons who, from total ignorance of the physiology of cattle, and the natural causes and action of disease, ascribe calamities of this kind to witchcraft or other supernatural influences. Let all such quacks, and their irrational salvos, be carefully shunned.

Fattening Cattle for Market.

The stall-feeding or soiling of cattle is considered to possess several advantages over feeding in the fields. In field-feeding the animals waste a certain quantity of pasture by treading and lying upon it, and by dropping their dung, the grass which grows on the dung spots being ever after rejected; the animals also spend time in seeking for the herbage which suits their fancy, and much is allowed to go to seed untouched. In stall-feeding, the whole time is devoted to eating and ruminating, while no food is lost, and the animals are brought to a higher condition. Another important advantage of soiling is, that it uses up the waste straw of a farm as litter, and thus furnishes a plentiful supply of that indispensable article, manure, for the fields. Some feeders tie up their cattle to the stall while preparing for market; but others permit them to roam about on a thick bed of straw in an enclosure in the farm yard, with a shed to retire to for shelter, the feeding in this case being from racks. Unless for a period during the final process of fattening, the straw-yard method is reckoned the best for keeping the cattle in a healthy state, and consequently for producing beef of the finest kind. The practice of feeding cattle for a considerable length of time, in darkened stalls, on oil-cake, carrots, mangel wurzel, &c., produces, as is well known, a great deposition of fat, and swells the animals to a monstrous size. The beef, however, of such overfed cattle is never fine. The fat with which it is loaded easily escapes in cooking, and leaves lean of an inferior quality. The best sign of good meat is its being *marbled*, or the fat and lean well mixed, when brought to the table, and this is not to be expected from beef fed in an unnatural condition.

Speaking on this subject, the writer of the article Agriculture, in the "Encyclopædia Britannica," observes —"The age at which cattle are fattened depends upon the manner in which they have been reared, upon the properties of the breed in regard to a propensity to fatten earlier or later in life, and on the circumstances of their being employed in breeding, in labour, for the dairy, or reared solely for the butcher. In the latter case, the most improved breeds are fit for the shambles when about three years old, and very few of any large breed are kept more than a year longer. As to cows and working oxen, the age of fattening must necessarily be more indefinite; in most instances, the latter are put up to feed after working three years, or in the seventh or eighth year of their age."

Many of the cattle fed for the metropolitan markets, as formerly mentioned, have originally been brought from the Highlands and isles of Scotland, also from Wales and Ireland. "The Highland cattle often pass through three different hands or more before they come to the butcher. They are improved at every stage by a greater quantity and better quality of food, instead of being suddenly transported from poor to rich feeding; and while each successive owner applies his produce to the best advantage, and receives a suitable return according to its value, from the advance of price, the consumer at least purchases his beef cheaper, and of a much superior quality, than if the cattle had been sent to the shambles from any of the intermediate stages.

"The West Highland cattle make this progress oftener than the larger cattle of the north-eastern counties. Many of them are brought to Dumbartonshire and other places at the age of two years and two years and a half, wintered on coarse pastures, with a small allowance of bog-hay or straw, and moved to lower grounds next summer. They are then driven farther south, where they get turnips in straw-yards through the following winter, and in April are in high condition for early grass, upon which they make themselves fat in the month of June.

"The larger varieties of the north-eastern counties do not leave the breeder at so early an age. They are seldom brought to market till they are three or three years and a half old, and then frequently in good condition for being fattened either on grass or turnips. A great many of the Aberdeenshire cattle are bought for the straw-yards of the southern counties, get a few turnips through winter and spring, and are either driven to England in April, or fattened at home in the course of the ensuing summer. The Fife cattle, like the other breeds of the Lowlands, are generally sold to the graziers at three years old, having got a liberal allowance of turnips during the preceding winter."*

Rules for Selecting Cattle

In selecting cattle for feeding, their qualities may be in some measure known by examining the hide, horns, &c. "It is well known that the grazier and the butcher judge of the aptitude that any animal has to fatten from the touch of the skin. When the hide feels soft and silky it strongly indicates a tendency in the animal to take on meat; and it is evident that a fine and soft skin must be more pliable, and more easily stretched out to receive any extraordinary quantity of flesh, than a thick or tough one. At the same time, thick hides are of great importance in various manufactures. Indeed, they are necessary in cold countries, where cattle are much exposed to the inclemency of the seasons; and, in the best breeds of Highland cattle, the skin is thick in proportion to their size, without being so tough as to be prejudicial to their capacity of fattening. It appears, from Columella's description of the best kind of ox, that the advantage of a soft skin is not a new discovery, but was perfectly well known to the husbandmen of ancient Italy." These are the observations of Sir John Sinclair,† who adds the following as a summary of good points to be attended to in choosing cattle. They should be—1. Of a moderate size, unless where the food is of a nature peculiarly forcing; 2. Of a shape the most likely to yield profit to the farmer; 3. Of a docile disposition, without being deficient in spirit; 4. Hardy, and not liable to disease; 5. Easily maintained, and on food not of a costly nature; 6. Arriving soon at maturity; 7. Producing considerable quantities of milk; 8. Having flesh of an excellent quality; 9. Having a tendency to take on fat; 10. Having a valuable hide; and, lastly, Calculated (should it be judged necessary) for working." It is thought best to begin to break-in oxen at three years old, and to give them full work at four.

With respect to judging of cattle by their horns and teeth, we offer the following observations from the "Cyclopædia of Practical Husbandry, by Martin Doyle" (Rev. Mr. Hickey).

"The ordinary guide for ascertaining the precise age of cattle is the horn, which is also indicative of the breed; at three years old (this is laid down as a rule) the horns are perfectly smooth, after this a ring appears near the root, and annually afterwards a new circle, so that, by adding two years to the first ring, the age is calculated; but the contributors to the volume so frequently quoted, have clearly shown that this is a very uncertain mode of judging; 'that the rings are only distinct in the cow;' and that 'if a heifer goes to the bull when she is two years old, or a little before or after that time, there is an immediate change in the horn, and the first ring appears; so that a real three-year old would carry the mark of a four-year old.' 'In the bull they are either not seen until five, or they cannot be traced at all;' nor in the ox do they 'appear until he is five years old, and they are often confused;' besides, there is also an instrument called a rasp, which has been said to make many an arm ache a little before a large fair.' Without any delusive intentions, however, an ugly set in the horns of young cattle is often remedied by filing a little off the sides of the tips opposite to the direction which it is desired that the horns should take.

"Some men have an antipathy to horns altogether, and would even carry their dislike so far as to extirpate them from the brows of all their cattle; they can indulge their taste by paring off the tops of the horns when they first break through the skin. Perhaps it is not generally known, that the larger the horn the thinner the skull.

* General Report of Scotland, vol. viii, p. 64.
† Farmer's Magazine, vol. viii.

"The age is indicated with unerring certainty by the teeth, to those who have judgment and experience, until the animal reaches the age of six or seven; until two years old, no teeth are cast, at that age two new teeth are cut; at three, two more are cut; and in the two succeeding years, two in each year; at five the mouth is said to be full, though not completely so until six, because until that period the two corner teeth (the last in renewal) are not perfectly up. The front or *incisor* teeth are those considered, for a full grown beast has altogether thirty-two teeth."

Method of ascertaining the Weight of Cattle while Living.

"This is of the utmost utility for all those who are not experienced judges by the eye, and by the following directions, the weight can be ascertained within a mere trifle:—Take a string, put it round the beast, standing square, just behind the shoulder-blade; measure on a foot-rule the feet and inches the animal is in circumference; this is called the girth; then, with the string, measure from the bone of the tail which plumbs the line with the hinder part of the buttock; direct the line along the back to the fore part of the shoulder-blade; take the dimensions of the foot-rule as before, which is the length, and work the figures in the following manner:—Girth of the bullock, 6 feet four inches; length, 5 feet 3 inches; which, multiplied together, make 31 square superficial feet; that again multiplied by 23 (the number of pounds allowed to each superficial foot of cattle measuring less than 7 and more than 5 in girth), makes 713 pounds and, allowing 14 pounds to the stone, is 50 stone 13 pounds. Where the animal measures less than 9 and more than 7 feet in girth, 31 is the number of pounds to each superficial foot. Again, suppose a pig or any small beast should measure 2 feet in girth, and two feet along the back, which, multiplied together, make 4 square feet; that multiplied by 11, the number of pounds allowed for each square foot of cattle measuring less than 3 feet in girth, makes 44 pounds; which, divided by 14, to bring it to stones, is 3 stone 2 pounds. Again, suppose a calf, a sheep, &c., should measure 4 feet 6 inches in girth, and 3 feet 9 inches in length, which, multiplied together, make 16¼ square feet; that multiplied by 16, the number of pounds allowed to all cattle measuring less than 5 feet, and more than 3 in girth, makes 264 pounds; which, divided by 14, to bring it into stones, is 18 stones 12 pounds. The dimensions of the girth and length of black cattle, sheep, calves, or hogs, may be as exactly taken this way as is at all necessary for any computation or valuation of stock, and will answer exactly to the four quarters, sinking the offal, and which every man, who can get even a bit of chalk, can easily perform. A deduction must be made for a half-fatted beast of 1 stone in 20, from that of a fat one; and for a cow that has had calves, 1 stone must be allowed, and another for not being properly fat."*

* Cattle Keeper's Guide.

SHEEP.

In the *Ruminant* order of the Mammalia, a distinguished place is given to the sheep, the flesh and wool of which have been recognised as alike of the greatest use to man from the earliest ages. In our own country, within the last half century, the different breeds of sheep have been improved by the growing intelligence, skill, and industry, of the farmers: and their management has, under high patronage, been brought to a degree of perfection perhaps nowhere else attained. It may be added that, as the sciences of anatomy, physiology, botany, and chemistry, are every year throwing new light on those laws of nature, which regulate the structure, health, nutrition, and reproduction of the animal kingdom, we may entertain the hope of still further improvement in this department of rural economy.

DIFFERENT BREEDS OF SHEEP.

The varieties of sheep that now exist in different parts of the globe, have all been reduced by Cuvier into four distinct species.

1. (*Ovis Ammon*)—the Argali; this species is remarkable for its soft reddish hair, a short tail, and a mane under its neck. It inhabits the rocky districts of Barbary and the more elevated parts of Egypt. 2. (*Ovis Tragelaphus*)—the bearded sheep of Africa. 3. (*Ovis Mismon.*) 4. (*Ovis Montana*)—the Mouflin of America; but this species, which inhabits the rocky mountains of North America, is now believed to be identical with the Argali, which inhabits the mountains of Central Asia, and the higher plains of Siberia northwards to Kamschatka. This leaves only three distinct species of wild sheep as yet discovered.

It is still a point in dispute from which of these races our domestic sheep have been derived; nor is the question, in our circumstances, of great practical importance, though its solution is very desirable in a physiological point of view. Whether the wild races may be regarded as of one species, as some naturalists contend, or of different species, according to others, the best judges are next to unanimous that the domestic races of this country are of one species; and what are called different breeds are nothing more than varieties, the result of different culture, food, and climate. The influence of these conditions, in diversifying the character and condition of sheep, will be adverted to under their proper heads.

The following may be regarded as the principal breeds of this country:—1. The Zetland sheep; 2. The Dun-wooled sheep; 3. The Black-faced heath sheep; 4. The Moorland sheep; 5. The Cheviot sheep; 6. The horned varieties of fine-wooled sheep of Norfolk, Wiltshire, and Dorset; 7. The Ryeland sheep; 8. The South down sheep; 9. The Merino sheep; 10. The Devonshire Notts, Romney Marsh, old Lincolnshire, Teeswater, and Old Leicester sheep; 11. The New Leicester and Improved Teeswater sheep.

1. The *Zetland sheep* inhabits those islands from which they derive their name, and extend to the Faroe Islands and the Hebrides. In general, they have no horns. The finest fabrics are made of their wool, which forms a fine fur. This wool is mixed with a species of coarse hair, which forms a covering for the animal when the wool falls off. A similar species are known to inhabit the most northerly parts of Europe, from which it is supposed the fine-wooled sheep of our northern islands and Highlands have been derived. They are hardy in constitution, and well adapted to the soil and pastures on which they are reared, but would ill repay their cultivation in Lowland districts.

2. The *Dun-wooled breed*.—The dun colour of this species is not confined to the wool, but extends to the face and legs. They seem at one time to have been cultivated very extensively, and remnants of them still exist in Scotland, Wales, and the Isle of Man.

3. *The Black-faced heath breed*, being the most hardy and active of all our sheep, are the proper inhabitants of every country abounding in elevated heathy mountains. They have spiral horns, their legs and faces are black, with a short, firm, and compact body; their wool is coarse, weighing from 3 to 4 lbs. per fleece; they fatten readily on good pastures, and yield the most delicious mutton, weighing from 10 to 16 lbs. per quarter. They still exist in considerable numbers in the more elevated mountains of Yorkshire, Cumberland, Westmoreland, Argyleshire, and the central Highlands of Scotland.

4. *The Moorland sheep of Devonshire* are sometimes termed the Exmoor and Dartmoor, from the different districts of Devonshire in which they are reared. They have horns, with legs and faces white, wool long, with a hardy constitution, and are said to be well adapted to the wet lands which they occupy. Their wool weighs 4 lbs. the fleece; but they are rather small, and in some respects ill formed.

5. *The Cheviot breed* derive their name from the Cheviot mountains, in which they are indigenous. They are longer and heavier than the black-faced. Their wool is fine; a medium fleece weighs about 3 lbs.; a carcass, when fat, weighs from 12 to 18 lbs. per quarter. Their faces are white; their legs are long, clean, and small boned, and clad with wool to the hough. Their only defect of form is a want of depth in the chest; yet, with this exception, their size, general form, hardy constitution, and fine wool, are a combination of qualities in which, as a breed for mountain pasturage, they are yet unrivalled in this country.

6. *The Horned varieties of fine wooled sheep of Norfolk, Wiltshire, and Dorset*.—This breed of sheep have short wool, in which they differ from the black-faced sheep, and moorland sheep of Devonshire, and from the Cheviot, in having large spiral horns. They are not much lighter than the Cheviots, but they are ill formed, and thin, flat in the ribs, and slow feeders; a medium fleece weighs about 2 lbs. It is believed that the South-down will eventually displace them. The Wiltshire sheep are still heavier than those of Norfolk, being the largest of our fine wooled sheep; they are said to thrive well in the downs of Wiltshire, but they are also giving ground to the South-downs. The Dorset sheep have horns, white faces and legs; their three-year-old wethers weigh from 16 to 20 lbs. per quarter; their wool is less fine, but heavier than that of Wiltshire, weighing from 3 to 4 lbs. the fleece. The peculiar advantage of this breed is, that the ewes admit the ram at so early a period that they generally have lambs in the months of September and October, which find a ready market in large towns for winter consumption.

7. *The Ryeland breed* derive their name from a southern district in Herefordshire, which at one time was regarded as incapable of growing any thing but rye. This species are white-faced, and without horns; their general form is tolerable; they fall short of the improved breeds in being more flat in the ribs, and less level in the back; their wool is fine, weighing from 1½ to 2 lbs.; their mutton is delicate; they arrive soon at maturity, and fatten easily, and weigh from 12 to 16 lbs. per quarter: this breed has been crossed by the Spanish Merino. The produce of this cross were at one time in high fame in England, under the name of the Anglo-Merino; and though their wool is said to have been of a fine quality, the breed has for long declined in popular favour.

8. *The South-down breed*.—This species have no horns; their legs and faces gray. They have fine wool, which is from two to three inches in length, and weighs from 2½ to 3 lbs. per fleece; they are slightly deficient in depth and breadth of chest, but their mutton is excellent, and highly flavoured; they are kindly feeders, and when fat, their average weight may be stated at from 15 to 18 lbs. per quarter. This species of sheep have, from time immemorial, been reared upon the chalky soils of Sussex, but are now widely extended, and thrive excellently not only on the chalk downs and light soils of England, but on the sheltered lawns of Scotland. In a note to the author from Lord Pitmilly, near St. Andrews, are the following facts:—"I generally keep about a score of South-down ewes for early lambs; they pasture in the lawn with the black-faced wethers kept for family use. The lambs dropped early in winter 1839–40, not being wanted, were sent to Edinburgh; ten of the ewes lambed again in September, 1840, and again in March, 1841. Some of them had twin lambs; all did well. The September lambs I sold in August, 1841, when eleven months old, at 30s. a piece. I ascribe the fact of the ewes thriving so well to the dry ground, and to their being put every night, summer and winter, into a shed, and well bedded; they have no extra food, except at lambing time, when they get a little oil-cake or sliced turnip." The above note is highly deserving the attention of breeders of this species of sheep, it testifying to the greatest degree of fecundity of which I have yet heard.

9. *The Merino breed*.—This species of sheep is supposed to have been originally from Africa. Marcus Columella saw a variety from that country at some of the games exhibited at Rome. He procured some of them for his own farm, crossed them with the breeds of Tarentum, and sent the offspring of this cross to Spain. In Spain they soon rose to such perfection and celebrity, that they attracted the attention of breeders of stock in other nations, and this breed may now be found in every part of the globe. They were imported into England for the first time in 1769. The Ryeland and other fine-wooled breeds of England were crossed by Merino rams in 1792. The Merino breed of rams were cultivated with great care by his late majesty, King George III. The sales of his majesty's stock which commenced in the year 1804, attracted such general attention in England that a society was formed for promoting the breed in 1811; but the high expectations which were formed of the result of this cross with native sheep were far from being realized. The quality of the wool of the native sheep was improved, but the increased value of the fleece was an inadequate compensation for defects in the character of the animals themselves, which proved less hardy than the parent stock, were slow feeders, and very defective in form.

The Merinos that have been naturalized in this country retain their natural characters, except that they become larger in the carcass, and the wool longer and heavier, than in Spain; but the Merino, as a feeding animal, is too small and ill-formed, and the mutton deficient both in quantity and quality. These points have given rise to some controversy; but in the forcible language of Professor Low—"It is vain that some breeders still contend for the superiority of the pure Merino; the general judgment of farmers is against them, and with perfect reason."*

The Merino sheep are cultivated in Spain and Germany with a greater regard to the wool than to the weight and value of the animal; but the farmers in England think it more profitable to raise the weight and value of the mutton, and it is believed, by those well qualified to judge, that the best of the Merino sheep, under the more rigorous climate of Great Britain, would never yield mutton equal in quality to that of Spain. The wool of this breed is finer than that of any other sheep. In Spain, the fleece of the ram weighs 8 lbs and that of the ewe 5 lbs.; but this wool having such a large quantity of yolk, which absorbs every kind of impurity with which it comes in contact, the wool loses three-fifths of its weight by being properly washed.

10. *The Devonshire Notts, Romney Marsh, Old Lincolnshire, Teeswater, and Old Leicestershire sheep.*—The Devonshire Notts consist of two varieties. The one is called the Dun-faced Notts, from the colour of the face; this is a coarse animal, with flat ribs and crooked back, but it yields a fleece weighing 10 lbs., and when fat, weighs 22 lbs. per quarter when only thirty months old. The second variety is called the Hampton Notts; it resembles the former in many respects, but is easier fed, yields less wool, and has a white face and legs. Both varieties have been crossed by the Leicester, by which both breeds have been much improved.

The Romney Marsh breeds are very large animals, with white faces and legs, and yield a heavy fleece, the quality good of its kind. Their general structure is defective, the chest being narrow and the extremities coarse. The result of their being crossed by the New Leicester is still a point in dispute—one party alleging, that though the quantity of wool has been lessened, and the size of the animal diminished by the cross, yet the tendency to fatten and their general form have been much improved. On the other hand, some well-informed breeders say, that besides the loss of the quantity and quality of the wool, the constitution of the animal is rendered less fitted to the cold and marshy pastures on which it feeds.

The Old Lincolnshire breed are large, coarse, ill-shaped, slow feeders, and yield indifferent mutton, but a fleece of very heavy long wool. The Teeswater breed were originally derived from the former and pastured on the rich lands on the banks of the Tees, from which they derive their name; but Professor Low remarks, that "it is entirely changed by crossing with the Dishly breed, and that the old unimproved race of the Tees is now scarcely to be found." They are very large, and attain a greater weight than almost any other breed, the two-year-old wethers weighing from 25 to 30 lbs., and yielding a long and heavy fleece of wool.

The Old Leicester is a variety of the coarse long-wooled breeds. On rich pastures they feed to a great weight; but being regarded as slow feeders, their general character has either been changed by crossing, or altogether abandoned for more improved breeds.

11. *The New Leicester and Improved Teeswater breeds.*—Mr. Bakewell of Dishly, in the county of Leicester, has the honour of forming this most important breed of sheep. He turned his attention to improving the form of feeding animals about the year 1755. The exact method he followed in forming his breed of sheep is not accurately known, as he is said to have observed a prudent reserve on the subject. But we now know that there is but one way of correcting the defective form of an animal, namely, by breeding for a course of years from animals of the most perfect form, till the defects are removed and the properties sought for obtained.

The great properties of the New Leicester for the farmer, are their early maturity and disposition to fatten, in which they excel all other breeds. They are less in size than several other breeds, and their wool is deemed inferior to the Cheviot; but this breed is now cultivated with great success in almost every part of England.

That class of sheep now known by the name of the Improved Teeswater, is derived from the old breed. Its improvement has been chiefly effected by crossing with the New Leicester. They are not so large as the older race, but are still the largest of our improved breeds; productive in lambs, and yield a good fleece; yet their form renders them less fitted for general cultivation than the New Leicester.

CHOICE OF BREEDS.

If the farmer has rendered himself master of the constitution and character of the different breeds of domestic sheep, already given, and with the general and peculiar character of the climate, soil, and pasturage of the locality on which he is to settle, the selection of the breed that will, upon the whole, yield him the highest profit, will not be a matter of very difficult calculation. But should an error be committed on this head in the first trial, very slight experience would enable a practical farmer to correct it, unless he belong to that class of persons to whom the lessons of history and experience convey neither knowledge nor correction.

The breeds best adapted to the soil and climate of the different districts of Great Britain, are arranged by that distinguished agriculturist, Professor Low, in the following manner:—"The breeds of sheep, then, of this country, may be divided into two classes—the sheep of the mountains, lower moors, and downs, and the sheep of the plains. The sheep of the first class have sometimes horns, and sometimes want them. The finest of them have no horns, namely, the Cheviot and South-down. One of them, the black-faced heath breed, has coarse wool; another of them, the Moorland sheep of Devonshire, has long but not coarse wool; and all the others have short and fine wool.

"Of the moorland and down breeds, as they may be called, the hardiest is the black-faced heath breed, and this property points it out as the most suitable for a high and rugged country, where artificial food cannot be procured. The breed next to this in hardy properties, but surpassing it in the weight of the individuals, is the Cheviot. Where the pasture contains a sufficiency of grasses, this breed deserves the preference over any other known to us for a mountainous country. The next breed deserving of cultivation is the Southdown. This breed is suited to the chalky and sandy downs of the south of England. It is in this respect a very valuable breed, but it is unsuited to the more rough and elevated pastures to which the black-faced and Cheviot are adapted

"The moorland and down breeds appear to be the most deserving of cultivation in this country. Of the larger breeds of the plains, the New Leicester is the best adapted to general cultivation, and wherever an improved system of tillage is established, this admirable breed may be introduced. The Leicester, the Cheviot, and the black-faced, have for long been regarded as the breeds best adapted for the different districts of Scotland. That those three breeds have nearly stood in the same numerical ratio to one another for some years, is a good proof that each has been placed in that locality best fitted by nature for promoting its health and productiveness. The Leicester is admirably adapted to the rich and alluvial soils of our cultivated plains; the Cheviot breed is peculiarly adapted to the grassy mountains chiefly formed of the transition series of rocks; then, our most elevated mountain ranges, formed chiefly of primitive rocks, and

* Low's Elements of Agriculture, p. 542.

covered with heath, on which none but the black-faced, the most active and hardy of our breeds, could survive."*

The above arrangements have generally been acquiesced in as the best possible by the farmers of Scotland. But the claims of South-downs for the middle range of the Highland pastures in Scotland have been urged lately by a gentleman neither destitute of talent for observation, and aided by twenty years' practical experience. This gentleman, Mr. H. Watson, Keillor Farm, shall be allowed to plead the claims of the South-downs in his own words:—"Having, during the last twenty-five years, been in the management or possession of a considerable breeding flock of South-down ewes, varying at different times from 500 to 1000 in number, and during that period having had good opportunities of drawing close comparisons between that and the other breeds of mountain sheep, namely, the Cheviot and black-faced, I have come to the conclusion (and am acting upon it in my own practice), that from a pasture ranging from 500 to 1200 feet above the level of the sea, having a moderate portion of green sward, the rest whin and heather, there can be no more profitable stock of sheep kept than a flock of South-downs of the best sort. My chief reasons for having preferred this breed are, that the South-down sheep, although naturally spirited and active, are easily controlled by a good shepherd; can go over more ground for their food than any other kind of sheep, without stopping their growth; and when tried by severe storms in winter, will brave it better than even the black-faced Highland sheep; and although reduced very low in spring, sooner pick up condition than the other short-wooled sheep. As a proof of the South-downs' inclination to fatten, when put to good keep, I may mention a fact, that while I have seldom been able to produce a fat Cheviot ewe the same season that she has reared a lamb, I never fail to make good fat of the cast South-downs off grass. Their wool is so closely matted on their backs, and about the head and neck, as to be almost impervious to rain or snow; hence, so soon as the storm ceases, they appear dry and comfortable, their coat not the least disordered, and altogether free from that *drouked* (Anglice, drenched) appearance which longer-wooled sheep exhibit even for days after a winter storm. In all my experience, the South-down sheep have kept remarkably healthy. I have never seen an instance of rot in my flock; while, during the last twenty years, I have been forced to clear off a lot of Cheviot and also of black-faced ewes, from that incurable disease. This, however, may have been owing more to the unsoundness of the pasture from which I got them than from any peculiarity of the animals themselves. My average loss in the South-down lot has invariably been much under that of any other sheep I have bred. They are hardy, and easily managed at lambing-time; affectionate mothers, and, on moderate keep, give a great quantity of milk; and if there is any inducement for early lambs, they will go with the ram almost as soon as the lamb is weaned. When crossed with a well-bred Leicester ram, and brought into good keep, they produce perhaps the most profitable lamb that is bred, taking wool and carcass into account. I have for the last ten years put all the ewes I could spare from pure breeding to this sort of crossing, lambing the ewes on turnips in spring, then turning them, as soon as the season would permit, to the hill pasture (the Sidlaws) till weaning-time, when the lambs are brought to the in-field pastures, and put to turnips for the winter, on which food they are kept for about 2d per week each, and kept on the earliest grass in spring; so that in a month or six weeks after they are clipped, they are fit for the butcher, who values this cross almost as high as the pure bred South-down. The wool is of the finest quality for combing, and fetches the highest price of any British grown wool, generally from 2s. to 2s. 2d. per lb.; and the clip in a good season will average about 6 lbs. At sixteen months old, I have never realized less than 40s. each, wool and mutton. In Smithfield, this cross is much sought after.

"On lands where folding is found necessary, the South-down submits to this treatment better than any other breed of sheep; such, indeed, in all cases where I have put them to the test, is their spirit and hardiness, that nothing short of ill treatment seems to injure them. Combining these facts, I can have no hesitation in recommending a South-down flock of sheep in preference to every other, on such situations as I have described, namely, too high to be occupied during the whole season by a flock of Leicesters, and under that level which the native black-faced sheep only can thrive upon.

"So far as I know, it is not yet sufficiently ascertained by experience how far a cross between the South-down and Leicester may be carried, so as to keep up the activity of the former with the well-known fattening qualities of the latter. Another train of breeding through the black-faced and South-down sheep, whose habits seem so much akin, seems likely to succeed. By this cross, improvement in quality of wool would be gained, while that of the mutton would not be deteriorated."

On the other side, Professor Low remarks:—"The South-down breed is best suited to the chalky and sandy downs of the south of England. It is in this respect a very valuable breed; but it is unsuited to the more rough and elevated pastures to which the black-faced and Cheviot are adapted."*

In Ireland, the breed of sheep has been much improved since the beginning of the present century. About that time, Mr. Culley attended the celebrated fair at Ballinasloe, and thus describes the Irish sheep of that period:—"I am sorry to say I never saw such ugly sheep as I saw there. The worst breeds we have in Great Britain are much superior. One would almost imagine that the sheep breeders in Ireland have taken as much pains to breed awkward sheep as many of the people in England have taken to breed handsome ones. I know nothing to recommend them except their size, which might please some old-fashioned breeders, who can get no kind of stock large enough. But I will endeavour to describe them, and leave my readers to judge for themselves. These sheep are supported by very long thick crooked gray legs, their heads long and ugly, with large flagging ears; gray faces, and eyes sunk; necks long, and set on behind the shoulders; breast narrow and short; hollow both before and behind the shoulders; flat-sided, with high narrow herring backs; hind-quarters drooping, and tail set low. In short, they are almost in every respect contrary to what a well-formed sheep should be."†

But an immense improvement was soon effected by Mr. St. George, and Mr. Astley of Odston, who imported a valuable selection from the flocks of the best breeders of the New Leicesters; and by carefully breeding from these, their sheep soon obtained a degree of perfection little inferior to those of England. They soon began to let their tups at very high prices. They let thirty rams, in 1800, at £1744. One of them was to have been 150 guineas. Mr. Casan, near Tipperary, was the person who had hired this famous animal, and had the misfortune of having him murdered the night after he had arrived at his farm, by some malignant opposer of the new breed.

The Irish sheep, since the introduction of the improved breeds, are now able to compete in the markets with the English breeders. There is no entry in the books of the Custom-House, of sheep exported from Ireland farther back than the year 1797, and in that year there is an entry of 1875. The number had increased in 1811 to

* Low's Elements of Agriculture, p. 545-6.

* Low's Elements of Agriculture.
† Culley on Live Stock, p. 166.

26,029; and the sheep exported from Ireland to Liverpool in 1831 was 134,762; and in 1832 amounted to 44,260; and, in addition to this immense number of sheep, 20,000 lambs, in good market condition, annually cross the Irish channel. And at the Fair of Ballinasloe, the number of sheep exhibited range from 80,000 to nearly 100,000. The most valuable sheep-husbandry in Ireland exists at present in Roscommon, Galway, Clare, Limerick, and Tipperary. But with all this advance, there is much still to be done in the management of sheep in Ireland. The soil and climate are in many places peculiarly adapted for sheep husbandry. And from the progress Ireland has made within the last forty years, there need be no misgivings regarding her future eminence in sheep-husbandry. Could the native talents and energies of Ireland be directed to the cultivation of the soil, arts, and commerce, instead of being perverted and enfeebled by fierce and feverish political agitation, from the genius of her people, the richness of the soil, the mildness of the climate, her geographical position, the number of her ports and harbours, the facilities for inland navigation, she might soon rival in wealth and civilization the most favoured nation of Europe.

The rising importance of Australia, its being a British colony, the progress it has already made in sheep-husbandry, entitle it to some notice in a treatise on sheep-farming. It had no native sheep; and the first importation was of an extremely ugly and ill-shaped race from Bengal. The fine dry and temperate climate, however, soon improved the breed in a most remarkable degree. In the course of two or three years they were changed so much for the better, that the hair disappeared, and in its stead arose a fleece of tolerable fineness. An importation of the Leicester and South-down breeds followed, which at once doubled the value both of the carcass and the fleece, though colonists at that period bred more for the mutton than the fleece. The increase at first was slow; there were only 6124 in the whole settlement in 1800, twelve years after the arrival of the first ship. The Merino were next imported, and the result far exceeded expectation. Three or four crosses with the prevalent stock of the colony, produced a breed of sheep that yielded wool equal in fineness to the pure Merino of Europe.

From this period, the number of free settlers rapidly increased in the colony, and in three years the number of sheep had amounted to 10,157; in 1813, to 55,121; in 1818, to 170,420; and in 1828, to 536,391.* Mr. Macarther, the great improver of the Australian sheep, and who raised the wool to a very superior quality, stated, on his examination on the trial of Colonel Johnson, in 1811—"That, to the best of his knowledge and belief, he had circulated among the settlers £20,000 worth of breeding animals, all raised by himself." And in answer to another question he says—"I have sent an immense quantity to the market to be slaughtered; and I am sure I may fairly estimate that, from my present stock, the colony will be supplied with at least 100,000 lbs. weight annually. It is perhaps proper that I should state to the court, that the stock from which such large supplies have been obtained originally consisted only of about six or seven cows, and about thirty ewes; and that from these I have raised 1000 or 1200 head of horned cattle, and at least 10,000 or 12,000 sheep."† And the increasing quantity and quality of the wool shows the progressive improvement of sheep-husbandry in Australia and Van Diemen's Land. They exported wool in 1832, to the amount of 237,757 lbs., and in 1833, to 3,516,869.‡ And with regard to the quality of the wool, the market price, in March, 1834, for the best Australian wool, was 4s. 6d. per lb., and for the best Saxon, 5s. 6d. per lb., and for the best Spanish Merino, 4s. per lb. These facts, which outweigh all speculation on the subject, prove that sheep, well bred and managed in Australia, yield a return of at least 70 or 80 per cent. per annum. And as sheep-husbandry must, for a long series of years, form the chief branch of rural industry in Australia, it cannot be regarded as unphilosophical to contemplate still higher results when we know that a higher degree of knowledge, energy, and enterprise, will annually be transferred from the mother country to the sheep-husbandry of that interesting colony.

* Wentworth's New South Wales, p. 130.
† Butler on Australia, p. 56.
‡ M'Culloch's Dictionary, article *Wool;* and Widowson's Van Diemen's Land, p. 50.

IMPROVEMENT OF BREEDS OF SHEEP.

The first point of essential importance to be attended to by the sheep-farmer in every part of the globe, is the selection of a breed whose size and constitutional qualities best accord with the climate and the pastures on which they are to feed. An error of any magnitude on this point would be attended with fatal effects on the health and productiveness of the flock, and thus ruin the finances of the farmer.

It is true that sheep can exist in almost every country, and may be said to reach nearly from the equator to the poles. They are found approaching the eternal snows and icy barriers of the arctic regions; they are found at great elevations in the Cordilleres of South America, and in the still more elevated Himalaya Mountains of Asia. Yet though sheep can be reared within an immense range of latitude and temperature, it is equally true that the climate and soil fix the limits within which our domestic breeds can be cultivated with advantage The climate wears down the rocks, and thus forms the soil, and hence the natural pastures of all countries.

The climate, and the condition of existence which it induces, affect, with irresistible force, the structure, health, and reproductiveness of men and animals from the equator to the poles. The laws of nature cannot be transgressed with impunity. But this condition being accurately adjusted, the next objects which the sheep-farmer ought to keep steadily in view, are the quantity and quality of the mutton and the wool. Nature has perhaps forbidden that the same sheep should, in any circumstances, yield the greatest weight of the best mutton, and a fleece of the greatest value. The farmer will be able easily to determine, from the country, climate, and various other considerations, to which of these he should direct his chief attention. In England, for example, the farmer finds it more profitable to promote the weight and quality of the mutton than the wool, while the farmer in Spain and Germany finds it his interest to attend more to the wool than the mutton.

The properties most desirable in the sheep are—1. Size; 2. Form; 3. Early maturity; 4. Constitutional hardiness; 5. Productiveness; 6. Disposition to fatten; 7. Lightness of offal; on each of which points we shall proceed to treat in detail.

1. The *size* of the sheep must be regulated by the climate, the pasture, and the steepness or levelness of the lands on which it is to feed. One rule never to be violated is, that the size of the sheep should bear some reference to the nature of the pasture. And very heavy sheep are unsuited to very elevated and precipitous mountain ranges.

On the subject of size, a practical question of very considerable importance is still undetermined, and that is, what is the ratio of food consumed by a large animal and one of moderate size. The result of an experiment is given by Dr. Parry,* where it is stated, that by breeding small sheep instead of large ones, the numbers were increased from 660 to 890 ewes and lambs, and the profit from £450 to above £724. But this experiment, and

* Communications to the Board of Agriculture, vol. [illegible] p. 150

all others that have been tried, have never contained all the elements necessary to determine the question with any thing like philosophical accuracy.

2. The *form* of the sheep should consist of that happy combination of anatomical structure on which the health and productiveness of the animal depend; and the points of practical men must be tested by this internal anatomical structure. That eminent surgeon, Mr. Cline, in his Communications to the Board of Agriculture, states—"That the lungs of an animal are the first objects to be attended to, for on their size and soundness the health and strength of an animal principally depend: that the external indications of the size of the lungs are the form and size of the chest, and its breadth in particular: that the head should be small, as by this the birth is facilitated, and affords other advantages in feeding, and as it generally indicates that the animal is of a good breed: that the length of the neck should be in proportion to the size of the animal, that it may collect its food with ease; and that the muscles and tendons should be large, by which the animal is enabled to travel with greater facility; and the bones should be small and clean."

We may here add a description of the best proportions of a Cheviot ram, by the late Mr. Culley of Northumberland:—"His head should be fine and small; his nostrils wide and expanded; his eyes prominent, and rather bold and daring; ears thin; his collar full from the breast and shoulders, but tapering gradually all the way to where the neck and head join, which should be very fine and graceful, being perfectly free from any coarse leather hanging down; the shoulders broad and full, which must at the same time join so easy to the collar forward, and chine backward, as to leave not the least hollow in either place; the mutton upon his arm or fore-thigh must come quite to the knee; his legs upright, with a clean fine bone, being equally clear from superfluous skin and coarse hairy wool, from the knee and hough downwards; the breast broad and well forward, which will keep his fore legs at a proper wideness; his girth or chest full and deep, and instead of a hollow behind the shoulders, that part, by some called the fore flank, should be quite full; the back and loins broad, flat, and straight, from which the ribs must rise with a fine circular arch; his belly straight, the quarters long and full, with the mutton quite down to the hough, which should neither stand in nor out; his twist or junction of the inside of the thighs deep, wide, and full, which, with the broad breast, will keep his four legs open and upright; the whole body covered with a thin pelt, and that with fine bright soft wool. The nearer any breed of sheep comes up to the above description, the nearer they approach towards excellence of form; and there is little doubt, but if the same attention and pains were taken to improve any particular breed that has been taken with a certain variety of the Lincolnshire, the same advantages would be obtained."*

3. *Early Maturity* is a property of great importance to the farmer who breeds and feeds all his own sheep for the shambles; they not only make a quicker return for their food, but yield a higher profit to the breeder than slow-feeding animals. This valuable property of early maturity can be induced by breeding, food, and treatment. The New Leicester breed possess this property in a higher degree than any other of our domestic breeds, and they also yield a greater quantity of mutton on the same quantity of food than any other breed.

4. *Constitutional hardiness.*—In a rigorous climate, and in bleak and elevated mountains, in which artificial food cannot be obtained, this quality is indispensable. But a farmer will seldom make a wrong selection in circumstances so obvious.

* See Culley on Live-Stock.

5. *Productiveness.*—This is a property which characterizes some varieties of sheep and other animals; it may be extended by careful selection in breeding, and from food and treatment. Pets have almost invariably twin lambs. The draft ewes from the mountains of Scotland have generally twins when taken to a milder climate, and kept on superior food.

6. *Disposition to Fatten.*—This property is of very great importance to feeders, as his sheep can be made fit for the market both in a shorter period and with a less quantity of food. None of our domestic breeds possess this quality in greater perfection than the New Leicester; this quality also may be ascertained by examining the depth and breadth of the chest, according to Sir John S. Sibright. And the great John Hunter found that easy corpulence was concomitant with small bones; it is also accompanied with a pliable, soft, and mellow skin.

7. *Lightness of offal.*—It is obvious that, to whatever extent the weight of the offal can be diminished, the value of the animal is increased. The perfection of an animal is, when the dead weight of all the eatable parts approaches the nearest to the weight of the animal when alive.

The following statement of the live and dead weight of a Devonshire ox, aged 3 years and 10 months, will explain the manner in which these accounts are drawn up:—

			Stones
Live weight,			114
Offal.	Stones.	lbs	
Tallow,	10	6	
Hide,	6	3	
Head and tongue,	2	9	
Heart, liver, and lungs,	2	7	
Feet,	1	4	
Entrails and blood,	11	13—35	
Carcass, or four quarters,			79—11

Principles of Breeding.—The fundamental and essential principles of improving any of our domestic animals by breeding, consist in a skilful selection of those males and females, the union of whose qualities will remove the defects and induce the properties desired. The sheep-farmer can neither raise nor keep his flock in the highest perfection of which the climate and pasture admit, without a rigid adherence to this primary principle. It was upon this principle that Bakewell formed his celebrated breed of sheep, and it is the only principle upon which any breed can be raised to the highest perfection of which it admits. *Breeding in and in*, as it is called, has given rise to a long controversy, which our increasing knowledge of the physiology of the animal economy, and a wider induction of facts, carefully observed and accurately recorded, will speedily bring to a final close. The facts now collected from a wide surface, and attested by men skilled in the sciences of physiology and anatomy, as well as by practical breeders of live-stock, establish the important fact, that, breeding by too near affinities, the offspring degenerates. It is a law of nature and applies to men and animals, and even plants. The accurate experiments of Mr. Knight establish the fact, that in the vegetable as well as in the animal kingdom, the offspring of male and female plants, when not related, possess always more strength and vigour than those of near affinities. Sir John S. Sibright tried many experiments by breeding in and in with dogs, fowls, and pigeons, and found that the offspring uniformly degenerated.† Sir John Sinclair relates an experiment with pigs, which he carried so far that the females almost ceased to breed; and if they did breed, the offspring was so small and delicate that they died as soon as they were born.‡ To breed, therefore, from the same race, but of different families, is now established as the only system that will secure the highest results in the different breeds.

* Code of Agriculture, p. 92. † Code of Agriculture
‡ See Sir S. Sibright's Essay, p. 13.

Crossing.—This is a means of improving a breed that requires many concurring circumstances to ensure success. The climate and the food must accord with the size and constitution of the animal that is to be produced. To increase the size of a breed of sheep, without augmenting or improving their food, would be a ruinous enterprise, and in the face of all principle. The attempt to increase size by crossing with heavier rams from another country requires also great care that the food and climate be adapted to the condition and character of the expected race; for it is in proportion as size is gained by crossing, that delicacy of constitution and liability to disease are increased. The constitutional qualities of a race of sheep will not accommodate themselves to the soil or climate of a country differing much in pasturage and temperature from that on which it has been long a native, without time, great care, skill, and attention. Were we to cross our mountain Cheviot ewes with Leicester rams, the offspring would labour under two fatal disadvantages—a constitution too delicate for the climate, and a size above the pasture. An attempt was made in Scotland some years ago to raise the quality of the wool of our mountain sheep by crossing them with Cheviot rams, and the result was a complete failure.

The influence of Sex.—It is now generally admitted that the male has a higher influence on the character of the offspring than the female. This law is in beautiful accordance with that beneficent design so visible in the arrangements of nature, as it enables man to bring the domestic animals to their most profitable condition in a far shorter period than if the law had been reversed. There is another fact perfectly established, that the male by one connection has a higher influence on the second generation than its actual father. This shows that no important change in the character of a breed can be effected, unless the crossing is continued until the fourth or fifth generation.

Age of the Parents; its Effects on the Sex of the Offspring.—Some very interesting experiments were begun some years ago, the results of which, so far as they go, tend to establish, as a general law of nature, that the offspring of a young ram and ewe, of from four to five years old, will in general be a feminine, while that of an old ram and young ewe will in general be masculine. Could such a law be practically acted upon, it would be of immense advantage to breeders of stock in every country, but particularly to breeders of stock in such a country as Australia, in which the rapid increase of the number of stock is an object of such paramount importance. There is an able paper on this curious subject in the first number of the "Quarterly Journal of Agriculture," containing the results of the experiments made in France, from which the following facts and views are extracted. In the "Annales d'Agriculture Française," vols. xxxvii. and xxxviii., some very interesting experiments are recorded, which have lately been made in France, on the breeding of live stock. M. Charles Giron de Buzareingues proposed, at a meeting of the Agricultural Society of Severac, on the 3d of July, 1826, to divide a flock of sheep into two equal parts, so that a greater number of males or females, at choice of the proprietor, should be produced from each of them. Two of the members of the society offered their flocks to become subjects of his experiments; and the results have now been communicated, which are in accordance with the author's expectations. The first experiment was conducted in the following manner:—He recommended very young rams to be put to the flock of ewes from which the proprietor wished the greater number of females in their offspring, and also, that during the season when the rams were with the ewes, they should have more abundant pasture than the others; while to the flock from which the proprietor wished to obtain male lambs chiefly, he recommended him to put strong and vigorous rams four or five years old. The following tabular view contains the result of his experiments, which are highly in favour of the views of M Giron:—

Flock for Female Lambs. Age of the Mothers.	Sex of the Lambs. Males.	Fem.	Flock for Male Lambs. Age of the Mothers.	Sex of the Lambs. Males.	Fem.
Two years old,	14	26	Two years old	7	3
Three years,	16	29	Three years,	15	14
Four years,	6	21	Four years,	33	14
Total,	35	76	Total,	55	31
Five years and older,	18	8	Five years and older,	25	24
Total,	53	84	Total,	80	55
N.B.—Three twin births in this flock. Two rams served it, one fifteen months, the other nearly two years old.			N.B.—No twin births in this flock. Two strong rams, one four, the other five years old, served it.		

"The general law, as far as we are able to detect it, seems to be, that when animals are in good condition, plentifully supplied with food, and kept from breeding as fast as they might do, they are most likely to produce females; or, in other words, when a race of animals is in circumstances favourable for its increase, nature produces the greatest number of that sex which, in animals that do not pair, is most efficient for increasing the number of the race. But if they are in a bad climate, or on stinted pasture, or if they have already given birth to a numerous offspring, then nature, setting limits to the increase of the race, produces more males than females. Yet, perhaps, it may be premature to attempt to deduce any law from experiments which have not yet been sufficiently extended. M. Giron is disposed to ascribe much of the effect to the age of the ram, independent of the condition of the ewe."* The author of this treatise has uniformly observed, that in every favourable season, when his stock was in high condition, he had a much larger number of female lambs than of males; and in one of the most favourable seasons that has occurred during his own personal experience, the female lambs exceeded the males to the number of ninety, in a flock of 600 ewes. The ewes had no artificial food at any season of the year; they lived entirely on the natural grasses of our mountain pastures. They got bog and lea hay in snow storms, but nothing else.

GENERAL MANAGEMENT OF SHEEP.

The management of sheep must be varied according to the nature and character of the breed, the soil and climate, character of the pastures, natural or artificial, the position of the farm in reference to markets, and whether all the sheep upon the farm can be prepared for the butcher, or must all be sold lean, as is the case with those farmers whose flocks subsist entirely on the natural grasses of our mountain pastures; and whether early lambs would be profitable or otherwise. These and many other circumstances must regulate the proper time for admitting the rams to the ewes, and hence the lambing season, the proper time for washing, shearing, dipping, smearing, &c. Different names are applied to sheep at different periods of their age. A young sheep remains a *lamb* from birth till the first smearing time. From this till the first clipping it is called a *hog*. From the first to the second clipping it is termed a *gimmer*. It is now

* Quarterly Journal of Agriculture, No. 1.

called a *young ewe*, till it bears its first lamb. When male sheep are cut, they are denominated *wedders;* and, according to their age, are called wedder hogs, &c. At three years old, the wedder is in its prime for mutton.

Lambing.

The period at which sheep begin to breed is in the autumn of the second year after birth, when both rams and ewes are at their maturity. In the British islands, the company of the ram is permitted at the beginning of October. The ewe goes with young about 152 days, or between twenty-one and twenty-two weeks, and consequently the lambing season is at the beginning of March. It is of high importance that sheep, during gestation, should be managed with peculiar gentleness and care, the rash use of the dog being attended with the most pernicious consequences. The ewes should be well but not over-fed, as the ewes being in too high condition greatly increases the risk in lambing. Though parturition, being a natural process, cannot be regarded as a disease, still, in sheep, as well as in many of our domestic animals, it is attended with some risk; and in certain states of the atmosphere, and ewes in too high condition, the loss is often very considerable from inflammation.

"As the period of parturition approaches (observes an intelligent writer in the "Penny Cyclopædia"), the attention of the shepherd should increase. There should be no *dogging* then, but the ewes should be driven to some sheltered enclosure, and there left as much as possible undisturbed. Should abortion take place with regard to any of them, although it does not spread through the flock as in cattle, yet the ewe should be immediately removed to another enclosure, and small doses of Epsom salts with gentian and ginger, administered to her, no great quantity of nutritive food being allowed.

"The ewes should now be moved as near home as convenience will permit, in order that they may be under the immediate observation of the lamber. The operation of *clatting*, or the removal of the hair from under the tail and around the udder, should be effected on every long-wooled ewe, otherwise the lamb may be prevented from sucking by means of the dirt which often accumulates there, and the lamber may not be able at all times to ascertain what ewes have actually lambed. The clatting before the approach of winter is both a useless, cruel, and dangerous operation.

"The period of lambing having actually commenced, the shepherd must be on the alert, yet not unnecessarily worrying or disturbing the ewes. The process of nature should be permitted quietly to take its course, unless the sufferings of the mother are unusually great, or the progress of the labour has been arrested during several hours, or eighteen or twenty hours or more have passed since the labour commenced. His own experience, or the tuition of his elders, will teach him the course which he must pursue.

"If any of the newly-dropped lambs are weak, or scarcely able to stand, he must give them a little of the milk, which at these times he should always carry about him, or he must place them in some sheltered warm place; in the course of a little while, the young one will probably be able to join its dam. The lambing-field often presents at this period a strange spectacle. 'Some of the younger ewes, in the pain and confusion and fright of their first parturition, abandon their lambs. Many of them, when the udder begins to fill, will search out their offspring with unerring precision; others will search in vain for it in every part of the field with incessant and piteous bleating; others, again, will hang over their dead offspring, from which nothing can separate them; while a few, strangely forgetting that they are mothers, will graze unconcernedly with the rest of the flock.'

"The shepherd will often have not a little to do in order to reconcile some of the mothers to their twin offspring. The ewe will occasionally refuse to acknowledge one of the lambs. The shepherd will have to reconcile the little one to its unnatural parent, or to find a better mother for it. If the mothers obstinately refuse to do their duty, they must be folded by themselves until they are better disposed; and, on the other hand, if the little one is weak and perverse, it must be repeatedly forced to swallow a portion of her milk, until it acknowledges the food which nature designed for it."

Male lambs are cut nine or ten days after birth. Weaning or removal from the mother takes place from three to four months after birth, according to circumstances. In weaning, the ewes and lambs must be separated so far that they will not hear the bleatings of each other. The lambs are at first put on the tenderest herbage that can be selected. Some ewes may have so much milk that the udders will swell when deprived of the lambs, and this will require to be attended to by the shepherd at this trying season of his labours.

Food.

The best kind of food for sheep is nutritious grassy pasture, growing on a dry and firm soil. The sheep is most assiduous in picking up food, and will range over a great space in quest of the herbage which it is fond of. In the Highlands of Scotland, and in Australia, where the herbage is scanty, the sheep farm requires to be very large—twelve miles in length and breadth is no unusual size of a Highland sheep-farm. In countries liable to be covered with snow in winter, grass, hay, or some other vegetable material, must be preserved for the subsistence of the flocks when their ordinary walks are under a snowy mantle. Natural meadow hay and turnips are used in Scotland for winter keep, when ordinary resources fail; and the employment of these, in the case of heavy drifts, sometimes saves large numbers of sheep. If the flock can be conveniently driven to a cleared hay field, such is done in preference to carrying food to the animals: there should be one field for the rams and another for the lambs, or for sheep in a weakly condition. A general rule for sheep intended for the butcher is, that they should never be allowed to turn lean, but be kept in a constant state of improvement; and that kind of food should be selected that will bring the animals to the highest profit in the shortest time and at the least expense. In well-managed store-farms, sheep are now allowed many kinds of food little thought of in former times, and are, besides, provided with troughs of pure water, and a trough of salt, that they may lick when their taste leads them to that indulgence. In all artificial feeding, the food should be free of dirt or any insect spawn.

Heedless farmers are sometimes apt to purchase and keep more sheep than they can conveniently feed on their grounds, which causes a serious evil. To overstock a farm, where artificial food cannot be obtained, is one of the most fatal errors a farmer can commit. It does not only diminish the quantity, but also fouls and deteriorates the quality of the food. A farm may be overstocked for a few years, but death will by and by not only lessen the numbers, but diminish to a great extent the health and productiveness of those that survive. Avarice and ignorance have tempted not a few farmers to carry on this unequal struggle against the laws of nature and humanity for years, but it has always ended, as it ever must, either in the farmer's ruin, or reformation of his plan.

Herding.

The tendency which most sheep have to ramble, renders it necessary for them to be attended by a shepherd and his dog. The duties of a shepherd are very irksome, and require to be performed by a man of firm resolution, good temper, and discretion. To keep the flock within hounds may be troublesome, but much may be done in the way of preventive; and at all events, the sheep must not be harassed and chased as if they were so many wild beasts. Being naturally of a timid and gentle nature, the sheep ought to be treated with a degree of gentleness, and taught rather to look up to their shepherd as a friendly protector than a tyrant. Lazy shepherds, who do not exercise a judicious foresight in keeping the flock to its ground, try to remedy the evil by hounding the dog after the stragglers, besides giving no small toil to their own limbs in running. We are desirous to lay it down as a rule, well known to all good shepherds, that there should be *only a rare and cautious use of the dog.* Much also depends on the dog being of the proper breed, and well trained to his duty. A good dog gives little tongue; he is seldom heard to bark: his great knack consists in getting speedily and quietly round the further extremity of the flock, and then driving them slowly before him in the direction which his master has pointed out. A wave of the hand in a certain direction, and the word, *There*, are usually enough as a sign. Under-bred dogs bark at and fly upon the poor animals, chasing them hither and thither, without any rational purpose. All such dogs should be destroyed as unfit for the important duties which they are intended to perform. A first-rate shepherd's dog is invaluable to the store farmer, and he should grudge no reasonable price to get him.

Shelter—Sheepfolds.

In those districts which are exposed to storms, it is important to afford shelter to the flocks. Where there are jutting or overhanging rocks or bushes, the sheep will crowd under their lee, and so far protect themselves from harm; but where the country is bare, it will be necessary to erect artificial walls or enclosures of turf and stone, to which they can be led in cases of emergency. On the exposed hill-sides of Scotland, it is usual to build circular folds, locally termed *stells*, of sufficient size for a *cut*, or parcel of sheep. The stell is a rude enclosure, formed of a stone and turf wall about four feet in height, and is placed on a piece of ground known to be seldom drifted. Besides these, there should be on every sheep-farm ample and conveniently situated folds for the various sortings of sheep, such as for weaning lambs, shearing, and drafting or drawing out any animals required. These folds are ordinarily constructed of flakes or movable palings.

Shearing—Wool.

The winter coat of the sheep begins to be ragged in spring or early in summer, while the lambs are in course of being suckled; and towards June, the wool is seen to be falling off in lumps, or caught in every bramble. To save the wool in time, and relieve the animal, it is the practice to sheer them about the middle of June, when the lambs have been weaned, and the weather is genial. In any case, however, it should not be done till the new wool is observed to be pushing off the old. Previous to sheering, all the sheep should be collected and washed in a running brook or pool, to rid the fleece of impurities. Some shepherds employ a little soap in this operation. On being washed, the animals should be put into a clean field or fold to dry. Fine weather should be selected for washing. The shearing is performed a day or two after, by means of large sheers made for the purpose. In shearing, care should be taken not to break or tumble the wool, but to take off the fleece neatly, and without injuring the skin of the animal.

Australian Wool Management.—Mr. Walter Buchanan has written directions to the wool-growers of Australia respecting the management of wool, from which we make the following extract:—"It is of great importance that the fleece should be well washed, that the wool may be brought to market with as bright a colour as possible. Every convenience, and a very plentiful supply of pure water, should therefore be provided; a running stream being most desirable. The preferable mode of washing is that which is performed before shearing, according to the German manner. Some growers have tried the plan of washing after the fleeces have been shorn and sorted, and, as is supposed, to have used tepid water, following the French and Spanish method; but this has not been approved of by the buyers generally, and particularly by those who buy for combing purposes.

"The breaking of the fleece and washing after shearing, give the wool more the appearance of Spanish than of German wool, and it is consequently reduced to a lower standard of comparison. It is well known that the sheep of those German flocks that are best washed, are, after that operation, driven into some shed strewed with clean litter, or penned up with hurdles on clean grass; that the utmost care is taken to prevent their exposure to dirt, or whatever else might tend to sully their whiteness; and that they are not shorn until a sufficient degree of moisture is deposited in the fleece, by perspiration, to impart a soft handle to the wool. It may here be added, that it is very important, if possible, to prevent the sheep from filling their fleeces with grass seeds, broken leaves, and other extraneous substances, which cannot be removed in the operation of washing, and which are productive of labour and expense in every process of manufacturing, in some cases, indeed, render ing wool almost unsaleable. It may be here observed, that so conscious are the Spaniards of the superiority of the German mode of washing and assorting, that they are making every effort to introduce it.

"In order to assimilate the Australian wool as much as possible with the German, in preparing it for market, the fleeces should not be broken, but merely divested of the breech and stained locks, and so assorted or arranged, that each package may contain fleeces of the same character as to colour, length of staple, firmness of hair, and general quality.

"If the washing has been performed at the same time and place, and with an equal degree of care, the colour is likely to be uniform, and it will then only be necessary to attend to the separation of the fleeces as to length, fineness, and general quality: but if a larger grower has flocks of different breeds, and fed on different soils, care should be taken that the fleeces be separated, first as to colour, and then again as to length, fineness, &c.

"The fleeces, being assorted, as already suggested, should be spread one upon another, the neck of the second fleece being laid upon the tail of the first, and so on alternately, to the extent of eight or ten fleeces, according to their size and weight. When so spread, the two sides should be folded towards the middle, then rolled together, beginning at each end, and meeting in the centre, and the roll or bundle so formed held together by a slight pack-thread. The bagging should be of a close, firm, and tough nature. The material hitherto most generally used has been sail canvas, which very ill resists bad weather on a long voyage; and when received here, even in favourable condition, is so dry and crisp that it will tear like paper: a thicker, twilled, more flexible, and tough material, would be preferable. The size and form of the package may be in length about nine feet, and width four feet, sewed up on the two long sides and at one end, the other end being left open, and the sheet so formed being suspended, with the open end upwards, to receive the bundles, made up as before directed, which are to be put in one at a time, one of the flat sides of the roll or bundle being put downwards, and so on in succession, being well trod down, until sufficiently filled for the mouth to be closed. This is the German mode of packing; but it is doubtful whether smaller packages, of the dimensions that have been hitherto sent from the colonies, may not be more convenient for so long a voyage. The operation of screwing should be discontinued where it has been practised, as the screw pressure, and remaining compressed during the voyage, occasion the wool to be caked and matted together in a manner that is highly prejudicial to its appearance on arrival. The practice, also, of winding up each fleece separately, and twisting a portion into a band, is productive, in a minor degree, of the same prejudicial effect; and it is to avoid this that the making German bundles of eight or ten fleeces is suggested."

Qualities of Wool.—Improving the quality of the wool, or at least of not allowing it to deteriorate, is now an object of as great importance to the British store-farmer as in raising the weight of the carcass. The finest wools are those purchased for making broad cloths, merino, and mousseline-de-laine fabrics (*laine* is the French word for wool). "The wool of which good broad cloth is made," observes Dr. Ure, in his "Dictionary of Arts," "should be not only shorter, but, generally speaking, finer and softer than the worsted wools, in order to fit them for the fulling process;" and to judge of this degree of fineness, great nicety of discernment is required. "There are four distinct qualities of wool upon every sheep; the finest being upon the spine, from the neck to within six inches of the tail, including one-third of the breadth of the back; the second covers the flanks between the thighs and the shoulders; the third clothes the neck and the rump; and the fourth extends upon the lower part of the neck and breast down to the feet, as also upon a part of the shoulders and thighs, to the bottom of the hind quarter. These should be torn asunder, and sorted immediately after the shearing.

"The harshness of wools is dependent not solely upon the breed of the animal, or the climate, but is owing to certain peculiarities in the pasture, derived from the soil. It is known that, in sheep fed upon chalky districts, wool is apt to get coarse; but in those upon a rich loamy soil, it becomes soft and silky. The ardent sun of Spain renders the fleece of the Merino breed harsher than it is in the milder climate of Saxony.

"All wool, in its natural state, contains a quantity of a peculiar potash-soap, secreted by the animal, called in this country the *yolk*, which may be washed out by water alone, with which it forms a sort of lather. It constitutes from 25 to 50 per cent. of the wool, being most abundant in the Merino breed of sheep; and however favourable to the growth of the wool on the living animal, should be taken out soon after it is shorn, lest it injure the fibres by fermentation, and cause them to become hard and brittle. After being washed in water, somewhat more than lukewarm, the wool should be well pressed, and carefully dried."

The quantity of wool imported annually into the United Kingdom, a large portion of which is now from Australia, has latterly been about 60,000,000 lbs.—a quantity not nearly equal to that produced from native flocks. As the imported wools are chiefly of a finer quality than those of native growth, so far is the large importation from injuring the British wool growers, that it is the means of giving them higher prices for their commodity. It has been satisfactorily shown by cloth-makers before a parliamentary committee, that unless they imported foreign wool to mix with that of Britain, they could not produce the finer class of goods, and, consequently, that British wool would be much less in demand.

Smearing.

Smearing is a process of anointing the skins of sheep with certain ingredients, principally for the purpose of rendering the animal less liable to injury from winter cold (the unguent being a slight counter-irritant), and of destroying the vermin which lodge among the roots of the wool. Smearing with a mixture of tar and butter was general in Scotland in former times. The proportions varied in different districts; but in general 6 lbs. of butter to a gallon of tar were deemed sufficient for twenty sheep. The time for laying on this salve was in the end of October and beginning of November, before the rams are admitted to the ewes, which, in the mountain farms of Scotland, is in general about the 22d of November. The smearing with butter and tar has very much declined of late years, and various other preparations, such as butter and oil, turpentine, arsenic with a solution of soft soap, and various other baths, are used instead of butter and tar. Which of the various baths now in use are the best, it would be difficult to determine, as each has its advocates. On this, as on other subjects, the store farmer, without running rashly into experiments, ought to have his mind open to well-considered improvements, and adopt such measures as are supported by respectable authorities.

DISEASES OF SHEEP.

The sheep is subject to a great variety of diseases; but the most formidable, and by far the most destructive, is

The Rot.

It is unfortunate that in the early stages of rot the disease gives no external intimation of having commenced its destined fatal career; for it is at the beginning of most diseases that human skill is most efficacious in arresting their progress. But sheep in the early stages of the rot, instead of showing symptoms of disease and decay, acquire a great tendency to fatten, which has been turned to advantage by Mr. Bakewell and others. But after the disease has undermined the general health, the animal becomes listless and unwilling to move, leaves its companions, and sinks rapidly in flesh; its eye becomes sunk, dull, and glassy; the wool comes easily from the skin, the breath becomes fetid; the bowels variable, at one time loose, with a black purging, and at another costive; the skin becomes yellow, and sometimes spotted with black; emaciation now becomes more rapid; general fever is induced, and death ensues. There are various methods by which practical men endeavour to ascertain the incipient symptoms of the disease, but the two following are the most general:—

The first is by handling the sheep on the small of the back, and if the flesh feel firm and solid, the animal is judged sound, but if the flesh feel flabby and soft, and give a cracking sound when rubbed against the ribs, the animal is unsound. The other method is by examining the small veins at the corners of the eyes, and if filled with yellow serum instead of blood, the animal is pronounced unsound; but the greatest practical tact and talent will not always ensure success in discovering the early stages of this insidious disease.

Appearances on Dissection.—The whole cellular tissue is filled with a yellow serous fluid; the muscles are pale, and appear as having been macerated, being soft and flabby; the kidneys are infiltrated, pale, and flaccid; the mesenteric glands distended with a yellow serous fluid; the lungs filled with tubercles; the heart enlarged and softened; the peritoneum thickened; the bowels are often distended with water, and sometimes grown together. But the liver is the primary seat of the disease; its whole structure is in different states of disease; one part is scirrhous and indurated, and another soft and ulcerated, and the biliary ducts are filled with flukes. This appears to the author the origin of the disease which has involved so many organs, and effected such a vast disorganization of the whole animal frame.

Causes of Rot.—In endeavouring to ascertain the cause of this disease, it seems unnatural to begin by inquiring whether those parasites which are found in such numbers in the biliary ducts of the liver, are the cause or effect of the disease. The parasites named the liver fluke, the *fasciola* of Linnæus, the *distoma hepaticum* of Rudolphi, the *planaria* of Goese, are not peculiar to the sheep, but have been found in the biliary ducts of the goat, deer, ox, horse, ass, hog, dog, rabbit, guinea-pig, and various other animals, and even in the human being. The parasite is of a brownish-yellow colour, and resembles a small sole divested of its fins; in size it may be seen from that of a pin-head to an inch and a quarter in length, and half an inch in breadth.* It is supposed to be a hermaphrodite, as no distinction of sex has yet been made out. The spawn or eggs of this parasite are found in great numbers in the biliary ducts of the liver; these eggs are also found in every part of the intestinal canal, and very often seen in the dung of a sound sheep, though always numerous in that of a diseased one. This animalcule, and many other of the *entozoa*, have never been found out of the intestines, but this is not positive proof that they cannot or do not exist out of the body. Mr. Blacklock, in his very valuable treatise on sheep, after laying flat all his opponents, comes to the following conclusion:—"From all this data, the conclusion must at once be drawn, that as living flukes cannot reach the liver from without, they must, of necessity, be produced only in particular states of the animal they inhabit; how they originate we cannot of course determine, and this is not the place to hazard a physiological conjecture; but it will be found that their appearance in the bile is always preceded by tuberculous deposits on the lungs and liver."†

That Frommon found the fluke worm in the fœtus of the sheep is a strong fact, but not decisive; for Mr. Blacklock must know that, although he is anatomically correct when he states that there is no direct vascular communication between the fœtal and maternal side, yet the indirect communication may be sufficient. And besides this, Mr. Blacklock's views on this point are extremely unphilosophical when he says—"That living flukes cannot reach the liver from without, they (the flukes) must, of necessity, be produced only in particular states of the animal they (the flukes) inhabit." This is just saying that the flukes inhabit the animal before its particular states produce them. This must mean that the eggs of the flukes exist in the liver of the sheep, ready to be hatched by the peculiar states of the animal; and as these eggs could not, according to Mr. Blacklock, reach the liver from without, the only other alternative is, that the liver lays the eggs when in healthy state, and hatches them when diseased. This wont do; equivocal generation is absurd. But the limits prescribed forbid the author pursuing this interesting inquiry farther: he must simply state his belief that the ova of the fluke are not generated by the liver of the sheep, but find their way to that organ by means not yet ascertained; but these ova are not vivified in the liver except under certain states of that viscus. The ease with which Mr. Bakewell could induce rot in his sheep, by putting them on ground which he had previously flooded for that purpose, shows that other circumstances must concur to produce the disease. It is not caused by scanty food, as has often been alleged, for sheep may be starved to death without producing rot; the fact that the sheep has an extraordinary tendency to acquire fat in the early stages of the disease, shows that the causes act as a stimulant at first, and originate a slight degree of inflammation in the liver, as the first step in the progress of this fatal disease. But the numerous and well-attested facts now obtained from various climes and countries, lead to the conclusion that the nature of the soil and pasture, and the character of the seasons, are the chief agents in causing rot. This view is confirmed by the fact, that rot is most prevalent in wet seasons, and is nearly confined to lands subject to be occasionally flooded with water at certain seasons of the year, and to soils naturally moist and marshy. Moist and level lands of retentive soil, from which water is slowly evaporated by the sun, and a temperature favourable to the decomposition of vegetable matter—on such lands, when not thoroughly drained, rot may be said to be indigenous, while on lands that are dry and hanging, the disease is unknown. The nature of the plants which the soil produces is not so important as the plants being kept in a morbid state by that degree of moisture and heat favourable to their decomposition. These views will be amply verified by any one who will take an accurate survey of the midland, eastern, and southern counties of England, in which the disease is most destructive. Besides supporting the views here advocated, the following passage from the pen of M. Hammond, the founder of the veterinary school in Egypt, is highly interesting to every sheep-farmer:—"It appears every year in Egypt after the falling of the Nile, and it follows and keeps pace with the subsidence of the waters; desolation and death accompany it wherever it passes, and it annually destroys at least 160,000 sheep. As soon as the waters of the Nile subside, the pastures which were submerged are speedily covered by a tender rushy grass: the sheep are exceedingly fond of it, and they are permitted to feed on it all day long; in the course of a very little time they begin to get fat, when, if possible, they are sold; their flesh is then exceedingly delicate, but soon after this the disease begins to appear, and the mortality commences. The disease is more frequent and fatal when the sheep are first turned on the newly recovered pasture than when the ground becomes dried and the rushy grass harder. But if the sheep pasture in the midst of mud, or on the borders of the marshes and canals, rot attends every step; the rot does not occur in elevated countries, where the sheep feed on dry aromatic herbage. The Bedouins sell all the sheep which they can before they quit the Nile, for then they are in high and prime condition, after which they lose not a moment in reassembling their flocks and driving them back to the desert."*

Prevention and Treatment of Rot.—If the true causes of rot have been accurately given, every farmer has in his own hands the most efficient means for its prevention; on all lands that can be defended from being flooded with water, and on all lands whose levels admit of thorough drainage, the manner and amount of drainage must be determined by the position of the land, whether level or hanging, and by the character of the soil, and the quantity of the moisture to be removed, and on all these points the farmer must decide for himself, or be guided by the advice of a competent judge. The only indispensable rule is, that the drainage must be thorough, in order to be effectual; and if the drainage is carried to this point, the farmer will have the pleasure to see the rot, that dreadful scourge of his flock, disappear. This important point is established by practical men whose testimony cannot be impeached, that there would be no rotten sheep found, even upon the most spongy lands in the country. The treatment of rot is confined to narrow limits, from the curious fact that sheep, in the early stages of rot, acquire fat with singular rapidity; the best thing the farmer can do, as soon as he finds his flock tainted, is to sell them to the butcher for what they will bring in the market; from the condition of the sheep, this forced sale may be attended with considerable loss, but it will be a loss inferior to that sustained in the vain attempt to effect a general cure.

Tainted flocks have recovered, it has been alleged, by being sent to pasture on salt marshes; but though the efficiency of such pasture were admitted, it is a remedy which only a few farmers could obtain. To change the

* Library of Useful Knowledge, p. 418.
† Blacklock's Treatise on Sheep, pp. 211, 212.

* See Transactions of the Highland Society.

flock to a more dry and elevated part of the farm, when this is practicable, has been attended with favourable results. The free use of salt is universally admitted to be the best medicine within the reach of the farmer for checking the progress of this deadly disease. That many cures have been effected by the proper use of salt, is attested by persons of the highest character and intelligence. Sir John Sinclair states, that at Mr. Mosselman's farm at Chenoi, beyond the Wavre, he found that salt was used for sheep, and that, by allowing them to lick it, the rot was completely cured.* And as the only explanation of sheep taking on fat rapidly, in the early stage of the disease, is, that the digestive organs are stimulated for a time by inflammation of the liver, perhaps the disease might be checked *in limine* by copious bleeding; but the disease can scarcely ever be detected at that period in which bleeding would be proper, and bleeding late in this, as in almost all diseases, is fatal. But in this disease the sheep-farmer must direct his energies and care to the prevention rather than the cure, though some of the remedies just mentioned may be of service at the beginning; yet, from the insidious nature of the disease, it can undermine the constitution before it is perceived, to that extent which no known remedies can restore, so that every sheep-farmer must rest his hopes of safety, not in curatives, but in the vigorous use of the means of prevention.

Braxy.

Braxy, or Sickness, is an inflammatory disease, whose ravages are chiefly confined to hogs, and those in the highest condition are most liable to be attacked. This disease is not nearly so destructive as it was formerly, when hogs were hirsled; this has been accounted for by alleging the inexperience of hogs in selecting their food, and their tendency to feed too much on the succulent parts of their pasture. Braxy, being entirely an inflammatory affection, may be excited by a variety of causes, such as drinking cold water in a heated state; any great or sudden change of temperature; by hail, snow, or rain; feeding on soft rank grasses, which are apt to excite fermentation, and, by extrication of gas, distending the stomach, thus originating inflammation, and sometimes producing sudden death by pressure on the diaphragm. One very frequent cause of braxy is that kind of frosty mornings which load the pastures with hoar-frost. The hogs, from feeding chiefly on dry and binding pastures at that season of the year (from November till March), eat the succulent spots of grass laden with hoar-frost very greedily, and thus the temperature of the stomach is so suddenly lowered to icy coldness, that violent inflammation is immediately produced, and death often ensues in a few hours. In the list of the causes of braxy, the improper use of the dog must not be omitted. It is as clear as a sunbeam, that nothing is more fitted to produce inflammation than once heating a sheep by incessant use of the dog, at seasons of the year so liable to sudden and great falls of temperature.

Symptoms of Braxy.—The animal appears uneasy, often lying down and rising up, standing with its head down and back raised, taking no food, but often drinking water; fever then ensues, when the pulse becomes strong and quick, respiration laborious and rapid, the skin hot, and the wool clapped; the eyes are languid, watery, and half-closed; it ceases to follow the flock, and soon dies.

Appearances on Dissection.—On opening the body, the appearances vary according to the parts affected. Sometimes only the reed is affected, and all the rest of the viscera appear perfectly healthy, and the flesh not at all affected. In other cases the effects of violent inflammation are visible through the whole viscera, and the flesh of the whole animal is in a state of rapid putrefaction.

Treatment of Braxy.—From the nature of the disease, it is obvious that the first and most effective remedy is prompt and copious bleeding from the jugular veins, this being effected, the constipation of the bowels must be removed; the best purgative for this purpose is Epsom salts, two ounces for a dose, dissolved in warm water, and followed by thin warm gruels; these remedies would generally prove effectual if applied at an early stage of the disease; but in a large flock of mountain sheep the disease is frequently not observed by the shepherd till too late for any remedy. The best preventive of the disease in mountain sheep is skilful and attentive herding, by preventing the young sheep from fastening too much on succulent spots, and by seeing they graze regularly over every part of the pasture, and be allowed perfect repose for rumination undisturbed by the dog.

Sturdy.

The proximate cause of this formidable disease is hydatids formed in the brain, or by an accumulation of water or serum in the ventricles of the same organ. Many ingenious writers, both in France and in our own country, have favoured the public with a few facts and much speculation to account for the manner in which hydatids reach the brain, and the causes of the accumulation of water in the ventricles; but none of these speculations are in the least degree satisfactory, and many of them can be shown to be absurd, from the known anatomy and physiology of the brain of the sheep. Many plans have been adopted to extract the hydatids from the brain. Hogg, the Ettrick Shepherd, was successful by the use of the wire. He says—"When I was a youth, I was engaged for many years in herding a large parcel of lambs, whose bleating brought all the sturdies in the neighbourhood to them, and with whom I was exceedingly plagued; but as I was frequently knitting stockings, I fell upon the following plan:—I caught every sturdied sheep that I could lay my hands upon, and probed them up the nostrils to the very brain with one of my wires, and I beheld with no small degree of pleasure, that by this simple operation I cured many sheep to different owners; but I kept all my projects to myself, for I had no authority to try my skill on any of them;" and he adds, "that several years passed before I failed in this operation in any one instance;"* but nothing approaching this success has ever attended the operation in the hands of any of Mr. Hogg's disciples; though, when the hydatid is situated in the ventricles, or in the upper portion of the brain, some farmers and shepherds have acquired such tact in the use of the wire as to cure considerable numbers.

But the operation performed with the trocar, and various other instruments that have been used, is liable to many inconveniences and great danger. If the hydatid is situated in the base of the brain, it cannot be reached by the nostril; then there is great danger of rupturing some of the numerous blood-vessels of the brain, and thus producing inflammation—a disease as fatal as the one attempted to be cured. The use of the trephane is also attended with difficulty and danger. It lays open at once an immense vacuum in the brain to the action of the atmosphere, and its consequent irritation, and hence the risk of inflammation. When the situation of the hydatid can be ascertained by the softening of a portion of the skull, to destroy the vitality of the hydatid by perforating it with the trocar or other sharp instruments, is perhaps the method attended with the least danger of exciting inflammation, and hence the most likely to succeed. But the extent to which the disease must have injured the brain, before the softening of the bone to reveal the position of the hydatid, is an insuperable evil, diminishing the chances of success in any mode of co-

* Sir John Sinclair's State of the Netherlands.

* Hogg on Sheep, p. 58, 59.

ducing the operation that can be devised. There is no medicine that can justly be regarded as of any avail. But carefully observed and accurately recorded facts may yet throw some light on the remote causes of this formidable disease, under that higher anatomical and physiological knowledge which has within these few years been brought to bear on the diseases of our domestic animals.

Pining.

This disease, it is said, was unknown in this country before the sheep-walks were thoroughly drained and the moles exterminated. If this statement is correct, the cause of the disease must obviously be too dry and binding pasture; and in accordance with this view, constipation of the bowels is always present in this disease. To open the bowels freely, and change to a more nutritive pasture, are the obvious remedies; and when both can be readily applied, seldom fail of complete success.

Dysentery.

This disease begins with violent discharges from the bowels of a green slimy mixture, which in progress of time becomes mixed with blood. It has often been confounded with diarrhœa, from which it differs in many particulars. Diarrhœa attacks young sheep, particularly hogs, occasioned by a sudden rush of grass in the spring, or from too sudden a change from a scanty to an over-rich pasture; when such are the causes of diarrhœa, the mere change to a drier pasture will effect a cure. But dysentery attacks old sheep, and generally does not commence till June or July. Many writers allege that this disease is highly contagious, but the best established facts do not sustain the allegation. The disease prevails in fouled pastures, and in seasons characterized by a peculiar state of the atmosphere with regard to heat and moisture, a certain combination of which renders the disease so fatal to our army, especially in tropical climates. In the treatment of this disease, bleeding is a proper remedy in an early stage; but if late, gentle purgatives alone must be used; Epsom salts or castor oil, with 25 to 30 drops of laudanum, are the best purgatives. Mr. Stevenson also used an infusion of logwood, and doses of ipecacuanha in numerous cases, with great effect.*

Trembling.

Trembling, or Louping Ill, in mountain flocks, is a disease caused by cold east winds, which are prevalent in April and May, and at which season this disease, after a bad winter, is often very destructive. The animal sometimes leaps from the ground and falls down dead, but more generally it is seized with trembling, loses the power of its legs, and lies on its side, grinding its teeth, and moving its limbs with great violence. The appearances, on dissection, are very uniform; great congestion of blood in the liver and lungs, and particularly the heart, which is invariably gorged with dark blood; and the brain is also sometimes congested; the whole flesh of the body is as white as if the animal had been killed by bleeding.

These appearances, and various experiments, led the writer of this paper to view the disease as the effect of a lost balance in the circulation; the cold east wind acting on the surface of the animal when she is just beginning to return from the lowest point by the coming grass, drives the blood from the surface, congests the lungs and liver, and overpowers the action of the heart with a rush of dark venous blood. The numbness of the limbs, caused by the heart being unable to send the circulation to the extremities, has led some writers to regard the disease as a kind of palsy.

The Treatment. Copious bleeding in the first stage of the attack will often restore the balance of the circulation; but if the animal has been affected some time, it is often difficult to obtain a sufficient quantity of blood, which has been thrown from the surface upon the heart and other internal organs. In this state, the animal must be put into a tub of hot water at 98 degrees, which will cause the blood to flow, and thus restore the action of the heart, and tend to restore the balance of the circulation. After a sufficient quantity of blood has been drawn, doses of Epsom salts, dissolved in warm water, and followed with thin warm gruels, must be given till the bowels are freely opened. The prompt application of these remedies on the first attack of the disease, would in general be successful; but, like many other diseases of sheep, it is not observed till the action of the heart has become too feeble for any remedies to restore the lost balance of the circulation. The same views of the nature, causes, and treatment of this destructive disease, are supported by numerous facts and experiments brought forward by Mr. Tod, in his prize essay, published in the Transactions of the Highland Society of Scotland.

Foot-Rot.

Foot-rot is a disease most prevalent in luxuriant meadows, and in all soft grassy lands saturated with moisture. The opinions entertained regarding the cause of this disease are discordant in the extreme. Some writers contend that it is comparatively a modern disease, and was first mentioned by two French physicians, M. Etienne and M. Liebault, who published some cases of the disease in "La Maison Rustique," in the year 1529. Lullin says that it was brought from Piedmont to Geneva, in the year 1786, and that the foot-rot did not exist among Swiss sheep before that period; and in a report of the management of Flemish sheep in 1763, published by authority, foot-rot is not once mentioned. In our own country, it is mentioned by Sir Anthony Fitzherbert in the year 1523. But whatever may have been its history and progress in other countries, it was very prevalent in Great Britain in 1749. Ellis, who wrote in that year, says, "that it raged particularly in the counties around the metropolis. The ewes were seized with foot-rot, which was communicated to other sound ewes and to the lambs which they suckled; and most of the meadows are so much infected with this sheep malady, that few of the suckling ewes are ever clear of it in a greater or less degree, and the pain and anguish therefore keep them poor in flesh, and lessen their milk; so that two or three ewes thus affected give no more milk than one full milch ewe that is in perfect health."*

It will aid the reader to follow with greater clearness the following discussions regarding the nature and causes of foot-rot, to have first a correct view of the healthy anatomical structure of the foot of the sheep, at least in as far as this very formidable disease is concerned. "There are some points of importance," says that eminent veterinary surgeon, Mr. Dick, "to be kept in view, in order to understand properly either the functions of the foot of the sheep, or the nature of the diseases to which it is liable. The foot presents a structure and arrangement of parts well adapted to the natural habits of the animal. It is divided into two digits or toes, which are shod with a hoof composed of different parts, similar in many respects to the hoof of the horse. Each hoof is principally composed of the crust or wall, and the sole. The crust, extending along the outside of the foot round the toe, and turning inwards, is continued about half way back between each toe on the inside. The sole fills the space on the inferior surface of the hoof between these parts of the

* See Transactions of the Highland Society.

* See Ellis's Shepherd's Sure Guide, p. 298

crust, and being continued backwards, becomes softer as it proceeds, assuming somewhat the structure of the substance of the frog in the foot of a horse, and performing at the same time analogous functions. The whole hoof, too, is secreted from the vascular tissue underneath. There are, besides, two supplementary digits at the fetlock. Now, this diversity of structure is for particular purposes. The crust, like that in the foot of the horse, being harder and tougher than the sole, keeps up a sharp edge on the outer margin, and is mainly intended to resist the wear and tear to which the foot of the animal is exposed."*

This structure of the foot of the sheep is extremely well adapted to Alpine ranges, which are the native abodes of the sheep in their natural state. "Dwelling by preference," in the language of Mr. Wilson, "among the steepest and most inaccessible summits of lofty mountains, among its native fastnesses, it is seen to bound from rock to rock with inconceivable swiftness and agility."†

From these facts, it is easy to perceive how our domestic sheep are subject to foot-rot, when confined to a limited range on soft and rich pastures, and in wet and grassy lands. In these situations, the growth of the crust of the hoof exceeds the wear and tear, and soon overlaps the sole, and in this situation is either rent or broken off, when sand or dirt reach the vascular parts of the foot, and hence inflammation is produced. The animal then becomes lame, suppuration takes place, and ulcers discharge fœtid matter; and if these ulcers go on unchecked, they throw out fungous granulations; and if these be allowed to go on the hoof falls off. When the disease reaches to this extent, the constitutional disturbance is very great from high inflammatory fever, and the animal rapidly loses flesh, and, if unrelieved, dies of fever and starvation.

Such being the nature and causes of the disease, the author of this paper thinks the views of Mr. Dick rest upon a more secure and philosophical foundation than any other writer that has come under his observation. And if these views are admitted, the treatment and means of prevention are very obvious. To pare away all the detached hoof, and dress the diseased part with some caustic, perhaps the muriate of antimony, has the greatest weight of authority. But as prevention is in all cases to be preferred to cure, the shepherd should keep a vigilant eye upon the flock, and pare regularly on lands that require it. By the simple means here recommended, the writer has prevented the disease from injuring his flock of sheep for more than twelve years, though the lands were subject to the disease. But if foot-rot be as virulently infectious as it is affirmed to be by a whole host of writers, many of whom are men of high character and attainments, very different means both of prevention and treatment must be adopted. As the decision of the question whether foot-rot be infectious or non-infectious, is of great practical importance to every sheep-farmer, the evidence on both sides of the question would require to be stated with perfect candour, in order to arrive at the truth. In so far as evidence has been produced, the argument inclines to the side of those who contend for the non-contagiousness of the disease. Mr. Dick very reasonably asks, "Has any one ever attempted to produce the disease by inoculation? If it is highly infectious, surely it will at once be produced by inoculation. But this is not such an easy matter as one would expect, from a disease which is supposed to infect a whole field, and that, too, even if it be of five hundred acres in extent. Goheir, a French veterinarian, first applied a piece of horn from a diseased foot, covered with the matter, to the sole of a sound foot without effect; secondly, he rubbed a diseased foot against a sound one, without effect; thirdly, he pared the sound foot, and having applied a piece of diseased hoof, the disease afterwards appeared; but in this case the foot afterwards got well of itself, and there seems to have been a doubt in the mind of Goheir as to whether it was truly foot-rot or not. Other French veterinarians have tried similar experiments, and particularly Vielhan of Tulle, and Favre of Geneva; and although I have not seen an account of their experiments, it is said they succeeded in producing the disease by inoculation. Now, it will be asked, Is not this a sufficient proof of its infectious nature? I answer that it is not. It appears to me that this is a strong proof against it. If it is produced with so much difficulty by the direct application of matter, is it not absurd to suppose that a few sheep with diseased feet should infect a whole field. I have not seen an account of the manner in which the experiments of the French veterinarians have been performed; I know not what quantity of matter was employed, neither have we any account of counter-experiments, nor whether any were tried to prove whether a similar effect would not have been produced by the application of any other morbid matter; for example, whether the matter of grease from the heels of horses, or from thrushes would not have produced similar effects. I have little doubt of such being the case; that suppuration might be produced by inoculating with that or almost any other matter, if, in the operation, the wound was made sufficiently deep; nor would I doubt that disease would be produced if matter was spread over the foot in sufficient quantity, and applied for a sufficient time." The same writer continues—"I repeat, that it is absurd to suppose that, if applied to the hoof, it would produce the disease. The hoof is not governed by the laws of living matter; it is totally insensible, and it has not a circulation, neither has it nerves; it absorbs moisture only like a piece of inert matter, and it is not acted upon as a living part. Matter from the foot of a diseased sheep might as well produce the disease in a tree; nay, even more likely, because it is a living body, which the hoof is not. Why, then, are we to suppose the hoof to be acted upon by matter from diseased feet, and that, too, after the matter has been exposed to the influence of the atmosphere? But rain and sun, we must suppose, have no influence upon it. Arsenic may be diluted with water to such an extent as to be swallowed with impunity, but water seems to increase the virulence of the matter of foot-rot. It is true that heat and moisture will reduce, after sufficient exposure, animal matter to a putrid mass of the same consistency and properties, but the influence of these agents is lost upon the matter of foot-rot. The plague is now known not to be so infectious as it was once thought to be, but the foot-rot will still affect the most extensive domains. The upas-tree may annihilate the existence of all that comes within its pestiferous shade, but what is that to the infection of the foot-rot when a single sheep will contaminate a mountain? Nay, it will act even upon parts totally devoid of vitality; and such, too, is the eccentricity of its action, that it will allow its neighbouring toe to escape, and still infect the whole ground. But I need not discuss this point farther at present, as I trust I have already shown that all ideas of its infectious nature are merely chimerical."*

In support of these views, Mr. Black, farm overseer to his Grace the Duke of Buccleuch, states that he had thirteen score of black-faced sheep, the greater part of which was affected with foot-rot, and many of them crawling about on their knees. He turned

* Dick on Foot-rot. Quarterly Journal of Agriculture, No. xii. p. 85.

† Wilson on the Natural History of the Sheep, p. 355.

* Quarterly Journal of Agriculture, No. 12, p. 93.

them into a drier pasture, on which were seven score of Leicester and Cheviot sheep. All of the diseased sheep, except four, recovered, and not one of the Leicesters or Cheviots was infected. This is a very strong fact, from the pressure of which the contagionists cannot easily escape.

The Scab.

This frequent and very mischievous disease has annoyed the cultivators of sheep in different parts of the world from time immemorial. It is mentioned by Ovid,* Livy,† and in the Georgics it is very graphically described by Virgil. In our own country it is mentioned by our earliest writers; and in Italy, France, and Germany, there is scarcely a writer on sheep who does not describe this prevalent and ruinous disease.

Symptoms of the Disease.—The sheep becomes restless, scratching itself, tearing off the wool with its teeth, and rubbing violently against any post, stone, or gate. When the skin is carefully examined, there are seen numerous pustules, which, having broken and run together, form large patches of scab. The back and shoulders are generally first affected. The general health of the animal sinks in proportion to the extent of the eruption and the virulence of the disease, and if allowed to proceed unchecked, it brings on general inflammation, and the animal dies in a most miserable condition.

It is now ascertained that this disease in sheep is caused by minute insects of the class *acari*. M. Walz, a German veterinarian, has given a very curious and interesting account of the operations of these acari, which are said to burrow in the skin of the sheep, and reappear again about the sixteenth day with a numerous brood. These young insects commence operations at once, and propagate in the same manner till the poor sheep sinks under myriads of his destroyers. The work of M. Walz contains drawings of these insects, highly magnified. The subject deserves further investigation, being of great importance to the sheep farmer.

The treatment of scab is thus rendered very simple—the destruction of the insect which caused it. Infusions of tobacco, hellebore, or arsenic, have all been employed with success. In bad cases, the mercurial ointment has been applied with the happiest effect. A very good receipt is a decoction of tobacco and spirit of turpentine, with a little soft soap, and sulphur vivum.

The only caution necessary to be given in the use of any of these remedies, is to take care that they be brought thoroughly in contact with every part of the skin of the affected animal, lest any of the burrowed acari escape. And all folds or sheds in which infected sheep have been confined, and all gates, posts, and other rubbing places, must undergo thorough purification. Besides the acari, sheep are liable to be attacked by various other insects, such as the flesh-fly, and a species of aphis called the sheep-louse. The maggot only prevails in the moist and warm summer months, but inc[illegible] in numbers with amazing rapidity, and requires great watchfulness on the part of the shepherd, as they soon destroy a large portion of the skin and flesh of the sheep, if unchecked. The aphis also creates great irritation, but both species are easily destroyed by any of the preparations already detailed. The tick (*acarus reduvius*) is also a very formidable insect to sheep. It almost buries itself in the skin, and adheres so firmly by six legs, very muscular and powerful, and so armed with serrated claws, that it can scarcely be disengaged from its hold, but will yield, like most insects which infest the sheep, to the application of a mercurial preparation.

THE ALPACA.

It is perhaps not very generally known that attempts are now making, under the most respectable auspices, to introduce the alpaca, or Peruvian sheep, into the number of our domestic animals. As the subject is of vast importance in a national as well as individual point of view, we propose offering a few explanatory observations upon it.

Nature, as is well known, furnishes animals expressly suited to the climate, vegetable productions, and other circumstances connected with the locality which they are destined to inhabit. The Andes, and other high mountain ranges and slopes of South America, are accordingly provided with several species of sheep adapted, by their habits, to these lofty regions of scanty vegetation, and which so materially differ from the sheep of this and other European countries, as to seem a perfectly distinct tribe of animals. The two most common of these South American sheep are the llama and alpaca, and they abound most extensively in Peru. The llama is somewhat taller than the alpaca, and though in some respects a remarkable animal, its peculiarities are not such as to render it so especially interesting as the alpaca, for purposes of practical utility out of its native regions. The alpaca, which it is proposed to domesticate in Britain, is an animal combining the appearance of the common European sheep with that of the goat, and partly of the deer and camel. Like the sheep, the alpaca is lanigerous or wool-coated; in its general structure it is light, and possesses limbs adapted for springing and leaping like the goat; it resembles the deer in skin, flesh, and general appearance; and though without the camel's deformities, it is gifted like him with patience and docility, being often used as a beast of burden by the natives of South America. The height of the alpaca is from three to four feet, when measured from the ground to the top of the back; the eyes are large, black, soft, and expressive; the animal has no horns; the neck is long, slender, curved backwards, and finely set; the head handsome, and the muzzle and ears lengthened; the hoof is horny, and divided; the tail long, and resembling what is called a switch-tail; the body has a tapering towards the loins, resembling that of the greyhound; and, as regards other points, the alpaca has partly the characters of the sheep (its incisors on the lower jaw, for example, and six molar teeth on each side,) and partly those of the camel (the most remarkable being a similar reservoir in the stomach for fluids, suiting the creature to an arid climate.) To common observers the alpaca might seem to be a fine tall goat, with small head and no horns, but of more gentle and fleecy appearance than that animal.

The wool of the alpaca forms, of course, a point of peculiar importance, taking into view the proposal for introducing the animal into Great Britain. The colour of the wool varies considerably, the majority of the tribe being of a tint intermediate between black and brown, while others are of a pure white. The texture is admitted on all hands to be peculiarly fine. In a memoir on this subject, written by Mr. W. Walton, and printed for the Natural History Society of Liverpool, the wool is thus described:—"With the polite assistance of the secretary of the Polytechnic Institution, I was enabled to examine the anatomical structure of three samples of alpaca wool through a lens magnifying one million times. The colours of those subjected to the power of the microscope were white, black, and gray. When thrown upon the disc, each filament appeared equal in thickness to a man-of-war's topsail halyard, perfectly distinct, and the fibrous structure more evident than in the wool of common sheep. White was the first sample tried, and it produced an effect at the same time singular and pleasing. The

* Metamorph. lib. vii.

† Tit. Liv. iv., cap. 30.

surface appeared polished and distinguished by glittering brightness, almost, I could say, refulgence, which is wanting in sheep's wool. The general results produced by afterwards showing the black sample were the same, excepting that the shade on the disc was more opaque, and the brilliancy of each filament diminished. The gray exhibited a medium between the contrasts, and helped to show both to advantage.

"There are instances of alpaca wool measuring thirty inches long; frequently it is seen twenty inches, and it averages from eight to twelve. In the sample, there appeared to be no under wool—no closer and immediate covering. No shorter hair, or wool, could, in fact be perceived; the very reverse of what is observed when a morsel of an elk's or camel's coat is examined. Alpaca wool is also straighter than that of sheep, never appearing in those spiral curls which distinguish our piles, more particularly when the bearer of the fleece has been smeared. The smallness of the fibre, its softness and pliability, coupled with its elasticity, equally add to its value. There is, in the mass, what is technically called a *trueness*, that is, an equal growth and an exemption from shaggy portions, accompanied by a soundness, by which is meant the general strength of the fibre—properties certainly of the first import to the manufacturer. In consequence of this characteristic disposition, alpaca wool breaks less in the act of combing, is freer from shreds, spins easily, and not being so harsh or so stubborn, does not injure the machinery so much. The thread spun with it is also finer and truer. In the manufacture of fine goods, it is agreed that the pile cannot be too soft or too silky, provided the strength of the fibre is not impaired. As well as I could, I have compared the strength of a filament of alpaca with those of other wools, and found it the strongest; and as it is devoid of that irregularity of surface—the knots and joints which some persons liken to those of a bamboo cane—the cloth made from it must consequently be less harsh to the touch."

But the qualities of the alpaca wool for manufacturing purposes do not rest upon mere conjecture. "The merits of alpaca wool have for some time past attracted the notice of manufacturers and consequently of merchants; and through the advice of Mr. Danson and other enterprising individuals, the importations of it have within the last six years considerably increased. Mr. J. J. Hegan, of Liverpool, has been the largest importer, and it is believed that his house alone, since 1836, has imported 25,000 bales,* sold to the consumers at from 1s. 8d. to 2s. 6d. per lb. Other houses receive considerable quantities. One million lbs. arrived there in the course of February, 1841. During his tour in Scotland, Mr. Danson urged the expediency of introducing the alpaca into the Highlands, and pointed out the benefits which would accrue from this measure. In illustration of his views he exhibited samples of the wool, and specimens of articles manufactured in England from it, imitating silk, some as black as jet, although of the natural colour, and without the aid of dye. He very ably contended, that this wool would not enter into competition with that of our ordinary sheep, and, from the fineness and transparency of the filament, was peculiarly well adapted for the fine shawl trade of Paisley and Glasgow." Even these trials have been made under disadvantages, for the alpaca wool has only reached this country in a dirty and also in a mixed state, the wool of inferior breeds forming almost always a large proportion of the bales containing it.

The value of the wool being once determined, the next question is, Have we space and food for the alpaca in Britain? On this point, after some arguments in proof of his views, Mr. Walton reaches the following conclusions, which appear to be essentially correct:—"We therefore have, and must continue to have, large tracts, neither cropped with grain nor depastured by cattle, consisting of chains of barren hills, running in various directions through the United Kingdom, moors, heath, moss, lands, &c., wholly unproductive, the amount of which may be set down at from twelve to fourteen millions of acres. And would it not be highly expedient to stock these lands with another domestic animal, yielding a commodity of such a nature as to reward the farmer for his care, and besides triple in value by the beneficial application of labour—an animal requiring no additional subsistence for its support, and consequently not likely to interfere with any cattle already on our farms! Besides, if an improved race of domestic animals could be put even into our occupied lands, would it not be advisable to do so, even at the cost of diminishing in part the existing breeds?

Another material question is, Could the alpaca live in this country? "Although delicate in appearance, the alpaca is, perhaps, one of the hardiest animals of the creation. His abstinence has already been noticed. Nature has provided him with a thick skin and a warm fleece, and as he never perspires like the ordinary sheep, he is not so susceptible of cold. There is, therefore, no necessity to smear his coat with tar and butter, as the farmers are obliged to do with their flocks in Scotland—a process which, besides being troublesome and expensive, injures the wool, as it is no longer fit to make into white goods, nor will it take light and bright colours.

"'The Highland hills,' says the Ettrick Shepherd, 'are, for the most part, of a pyramidal form, very high, and commonly so steep and rugged, that to the eye of the traveller they have an appearance perfectly tremendous. The sides and banks of the glens and rivulets are commonly covered, or mixed, with a rich short grass, intermingled with numberless aromatic herbs and flowers. The extensive flats and sloping declivities around the bottom and lower parts are covered with a coarse mossy turf, interspersed with thin sapless heather, which has stood in the same squalid form since the time that it first made its appearance on the retreat of the universal deluge, mixed with some of the moss-stalks called ling and deer hair.' This is the description which so experienced a man as the Ettrick Shepherd gives of 'that vast range of stupendous mountains, deep glens, and trackless forests,' which (he says) 'at the first view every unprejudiced man must acknowledge nature never intended for the rearing of cattle,' and where no one (adds he) 'will hesitate whether sheep or goats are the most feasible stock.' What pen could have sketched a more faithful picture of the Andes mountains—those high and secluded regions, inaccessible to other animals, where the alpaca lives 'an inmate of the cloud and storm,' gathering subsistence from edible plants which otherwise would be left to wither on the land?" We are aware of only one doubtful circumstance as to the successful domestication of the alpaca in any of the British islands, particularly in the Highlands—this is the *humidity of our climate*. If the alpaca can resist damp as well as our South-downs, we shall have nothing to fear on the score of hardiness in other respects.

Mr. Walton alludes to the strong enamel on the alpaca's teeth, as fitting the creature peculiarly for rocky and mountainous pasturage. In the case of snow-storms, too, on our elevated ranges, by which so many of our common sheep are apt to be smothered every severe winter, the remarkable docility of the alpaca renders him almost secure, with little comparative toil to the herdsman. "Peruvian sheep have, in

* Each bale averages from 55 to 90 lbs.

fact, an unerring foresight of the coming danger, long before their tender (if they happen to have one) sees above him a threatening cloud or dreams of a drift. Instinctively they know the safest side of a crag, as if they saw the point of the compass from which the storm was approaching, and thus admonished collect their young, and fly to the *stell* which nature provided for them, even before the conflict of the elements and the roaming of the winds shall have commenced. If within reach, the alpaca asks protection at the cottage door where at other moments he had been welcomed." Again—"Another great advantage in the alpaca is, that he is not liable to the many diseases incidental to common sheep, and which have so often raged like a pestilence among the tenants of the Scotch hills. In Peru, where the circumstances are as near as possible alike, the llama and alpaca are not hurt by changes of diet incidental to the seasons. This may arise partly from their greater abstemiousness and discernment, and partly from their having a wider range, and consequently more choice of food. It is, however, a fact, which I have ascertained from natives, that the Peruvian breeds are not so liable to bowel complaints as ours, and their constitution being much stronger, they are consequently less affected by sudden transitions from one food to another. The distemper called pining, or daising, very usual in the west of Scotland, which occasions a thinness of blood, and when, though the animal continues to feed greedily, it pines away to a mere skeleton, is unknown on the Andes: neither are the fawns there liable to the many accidents which attend the feeding, herding, and folding of lambs among us. As regards vermin, they are much clearer." With respect to other diseases, though the alpaca is not exempt from some of them, its hardy constitution seems to render their influence less extended and destructive.

In reality, the experiment of keeping the alpaca in Great Britain has already been tried on a considerable scale, and the wool has been found to be even improved by the change of site. "The Earl of Derby, with that patriotic spirit and splendid taste which have distinguished him through a long life, also stepped forward among the first breeders, and his lordship has now at Knowsley a little flock of llamas and alpacas, amounting to fourteen, two of which were bred on the spot, whose wool is finer, softer, and more beautiful than that on the backs of their parents. The proof that the wool improves with our pasture is, in fact, established in this instance. The young are eight-and-twenty months old, and already the first has wool upon it six inches long. A fine male alpaca, shorn three years ago, has at present a coat upon it from eighteen to twenty inches long, thus proving that the wool grows from six to eight inches yearly, if regularly shorn. Speaking of the practicability of introducing the Peruvian sheep more generally, in a letter addressed to William Danson, Esq., of Liverpool, who, accompanied by a friend, visited Knowsley at the beginning of the current month, [April, 1841,] his lordship says that 'he certainly knows of nothing likely to prevent the propagation of the animal in this country. On the contrary,' he adds, 'the gentlemen will see in these grounds living specimens that they can and will do so, one female having produced in each of the two last seasons, and the young are doing well.' His lordship then expresses his anxious desire 'to obtain the remainder of the species, more especially the vicuna.' Already does this interesting animal adorn the pleasure-grounds of the Marquis of Breadalbane, at Aberfeldy, Perthshire; J. J. Hegan, Esq., Harrow Hall, Cheshire; Charles Tayleure, Esq., near Liverpool: Mr. Stephenson of Oban, and others. The Duke of Montrose has lately become a purchaser of alpacas; and Earl Fitzwilliam has also bought a llama at £80. Various isolated trials in other countries have proved equally successful." Messrs. Ducrow, Wombwell, and other proprietors of menageries, have also kept specimens of Peruvian sheep, which have been at once wonderful for docility, and have lived healthily upon the usual food procurable for animals in Great Britain.

From the tone in which this notice has been drawn up, it may be observed that the statements before us have been convincing in our eyes, in so far, at least, as regards the propriety of making fair and full experiments on the subject of the alpaca. This animal, we conceive, without infringing materially on the keeping of sheep, might prove the means of enlarging the profession of the pastoral farmer, and of varying, extending and improving our manufactures. From the alpaca wool which we do procure at present, yarn is spun, which the French import at from 6s. to 12s. per lb. In conclusion we give a few additional words from Mr. Walton. "When we consider the great improvement which we have attained in sheep's wool, there is every reason to look for a similar success in that of the alpaca; and in devising means to increase the productive power of the country, we ought never to forget, that there have been periods in our history when we were dependent upon foreign supplies for the raw material required for our woollen manufactures, and that the best way to be independent, is not to be under the necessity of buying that which it is in our own power to grow. The task of obtaining suitable breeds of the alpaca is by no means a difficult one; and in our attempts to naturalize them, we ought to feel the more encouraged, when we reflect on the recent changes in the growth and supplies of sheep's wool, and how soon a farming stock propagates under judicious management. It must be equally borne in mind, that in using alpaca wool we are not competing with that of our own sheep, but rather with that of the Angora goat (mohair) and silk; and the manufacture, it has been ascertained, does not cost half so much as that of the latter."

One other point calls for notice. Our present breeds of sheep are of essential importance as food to man. The flesh of the alpaca is spoken of as excellent by Acosta, Garcilasso de la Vega, and other writers on Peru. Of the various breeds of sheep on the Andes, "the alpaca (says Garcilasso de la Vega) is chiefly valued for its flesh." General O'Brien, an Irish gentleman in the Peruvian service, speaks of the flesh as "delicious," and likely also to improve much on the animal being placed on milder pastures than those of the Peruvian mountains. The flavour resembles that of venison, and, from all accounts, could not fail to command as fair a price in our markets as mutton, beef, or any other kind of meat.

PIGS, GOATS, RABBITS, POULTRY, CAGE BIRDS, &c.

PIGS.

As a source of sustenance and emolument to the humbler classes of society, the pig is only second in importance to the cow, and in many instances is found to be more available and useful than that animal. As an object of natural history, it is placed amongst the *Pachydermata* or thick-skinned order of the Mammalia, the hog, wild boar, and probably also the peccary of South America, being varieties of the same family. The most remarkable characteristic of the common pig is its long roundish snout, given for the purpose of grubbing in the earth for roots and other kinds of food; the feet are cloven, and each possesses four toes; the body is thinly covered with bristles, and the female is provided with from twelve to sixteen teats. The jaws of the pig are powerful, and the teeth with which they are furnished are very formidable, particularly in the wild varieties. Swine do not ruminate, and from this and other peculiarities, they can feed either on vegetable or animal substances, and thus form a kind of link between the herbivorous and carnivorous class of animals.

The particular breeds of pigs most esteemed in Great Britain are the Berkshire and Chinese breeds. These are also the breeds best marked by distinctive features; though, by crossings, and peculiarities of feeding and position, varieties, differing in a slight degree from one another, have been raised up in almost every county in England. The Berkshire breed, the parent stock of most of them, are marked by bodies of a reddish-brown tint, with black spots, large pendant ears, short legs, and small bones. This species of hog fattens to an enormous weight under good management, some having been killed which amounted to upwards of twelve hundredweight. The Chinese breed vary in colour from white to black, and from a piebald to a sandy hue. They are neat in form, comparatively speaking, and yield excellent flesh. They are usually not very large in size, but vary in this respect, and, of course, in weight also. The gigantic white and black breed of Cheshire, the white pigs of Suffolk and Hampshire, and the piebald hogs of Sussex and Shropshire, may be mentioned as the best known among the district-breeds of England. They are coarser, generally speaking, than the Berkshire and Chinese varieties. Both of these have been pretty extensively introduced into Scotland, where a less valuable white breed appears to have been earlier located, if not indigenous. There is also a small gray pig, apparently aboriginal, which feeds in herds on the natural pasture of the Highland hills, and furnishes very sweet flesh. By artificial feeding, it can be raised to a considerable bulk. But the breed most commonly esteemed both in England and Scotland, is a mixture of the Chinese dark-coloured swine with the Berkshire, or some of the large varieties of British swine. This cross possesses many good qualities, and is peculiarly prolific. Either belonging or allied to the Berkshire variety, is the Hampshire *hock*, a small black pig suitable for cottagers, for it is easily fed and fattened, and is therefore highly esteemed.

Littering.—The sow is very prolific, compared with other large-sized quadrupeds. She commences breeding at about twelve months old, and generally brings forth twice a year, her period of gestation being sixteen weeks. The number of young varies considerably; it is frequently below ten, and occasionally rises to twenty. The young pig is exceedingly delicate; and the brood-sow should not be allowed to furrow in winter, but in spring and autumn, when the weather is less severe and food more abundant. Another peril to the litter arises from the semi-carnivorous habits of the mother, which lead her to forget the dues of nature, and devour her own brood. She ought therefore to be well watched, and fed abundantly at such periods. The male, for the same reason, must be excluded altogether. Not unfrequently, moreover, the young are crushed to death by the mother, in consequence of their nestling unseen below the straw. To prevent this risk, a small quantity only of straw, dry and short, should be placed below them. The young are weaned when six weeks old; and after weaning, it is essentially necessary to feed the young with meal and milk, or meal and water.

The brood-sow ought to have an ample abdomen, and ought to be in good condition when breeding, otherwise little good can be expected of her progeny. Many persons labour under the mistaken notion that swine while breeding, should be kept lean; but nothing can be more erroneous; for, after farrowing, great part of those juices which would be converted into milk, were she in good condition, will naturally go towards nourishing her system. When required for the purpose of fattening, the male young pigs are cut, and the females spayed, which is an analogous process. These operations should be intrusted to a farrier or other skilled person.

Pig-houses.—Although swine are found to succeed in all countries, and their constitutions have been accommodated to every climate, yet they are found to degenerate and thrive ill either in the extremes of heat or cold. In a native state we find them, when inhabiting countries towards either extreme, seeking situations most adapted to their constitution. Swine, in a domesticated state, require to be kept very dry and warm, otherwise they will never thrive. It will be noticed that in cold weather they invariably bury themselves among the straw and litter with which they are supplied as bedding, thus pointing out their natural desire for heat. The piggery should therefore be in some well-sheltered spot, and, if possible, with a south or west exposure. If kept in small styes, there should be a small aperture at each end of them, so as to admit the free passage of air through them for ventilation. These may be kept open constantly during the summer months, but only allowed to be open for air once every second day in winter, and that in the forenoon, while they must be carefully shut up in the evening. Pigs will be found to grow notwithstanding the neglect of all these precautions; but we know, from experience, that they will grow much faster and will be more healthy with them.

In most cases pigs are kept in a shamefully filthy condition; their stye ill ventilated, the straw dirty, their small court-yard no better than a wet dunghill, and consequently the skin of the animal begrimed with scurf and all sorts of impurities. We cannot too strongly reprehend this infamous treatment of the pig, which is not naturally dirty, as some suppose, but loves to be kept dry and clean, as well as warm, as any one may observe by the delight it evidently takes in having its hide scratched and scrubbed. Let us, then, beseech all pig-keepers under whose eye this sheet may come, to preserve the stye in the most dry and clean condition possible, to change the straw frequently, and to curry the skin of the pig at least once a week. By doing so, without a particle of additional food, the animal will thrive and fatten in a very superior degree, while the flesh will be more pure and delicate. So true is this, that any man who keeps his pig dirty, may be said to be picking his own pocket, as he will realize less money for its carcass than if he had taken a little trouble to clean it.

To insure comfort to the pig or pigs, let the stye consist of at least two compartments—a sleeping apartment and an open court-yard, the one opening into the other. The sleeping apartment should be well-built and slated, for the sake of dryness, and the floor, formed of strong planks, should slope outwards to the door. The outer court should be paved in a substantial manner with large flag-stones, sloping also in a particular direction, to which the liquid refuse can flow into a gutter. It is advantageous for the erection to be near the dunghill, to which all liquid may run, and solid materials be carried without loss. Keep plenty of straw both in the pig-house and its court, in order to absorb moisture or dung, and let all be raked out regularly, and renewed. The money lost by allowing the dung to go to waste by mere evaporation—flying off into the atmosphere—no one can calculate. The open court of the pig-house should, if possible, lie to the sun, as the inmates are fond of basking in his beams. The feeding utensils placed in the court should consist of two strong troughs, which cannot be easily knocked over. These should be daily washed and scoured to keep them sweet.

Feeding.—In rural situations, where extensive woods exist, and where the grass is otherwise of no value, the feeding and breeding of pigs will be found very profitable to the cottager; for, where they have a wide range, they will require little food save what they find for themselves in grazing under the trees, and in digging for worms and roots of various kinds—for which latter task their long and strong snouts peculiarly fit them. Artificial feeding is only resorted to in winter, and when the pigs are to be fattened for the market or table. It is more common, however, for the cottager to keep one or two pigs entirely within a stye, to add to the means of subsistence of his own family; and even when kept with this limited view, the pig is a creature of no little consequence. As Cobbett acutely and pithily observes—"The sight of a flitch or two of bacon on the rack, tends more to keep a poor man from poaching and stealing, than whole volumes of penal statutes. They are great softeners of the temper, and promoters of domestic harmony."

When a young pig is to be purchased for feeding and killing, it is advisable to buy one which will be about sixteen months old at Christmas, that, or some time in January being the preferable period of slaughtering the animal. Unless for delicate pork, it should not be killed less than a year old. During the summer, the pig may be fed on any refuse from the kitchen or garden, including turnip and potato parings, table-waste, cabbage blades, &c.; but if barley-dust, or grains from a distillery, can be economically procured, either forms a good article of diet. Let it be kept in remembrance that the finer the feeding the finer will be the pork. The food should at all events be of a vegetable kind, or principally so; nothing beyond slops from the table being to be tolerated in the shape of animal food. Whatever be given, let it be offered in small quantities and frequently, it being a matter of importance never to allow the pig to become violently hungry. The half-starving system of feeding is poor policy, and is repaid by a lank poor carcass scarcely worth killing.

Farmers possess great advantages for feeding pigs. The straw-yard of itself affords continual support to them; and many pigs reach the age of one year without having received any food but what they themselves have gathered, yet are in good condition. What with the sweepings of the barn, and the straw, turnips, and clover, lying about a steading, with the refuse of the kitchen, a farmer, it has been calculated, may sustain swine in the proportion of one to every seven or eight acres of land under crop, without being conscious of the consumption made by them. In few instances are swine reared in such numbers as to have crops specially laid out for them, though some writers assert, that they would yield, in such a case, greater profits than other live-stock habitually reared in the same way.

About the month of September, the process of fattening pigs should commence, whether they be designed for pork or bacon. If for pork, the fattening need not be carried to the same extent. In either case a nourishing diet must be given, the only precaution being not to commence feeding too rapidly, otherwise surfeit may be produced. The best materials for feeding are barley and peas-meal; and if milk, either skimmed or churned, can be given at the same time, it will greatly facilitate the feeding, and improve the quality of the flesh. Many persons feed their pigs on potatoes, but in that case the flesh is not so solid and good, and the fat is somewhat loose and flabby. Soft meat may do very well for pigs when they are growing, but it is not the food which should be given when they are fed for killing. Those who feed pigs for their own use, generally give them a feed or two of corn daily for fourteen days before they are killed, and give them nothing else but churned or skimmed milk to drink; and for a day before killing the pig should not get any food. Where people's circumstances will not permit any of the modes of feeding for killing which we have above pointed out, boiled potatoes, mixed with a handful or two of oatmeal, may be resorted to as a substitute. It is undeniable, notwithstanding what has been said above, that the Irish peasantry produce excellent pork by feeding their pigs almost entirely on potatoes. It is not so fat as the pork produced from peas and barley, but it is on that account the better suited to stomachs unaccustomed to very strong food. When the time arrives for slaughtering, let it be done in a humane and neat style by a butcher, so as to avoid all mangling or injury to the flesh.

Pork.—The carcass of a pig is less frequently consumed as fresh than as salted pork, and the preparation of the salted article for home consumption or exportation forms a large and flourishing business. Those who pursue the occupation cut the carcass in pieces, and pack it in kits formed to hold from one to two hundred pounds, weight. A brine is then made by dissolving salt in water, until the mixture is so thick that an egg will swim in it. This is boiled, and poured upon the pork after it has cooled. Russian pork, always much esteemed, is steeped in a brine containing 2 lbs. of loaf sugar, and 3 oz. of saltpetre, to 6 lbs. of salt, the whole being boiled in six gallons of water. After brine is added to pork in kits, the end of the receptacle is fixed in, and the article is usually sufficiently cured in a few days. Four days are enough for small pork. People who pickle pork for private use must take care that the brine covers the meat, otherwise it will require to be turned daily. The same pickle may be several times used, if reboiled, and slightly strengthened anew.

Brawn.—Boars are also fattened for the purpose of procuring an article for the table called *brawn.* Male pigs of all ages are put into feeding with this view, but those experienced in such matters prefer them of the age of two years. They are kept separately, in pens which will not permit of their turning round, perfect inactivity being held to conduce to their fattening. Their food is beans, with water, into which a small quantity of sulphur has been put. The collar of the animal is the part prepared for brawn, by the processes of pickling and drying. A large collar will weigh about thirty pounds, and is valued at about £3 in the market. The lean parts of the animal are commonly used for sausage-meat.

Hams are the cured hind-legs of the pig, and are considered the finest parts of the animal. The following are general directions for curing them:—In the first place, the legs require to be cut in a neat rounded form, and it is usual to prepare a number at a time. Being properly prepared, pack them with rock-salt in a suitable tub or cask, being careful not to lay the flat sides of the large pieces upon each other, and filling the intervals with hocks, jowls, &c. To every 300 lbs. of meat, then take 20 lbs. of rock-salt, or Onondago coarse salt, 1 lb. of saltpetre, and 14 lbs. of brown sugar, or half a gallon of good molasses, and as much water (pure spring water is the best) as will cover the meat; put the whole in a clean vessel; boil and scum; then set it aside to cool, and pour it on the meat till the whole is covered some three or four inches. Hams weighing from 12 to 15 lbs. must lie in the pickle about five weeks; from 15 to 25 lbs., six weeks; from 25 to 45 lbs., seven weeks. On taking them out, soak them in cold water two or three hours, to remove the surface salt, then wipe and dry them. It is a good plan in cutting up, to take off feet and hocks with a saw instead of an axe, as it leaves a smooth surface, and no fractures for the lodgment of the fly. Some make only six pieces of a trimmed hog for salting, but it is more convenient, when intended for domestic use, to have the side pork, as it is called, cut in small pieces. The goodness of hams and shoulders, and their preservation, depend greatly on their smoking, as well as salting. The requisites of a smoke-house are, that it should be perfectly dry; not warmed by the fire that makes the smoke; so far from the fire, that any vapour thrown off in the smoke may be condensed before reaching the meat; so close, as to exclude all flies, mice, &c., and yet capable of ventilation and escape of smoke. The Westphalian hams are the most celebrated in Europe, and are principally cured at and exported from Hamburg. The smoking of these is performed in extensive chambers in the upper stories of high buildings, some of four or five stories; and the smoke is conveyed to these rooms from fires in the cellar, through tubes on which the vapour is condensed and heat absorbed, so that the smoke is both dry and cool when it comes in contact with the meat. They are thus perfectly dry, and acquire a colour and flavour unknown to those smoked by the common method. Hams, after being smoked, may be kept any length of time by being packed in any dry dust, which will keep them from the air. Bran is usually employed for this purpose. When fully smoked and dried, the meat may be hung up in a dry airy room; and if liable to be attacked by the bacon-fly, or other insects, draw over it a loose cotton bag, tied closely with a string. The small part of a ham should always be hung downwards in the process of smoking, or when suspended for preservation.

Bacon is the whole side of a pig cured. The method of preparation is as follows:—After being killed, the carcass should not be scalded to remove the bristles, as in the case of pork, but singed off by being covered lightly with straw, to which fire is applied. When the burning straw has cleared one side, the other side may be cleared in the like manner. By this means all the hair is to be singed clean off, but without scorching the flesh, and then the skin is to be well scraped as a finish. This singeing process gives a fine firmness to the bacon, which scalded bacon never possesses. In Hampshire, as Mr. Cobbett informs us in his "Cottage Economy," the plan of singeing is universally followed; and pig-keepers could not have a better example. The next steps in the process are related as follows by this writer:—"The inwards are next taken out, and if the wife be not a slattern, here, in the mere offal, in the mere garbage, there is food, and delicate food too, for a large family for a week, and hog's pudding's for the children. The butcher the next day cuts the hog up, and then the house is filled with meat; souse, griskins, blade-bones, thigh-bones, spare-ribs, chines, belly-pieces, cheeks, all coming into use one after the other, and the last of the latter not before the end of about four or five weeks. All the other parts taken away, the two sides that remain, and that are called *flitches*, are to be cured for bacon. They are first rubbed with salt on their insides, or flesh sides, then placed one on the other, the flesh sides uppermost, in a salting trough, which has a gutter round its edges to drain away the brine; for, to have sweet and fine bacon, the flitches must not lie sopping in brine, which gives it that sort of taste which barrel-pork and sea-junk have, and than which nothing is more villanous. Every one knows how different is the taste of fresh dry salt from that of salt in a dissolved state; the one is savoury, the other nauseous. Therefore change the salt often; once in four or five days. As to the time required for making the flitches sufficiently salt, it depends on circumstances—the thickness of the flitch, the state of the weather, the place wherein the salting is going on. It takes a longer time for a thick than for a thin flitch; it takes longer in dry than in damp weather; it takes longer in a dry than in a damp place. But for the flitches of a hog of twelve score, in weather not very dry nor very damp, about six weeks may do; and as yours is to be fat, which receives little injury from over-salting, give time enough, for you are to have bacon till Christmas comes again. The place for salting should, like a dairy, always be cool, but always admit a free circulation of air; confined air, though cool, will taint meat sooner than the mid-day sun accompanied with a breeze. The flitches of bacon are now to be smoked, for smoking is a great deal better than merely drying, as is the fashion in the dairy counties in the west of England. When there were plenty of *farm*-houses, there were plenty of places to smoke bacon in; since farmers have lived in gentlemen's houses, and the main part of the farm-houses have been knocked down, these places are not so plenty. However, there is scarcely any neighborhood without a chimney left to hang bacon up in. Two precautions are necessary: first, to hang the flitches where no rain comes down upon them; second, not to let them be so near the fire as to melt. These precautions taken, the next is, that the smoke must proceed from *wood*, not turf, peat or coal. Stubble or litter might do, but the trouble would be great. Fir or deal smoke is not fit for the purpose. I take it, that the absence of wood, as fuel, in the dairy countries and in the north, has led to the making of pork and dried bacon. As to the time that it requires to smoke a flitch, it must depend a good deal upon whether there be a constant fire beneath, and whether the fire be large or small. A month may do, if the fire be pretty constant, and such as a farm-house fire usually is; but over-smoking, or rather too long hanging in the air, makes the bacon rust. Great attention should therefore be paid to this matter. The flitch ought not to be dried up to the hardness of a board, and yet it ought to be perfectly dry. Before you hang it up, lay it on the floor, scatter the flesh-side pretty thickly over with bran, or with some fine saw-dust other than that of deal or fir. Rub it on the flesh, or pat it well down upon it. This keeps the smoke from getting into the little openings, and makes a sort of crust to be dried on, and, in short, keeps the flesh cleaner than it would otherwise

&c." Other writers recommend plans slightly differing from the preceding, but the English, unquestionably, are most skilled in the mode of preparing superior bacon; and whatever other characteristics were displayed by the author quoted, he at least knew thoroughly all the processes incidental to farm management in his native land.

Lard is that part of the fat of the hog which easily melts, and forms a soft grease. The saving of this material is of great importance, for it may be put to many uses in household economy. Martin Doyle, in his "Cyclopædia of Agriculture," makes the following observations on this subject:—"The lard should be of *two* qualities; the finest and whitest (that taken from the sides) should be chopped into small pieces in a pan, over a slow fire, and kept constantly stirred, lest it should stick to the sides of the boiler; then strained and put into bladders, turned inside out, and thoroughly purified, by having all the fat cut out, and being well blown, and perfectly dried in the open air; when the wind is pressed out, they are to be put into a little salt pickle for a few days, then washed in lukewarm water, after which they may be turned by means of a stick. That of the first quality, when well made, is far better than any salt butter for cookery, and, from the delicacy of its colour, is used by confectioners for the finest kinds of cake and pastry. The inferior lard is obtained from the *intestines*, and is treated as the fine lard in every particular. The feet, when taken off, are chopped in two or three places, and put into brine, in which they may be kept until required."

The same author continues—"Both the hair and bristles are serviceable for brush-makers' and cabinet-makers' purposes. No part of the pig is useless; even the intestines are converted into an inferior kind of lard, by being cut open and washed clean, and (after the water is well pressed out of them) melted in the same way as lard; this substance is very useful for making candles, greasing wheels, and such purposes."

GOATS.

Goats form one of the families of the *Ruminant* order of Mammalia. The common domesticated goat is usually about the size of the sheep, though less round in form, and is marked by keen eyes, long hair, and generally bent horns; the males, called familiarly in England *billies*, have a long beard; but the females, or *nannies*, are seldom provided with that appendage. Whether in a state of nature or tamed, the goat is remarkably swift and agile, and will browse fearlessly on the most rugged precipices. We find, from ancient writers, that goats have long formed part of the stock of mountain-herdsmen, and were tended with even greater care in former than in present days. In many respects, indeed, the animal is valuable. Its skin is convertible to several useful purposes, and the flesh of the full-grown goat is good, though scarcely equal in quality to that of the sheep. But it is for the milk, chiefly, that the goat is prized, the qualities of that secretion being not only very nutritious but even medicinal. Where cottagers have not the means of keeping a cow, a goat will be found a very useful animal, being easily fed, and contented with grasses which are rejected by the cow and the sheep. To those peasants who live in the neighbourhood of mountainous countries, the trouble and expense of keeping a couple of goats will be nothing, as they will find sufficient nourishment in the most heathy, rough, or barren grounds. Heaths, also, which are unfit for any kind of pasture, will afford this animal an ample supply of food; and it requires no care or attention, easily providing for itself proper and sufficient food. In some countries, goats render considerable service to mankind, the flesh of the old ones being salted as winter provision, and the milk is used in many places for the making of cheese. The flesh of the kid is highly palatable, being equal if not superior in flavour to the most delicate lamb.

In Britain, the goat produces generally two young at a time, sometimes three, rarely four. In warmer climates it is more prolific, and produces four or five at once though the breed is found to degenerate. The time of gestation is five months. The male is capable of propagating at one year old, and the female at seven months, but the fruits of a generation so premature are generally weak and defective; their best time is at the age of two years, or eighteen months at soonest. A goat is old at six years, although its life sometimes extends to fifteen.

If goats are properly trained, they will return to their owners twice a day to be milked, and prefer sleeping under a roof when accustomed to it. The milk of the goat is sweet, and not so apt to curdle upon the stomach as that of the cow; it is therefore preferable for those whose digestion is but weak. The peculiarity of this animal's food gives the milk a flavour different from that of either the cow or the sheep; for, as it generally feeds upon shrubby pastures and heathy mountains, there is a savoury mildness in the taste, very pleasing to such as are fond of that aliment. The quantity of milk produced daily by a goat is from three half pints to a quart, which yields rich and excellent cream. If properly attended to, a goat will yield milk for eleven months in the year. In several parts of Switzerland and the Highlands of Scotland, the goat is the chief possession of the inhabitants. On those mountains where no other useful animal could find subsistence, the goat contrives to glean sufficient living, and supplies the hardy natives with what they consider a varied luxury. They lie upon beds made of their skins, which are soft, clean, and wholesome; they live upon their milk, with oat-bread; they convert part of it into butter, and some into cheese; and the flesh furnishes an excellent food, if killed in the proper season, and salted. They are fattened in the same manner as sheep: but taking every precaution, the flesh is never so good or so sweet in our climate as that of mutton. It is otherwise between the tropics. The sheep there becomes flabby and lean, while the flesh of the goat rather seems to improve, and in some places is cultivated in preference to that of the sheep. The cream of goat's milk coagulates as easily as that of cow's, and yields a larger proportion of curd. The cheese is of an excellent quality, and high flavoured; and although, to appearance, it looks poor, it has a very delicate relish, and strongly resembles Parmesan cheese. Some farmers have been in the practice of adding a little goat's milk to that of cow's, which materially improves the flavour. In winter, when native food becomes scarce, the goat will feed upon turnip-peelings, potato-peelings, cabbage-leaves, and other refuse of a house. In addition to the other products yielded by the goat, its tallow, we should mention, is also an article of some importance. It is much purer and finer than that of sheep, and brings a high price, being calculated to make candles of a very superior quality.

Cobbett advocates the keeping of a goat by cottagers. "There is one great inconvenience belonging to goats, that is, they bark all young trees that they come near; so that if they get into a garden, they destroy every thing. But there are seldom trees on commons except such as are too large to be injured by goats; and I can see no reason against keeping a goat where a cow cannot be kept. Nothing is so hardy; nothing is so little nice as to its food. Goats will pick peelings out of the kennel and eat them. They will eat mouldy bread or biscuit, fusty hay, and almost rotten straw, furze-bushes, heath thistles; and, indeed, what will they not eat, when they will make a hearty meal on *paper*, brown or white, printed on or not printed on, and give milk all the while! They will lie in any dog-hole. They do very well clogged, or stumped out. And then they are very healthy things into the bargain, however closely they may be confined. When sea-voyages are so stormy as to kill geese, ducks, fowls, and almost pigs, the goats are well and lively; and when a dog of no kind can keep the deck for a minute, a goat will skip about upon it as bold as brass."

In Britain, no attempts have been made, at least successfully, to introduce foreign breeds of goats, though in France this has been done to a considerable extent. The Cashmere goat, famous for its long silky hair, or wool, has been brought to the country mentioned, and there bred with the Thibet goat, a hardier species, but almost equally esteemed for its wool. The manufactures producible from this material, as the Cashmere shawls have long testified, are scarcely to be surpassed for fineness, and yield immense prices. It is probable that, in our warmest districts, a cross of these foreign goats with the common breed might be successfully and advantageously effected.

RABBITS.

Rabbits belong to the family of *Leporidæ*, members of the *Rodentia* or Gnawing Order of animals. Their form and appearance are too well known to require any general description. In a wild state, rabbits live in holes in the earth; and where the proprietor permits of their accumulation for sport, they collect in great numbers, undermining with their burrows whole plains or tracts of land, and forming what are called *warrens*. Their amazing fecundity renders the keeping of a few of them in a tame state an object of some consequence in cottage economy. The rabbit breeds seven times in the year, and generally produces eight young at a time. At the age of five months, the animal begins to breed; and, taking an estimate perfectly within bounds, it is supposed that a pair of wild rabbits, which breed no oftener than seven times in a year, would multiply in the course of four years to the amazing amount of a *million and a quarter*, if the young were preserved. But many of them die, being injured by the cold and damp, or devoured by the male, or *buck*.

Experienced rabbit-breeders conceive too frequent breeding to be injurious; but even when proper rules are observed in this respect, three domesticated females (*does*) and a buck will give a family a rabbit for dinner at least twice a week. This is a matter of some consequence. By keeping a few of these pretty little creatures, which wild vegetables will almost entirely supply with food, the poor man may derive ten times the benefit to be gained by violating the laws, and poaching on the game-preserves of his rich neighbours. A stock of rabbits is easily set a-going; they may usually be bought under one shilling, and sometimes even at twopence a pair. It is of importance, in making such a purchase, to attend to the kinds which furnish the best food.

The short-legged stout rabbits are generally supposed to be the most healthy, and also the best breeders. The large hare-coloured variety is much esteemed by some people; but the white, or white mottled with black or yellow, are more delicate in flesh. The gray, and some of the blacks, approach nearer to the flavour of the wild rabbit than any others. With respect to the colours of these animals, gray is considered the worst of all colours; black is the next in gradation; fawn, and white, and gray, hold the third place in estimation; pure white, with red eyes, is by some reckoned equal with, and by others superior to, these; tortoise-shell (a rich brown and white, and brown, gray, and white), and black and white, rank the highest; mouse-colour, though little noticed by fanciers in general, is much admired by a few.

The most important part of the duty of the rabbit fancier is to erect his rabbit-house or hutch on proper principles. Two objects are particularly necessary to be attended to. The house or rabbitry must be kept always dry and well aired; because the rabbit, in its natural state, prefers a dry and airy habitation. Rabbits are sometimes placed in boxes, but whether kept in these or in regularly erected houses, the place must be kept quite dry, as too much humidity will cause the rabbits to rot. Where considerable numbers are together, fresh air is of great moment; still they should not be exposed to draughts, which may bring on a disease called the snuffles—a dangerous and frequently fatal malady.

Persons who live in large towns will in general find considerable difficulty in keeping rabbits, as it is seldom they have open grounds behind their houses wherein they might construct their rabbitry. In cases of this nature, rabbits might be kept on a small scale, in wooden hutches, open in front, with spokes like a cage, and having a division to separate the sleeping apartment from the feeding-place, and a small door betwixt the one place and the other. But it will be found, on trial, that rabbits do not thrive well when put in cages, or confined in this manner. The genuine rabbitry must be a small house constructed on purpose, where the animals will have liberty to feed and amuse themselves. These houses may be built about four feet square, and the same in height, with a sloping roof, covered with thatch, or some other substance that will carry off the rain. This house ought to be paved on the floor, so as to prevent the rabbits from burrowing, and undermining the walls. It should be well laid with dry straw or meadow-hay, and possess several boxes with the open side downwards, and holes for the rabbits to go in and out. It would also be as well for these holes to be provided with doors, which you could shut when necessary. To this house there ought to be attached a little open court, also paved, and covered completely with open spokes, so as to give air and light, as well as to afford you an opportunity of seeing the creatures feeding.

On the subject of feeding rabbits, the following extract may be offered from "The Boys' Own Book"—a pleasing work addressed to the young:—

"If too much food be given at once, the animals will get disgusted with and refuse it, so that a rabbit may be nearly starved by affording it too great a quantity of food. Most persons feed their rabbits twice, but for our own part we feed ours thrice a day. To a full-grown doe, without a litter, in the morning we give a little hay or dry clover, and a few such vegetables as are in season; in the afternoon we put two handfuls of good corn into her trough; and at night we give her a boiled potato or two, more vegetables, and, if her hutch be clear of what we gave her in the morning, but by no means otherwise, a little more hay or clover. If you give rabbits more hay than they can eat in a few hours, except it be a doe just about to litter, they will tread it under foot, and waste it; if you give them but a moderate quantity at a time, they will eat and enjoy it. Generally speaking, rabbits prefer green or moist food to corn; but it is necessary to make them eat a sufficient proportion of solid food, to keep them in health; occasionally, instead of corn, we give our rabbits a few split or whole gray peas. When a doe has a litter by her side, and also for rabbits recently weaned, we soak the peas a few hours previously to putting them in the trough. If a rabbit will not eat a proper quantity of corn, we mix a small quantity of squeezed tea-leaves with her portion, and stint her proportionately in green meat. Tea-leaves, in small quantities, well squeezed, may at all times be given, by way of a treat; but it is highly improper to make them a daily substitute for green meat.

"Almost all the vegetables and roots used for the table may be given to rabbits; in preference to all others, we choose celery, parsley, and the roots and tops of carrots and in this choice the animals themselves heartily agree with us; lettuces, the leaves, and, what are much better, the stumps of cabbages and cauliflowers, they eat with avidity, but they must be given to them with a sparing hand; turnips, parsnips, and even potatoes in a raw state, we occasionally afford our stock, on an emergency, when better roots or good greens are scarce. In the spring time, no soft meat is better for them than tares, so that they be not wet; in fact, no green meat ought to be given to rabbits when there is much moisture on its surface. We have heard of some country persons feeding their rabbits on marsh-mallows, but we never did so ourselves. Dandelions, milk-thistles, or sow-thistles, we know, by long experience, they take in preference to all other food, except celery, parsley, and carrots; and nothing, as green meat, we are convinced, can be better for them.

"It must be remembered, that a doe will eat nearly twice as much when suckling as at other times; and when her litter begins to eat, the allowance of food must be gradually increased. In our own rabbitry, we never admit chaff, and grains only in a dearth of green food. If we can obtain neither greens, roots, nor grains, at feeding-time, we make it a practice to moisten the corn with water, milk, or, as we before stated, with tea-leaves. Though a rabbit must be restricted from rioting in green or soft meat according to its own appetite, for its own sake, yet it is cruel to afford it only such food as will increase rather than appease its thirst; for this reason, in such a case as we have mentioned, we moisten the grain; and some rabbits will even do well with an occasional table-spoonful of water, beer, or milk; but it is a dangerous experiment to try the effect of a liquid on their stomachs.

"If well fed, and kept warm, does will breed all the year; but most fanciers are contented with five litters a year, and let them rest during the winter. It is a disadvantage, rather than otherwise, to have above six produced in a litter, as the young rabbits, when that is the case, are almost invariably weak and puny; and even if they be reduced to a moderate quantity, by removing some of them to another doe, or otherwise, they rarely become remarkable for their size or beauty.

"Diseases may in a great measure be prevented by regularity in feeding, good food, and cleanliness. The refuse of vegetables should always be scrupulously rejected. For the liver complaint, to which rabbits are subject, there is no cure; when they are attacked by it, fatten them, if possible, for the table. The snuffles are occasioned by damp or cold. If there be any cure for this disorder, it must be dryness in their hutches and food. Squeezed tea-leaves generally restore a doe to health, if weak, or otherwise affected after kindling. [A little bread moistened with warm milk may also be advantageously given to a doe at this critical period.] When old rabbits are attacked by a looseness, dry food will in general restore them; but do what you will, it is very difficult, and in most cases impossible, to save young ones from sinking under it; dry food for them, as well as for the old ones, is the only remedy.

"Be careful (continues this author) to keep your rabbit-hutches particularly clean; a short hoe, or a trowel, and a hand-brush, will be necessary for this purpose. Do not handle your rabbits, particularly the young ones, too much; when you lift them, take them with one hand by the ears, and place the other under the lower part of their backs."

When rabbits are to be used as food, it is commonly deemed beneficial to feed them for a short time on hay, and afterwards on shellings and oats, when the flesh will grow very delicate in flavour. As an example of the ordinary extent to which rabbits may be made productive, with common care, the case of a labouring man in the country may be mentioned, who, in a small wooden house enclosed by a railing, fed a batch of rabbits, and killed annually about twenty dozen, still maintaining his stock unbroken. What with the skins, flesh, and sales of young, he turned the animals to great account, yet he scarcely expended a penny upon them, and even trouble was entirely spared to him, when he had fairly put his children in the way of management.

GUINEA PIG.

This animal is misnamed when called a pig, being one variety of the Gnawing Animals (*Rodentia*), and technically termed the *cavia cobaya*. It comes from South America, and is smaller than the common rabbit, with a body of variegated colours—white, black, fawn, or a mixture of all three tints, being common characteristics. Some of them have deep red eyes, and the whole tribe are remarkable for the want of tails. They feed on grain, bread, or kitchen vegetables, showing a marked preference for parsley. They bring forth from four to twelve young at a time, and begin to breed at the age of two months, repeating the process of parturition so often that a thousand young might readily spring from a single pair in the year. But these little creatures are very tender, and many of them perish, soon after birth, through natural causes and accidents. Guinea pigs are of no use, their flesh being of a very inferior quality, but they form a pretty ornament to the court-yard. In their habits, they are extremely quick and restless, and spend much of their time in cleaning one another, having such a predilection for tidiness, that the mother will even take a permanent dislike to her young, if any of them chance to get dirtied. They are gentle in disposition, and seem so objectless in their habits, that Buffon compares them to living machines, calculated only to represent and perpetuate a species. It is believed they frighten away mice from a house, and are sometimes kept for that purpose.

POULTRY.

Poultry (from *poule*, French for hen) is a term applied to different kinds of large birds in a state of domestication, as the chicken or barn-door fowl, turkey, goose, pea-fowl, and guinea-fowl. The most numerous and important in every respect are those first mentioned.

Chickens.

The chicken is classed by naturalists in the tribe of the *Gallinaceæ*, forming part of the order *Rasores*, or Scraping-Birds. It is needless to describe minutely the appearance of the barn-door fowl. The most prominent characteristics of the cock, or male-bird, are a thin indented comb, with wattles on each side under the beak; a tail rising in an arch, and a great variegation of colours. The female, or hen, is smaller as regards body, comb, and wattles, and her tints are less vivid. The domestication of this bird seems to have taken place in the earliest times, and Persia is usually supposed to have been the place of its origin. Many varieties of it have been enumerated as existing in Britain; but the differences betwixt these, in the majority of cases, seem to lie as much in colour as in any more important features. The best marked kinds are the following:—The Dunghill Fowl, Game Fowl, Dorking Fowl, Poland Fowl, Spanish Fowl, and Bantam.

The first of these varieties is a mongrel one, arising from crosses with all the other breeds; but it is the common and most useful variety. The best fowls of this sort are of middle size and dark colour, and have white, clean legs; the pure white dunghill-fowls are held to be the weakest in constitution, and to lay fewest eggs. It has been usually agreed to call the game fowl the proper English fowl. The body is erect and slender, and the colours showy, particularly those of the cock. In comparison with other breeds, the game bird is like the race horse beside that which draws the cart and plough. The flesh, moreover, is peculiarly white and delicate in flavour, while, though small, the eggs are also of a very superior quality. There is a peculiarity of disposition, however, in this variety of the domestic fowl, which while for ages the source of a cruel species of sport, has always impaired the real utility of the creature to a very great degree. We allude to the pugnacious spirit which has gained for the fowl its peculiar name. So strongly-marked is this propensity, that broods scarcely feathered are found occasionally to have reduced themselves to utter blindness by reciprocal battling. Even when the breed is crossed and recrossed, a tincture of the love of fighting still remains, rendering such admixtures of species the source of risk and trouble, though in other respects very advantageous. Hence, game-cocks are bred on a large scale almost solely for the battles of the cock-pit. Where persons prefer to have a game-cock in their poultry yard, their choice, according to the best authorities, should be directed to birds of some one or other of the following colours:—dark-red, dark black-breasted red, dark gray, mealy gray, and red dun. The Dorking fowl is named from a town in Surrey, where it has long been bred in great numbers. It is a large bird, well-shaped, with a long capacious body, short legs, and five claws upon each foot instead of four. One spur characterizes other breeds of the common fowl, but the Dorking fowl has two spurs on each leg. These distinctive marks seem to be of old standing in peculiar breeds, as both Aristotle and Pliny mention five-toed fowls. Though, from repeated crossings, the Dorking fowls are now found of all colours, white or yellowish-white is supposed to have been the primitive and genuine tint. They lay large eggs, and in great plenty. The Poland (Polish or Paduan) fowl is much valued by breeders, but is seldom found perfectly pure in Britain. The species was imported principally from Holland, and when unmixed, was uniformly of a black colour, with a white crest or tuft on the heads of both cock and hen. Their form is plump and deep, and the legs of the best sorts not too long. They are called *everlasting* layers, from the number of eggs produced by them, and from their disinclination to sit and hatch, which office is usually done for their eggs by other hens. The Spanish fowl is of large size, and lays large eggs. It is of the Polish family, and is almost uniformly marked by a black body, black legs, and large red combs. In London and its vicinity, the breed is now extremely common, being valued for the size of the eggs; but it is supposed to be inferior in some respects to other breeds, though yielding good food. The bantam fowl is well known for its small size, and its feathered grotesque-looking limbs. It was originally a native of India, and the nankeen-coloured and black birds are the most esteemed. The bantam should have a rose-comb, a full tail, and a lively carriage, and should not weigh above one pound. It has been recently discovered that the characteristic of feathered legs is not an improvement, the birds with clean bright limbs being the best. The flesh of this breed of fowls is peculiarly delicate.

Besides these well-marked varieties of the common domestic fowl, there are a number of others brought from foreign countries, which have produced mixtures pretty familiar to breeders. The Turkish, Malay, Rumkin, Russian, and Barbary species, may be mentioned as the principal of these. It need only be observed here, that all the crested mixtures or varieties of fowls, are much esteemed, as possessing the best qualities of the race. All or any of these breeds of domestic fowls are valuable to the cottager, even one good laying hen being a treasure to an humble family.

Hen House.—The artificial assistance given by the cottager in housing the birds, is usually of the scantiest order. The upper part of the space at the door of the cottage, or the *baulks* (loft), is often the nightly roost of two or three hens, and the roadside is their daily walk. Yet, with the petty scraps of food furnished in addition to their own pickings there, these hens will lay good eggs, and produce fine birds. At farm-steadings, it is common for the hens to roost among the beams of the stables or cattle sheds, and to lay in holes formed by scraping away a portion of lime on the top of the side-walls. Very little pains might give to the humblest families much better and ampler accommodation for poultry. We quote on this subject the directions given in a little work by Mr. Peter Boswell of Greenlaw:—"Always in the building of a cottage, and sometimes even where there was no intention of the kind when it was built, very ample accommodation for poultry can be provided, almost without a shilling of additional expense. To this purpose a part of the space next the roof, so often unoccupied and useless, might easily be devoted. To accomplish the object, a part of it next the kitchen fire gable end should be partitioned off, floored, and fitted up with *baulks* and laying-places. This could be done either on a large or a small scale, according to the inclination or the means of the projector. An opening of sufficient width should be made in the wall, at the height of the lower ceiling, through which the fowls could be conducted, by means of a *hen-ladder*, to the enclosure prepared for them below. There must be a hatchway somewhere, to afford access for the purpose of inspection and cleaning. If the attics are sufficiently high, it may be placed anywhere, but evidently with greatest convenience in the passage of the house; but if they are low, the nearer it is to the space portioned off for the reception of the fowls the better. This is a location for poultry possessing many advantages. Having their berth immediately above the cottage kitchen, they are secured in a proper degree of dryness and warmth, which in winter, especially with the spring-hatched pullets, will tell well in the production of eggs. Perhaps this is the best hen-house locality for securing eggs in winter which can be suggested to the frugal and judicious. Besides, the fowls are here free from many dangers, and safe from many enemies, to which they are exposed in a lower and more open situation."

Another simple poultry-house of small size may be formed by building a shed against the gable of the house, opposite to the part warmed by the kitchen fire, and placing cross-bars in it for roosting, with boxes for laying in, or quantities of fresh straw. There should always be an opening to allow of the cleaning out, once a week at least, of the poultry-house—a process too often neglected, but very essential to the health of the poultry. They never will thrive long amid uncleanness; and even with the utmost care, a place where poultry have been long kept becomes what the housewives call tainted, and there they will thrive no longer. The surface of the ground becomes saturated with their exuviæ, and is therefore no longer healthy. To avoid this effect, some poulterers in the country frequently change the sites of their poultry-houses, to obtain fresh ground; and to guard against the same misfortune, farmers, who cannot change their hen-houses and yards, purify the houses by fumigations of blazing pitch, by washing with hot lime-water, and by strewing large quantities of pure sand both within and without the poultry-houses. Washing the floor of the house every week is necessary; for which purpose it is of advantage that it be paved either with stones, bricks, or tiles. But as these three modes are expensive, a good flooring, which is cheaper, may be formed by using a composition composed of lime and smithy ashes, together with the riddlings of common kitchen ashes; these having been all finely broken, must be mixed together with water, and put on the floor with a mason's trowel, and nicely smoothed on the surface. If this is put on a floor which is in a tolerably dry situation, and allowed to harden before being used, it will become nearly as solid and compact as stone, and is almost as durable. The inside of the laying-boxes requires frequent washing with hot lime-water, to free them from vermin, which greatly torment the sitting-hens. For the same purpose, poultry should always have a heap of dry sand or fine ashes laid under some covered place, or thick tree, near their yard, for them to dust themselves in; this being their resource for getting rid of the vermin with which they are annoyed.

The office of keeping and managing domestic fowls should be performed by some individual whom the hens know, as the voice and presence of a stranger scare the fowls, and disturb the operations of the hen-house. To distribute food and drink at regular hours, to visit the nests, to remove eggs as soon as laid, and carry them to a cool place, to examine by candle-light what eggs are fecundated, and place these under the hen, and mark the time, are among the daily duties to be performed by the keeper. When the hens lay in a secret place, the keeper may readily discover it by placing a few grains of salt in the oviduct, which hurries on the process of laying, and causes the hen to retire to the spot anew.

Feeding.—Most persons are doubtless aware that fowls swallow food without mastication. That process is rendered unnecessary by the provision of a *crop*, an organ which is somewhat similar to the first stomach of the cow, and in which the food from the gullet is macerated, and partly dissolved by secreted fluids. From the crop the food passes downwards into a second small cavity, where it is partly acted on by a digestive juice; and, finally, it is transferred to the gizzard, or last stomach which is furnished with muscular and cartilaginous linings of very great strength. In the gizzard the partially softened food is triturated, and converted into a thin paste, fit to be received into the chyle-gut, and finally absorbed into the circulation. Such is the power of the gizzard in almost all kinds of poultry, that hollow globes of glass are reduced in it to fine powder in a few hours. The most rough and jagged bodies do no injury to the coats of the gizzard. Spallanzani even introduced a ball of lead, with twelve strong needles so fixed in it that their points projected a fourth of an inch from the surface, and the result was, that all the needles, with the exception of one or two, were ground down in a short time to the surface of the ball, while those left were reduced to mere stumps. It is remarkable that, to add to the triturating powers of the gizzard, fowls are gifted with the instinct of swallowing stones with their food.

Fowls, when left to roam at large, pick up all sorts of seeds, grains, worms, larvæ of insects, or any other edible substances they can discover, either on the surface of the ground or by scraping. They also pick a little grass, as a stomachic. The more that hens can be allowed to run about and pick up their own food, the better for their own health and the pockets of their keeper. When secluded, and fed altogether in an artificial manner, their keep becomes expensive, and is, on the whole, seldom compensated by their produce. We have, indeed, great hesitation in advising any one to keep fowls who cannot unexpensively give them plenty of refuse from the table or kitchen, or permit them to range in a field or lane in quest of what seems proper for their natural appetite. The very pleasure of ranging and scraping seems advantageous to the animals.

If kept in a court-yard or pen, and requiring altogether artificial feeding, their natural tastes should be consulted as far as conveniently practicable. They should be fed regularly, and with a miscellaneous kind of diet; allowed at all times access to clean water for drinking, and have earth, sand or dust, to scrape at pleasure and roll themselves in. A certain quantity of chalk or lime should also be scattered about for them to pick up, as that material is required by them in the production of eggs. Speaking on this subject, Professor Gregory of Aberdeen, in a letter to a friend, published in a newspaper, observes—"As I suppose you keep poultry, I may tell you that it has been ascertained that, if you mix with their food a sufficient quantity of egg-shells, or chalk, which they eat greedily, they will lay, other things being equal, twice or thrice as many eggs as before. A well-fed fowl is disposed to lay a vast number of eggs, but cannot do so without the materials for the shells, however nourishing in other respects her food may be; indeed a fowl fed on food and water free from carbonate of lime, and not finding any in the soil, or in the shape of mortar, which they often eat off the walls, would lay no eggs at all, with the best will in the world."

In a state of domestication, the hard food of which fowls seem most fond are peas and barley (oats they do not like); and besides a proportion of these, they may be given crumbs of bread, lumps of boiled potatoes, not too cold, or any other refuse. They are much pleased to pick a bone; the pickings warm them, and excite their laying propensities. If they can be supplied with caterpillars, worms, and maggots, the same end will be served. Any species of animal food, however, should be administered sparingly; and the staple articles of diet must always be of a vegetable nature. When wanted for killing, the quantity of food may be increased and be more substantial; they should also be kept more within the coop. A fortnight's feeding in this way will bring a fowl of a good breed up to a plump condition.

Laying.—The ordinary productiveness of the hen is truly astonishing, as it usually lays, in the course of a year, two hundred eggs, provided it be allowed to go at liberty, is well fed, and has a plentiful supply of water. Many instances have been known of hens laying three hundred in a year. This is a singular provision in nature, and it would appear to have been intended peculiarly for the use of man, as the hen usually incubates only once in a year, although she will occasionally bring out two broods. Few hens are capable of hatching more than from twelve to fifteen eggs; so that, allowing they were all to sit twice a year, and bring out fifteen at a time, there would still be at least one hundred and seventy spare eggs for the use of man. It is therefore evident that, in situations where hens can pick up their food, they must prove very profitable; for, supposing that the eggs of one fowl during the year were sold, without any of them being hatched, they would bring (if near a large city) on an average ninepence per dozen, or fourteen shillings, and the hen herself would be worth two shillings at least. As the number of eggs which are annually brought out by a hen bear no proportion to the number which she lays, schemes have been imagined to hatch all the eggs of a hen, and thus turn her produce to the greatest advantage; so that, in place of twelve or fourteen chickens, upwards of two hundred may be produced.

Hens will lay eggs which have received no impregnation, but from these, as a matter of course, no hatching can take place; they are equally good, however, for eating. When the chief object is to breed chickens, a cock should be allowed to walk with ten or twelve hens; but when eggs are principally required, the number of hens may be from fifteen to twenty. Endeavour to procure a cock of a good breed, not game, and let him be in his prime, which is at eighteen months to two years old. Cocks will last two years, after which they lose their liveliness of colours, and become languid, inactive, and mere consumers of food. It is fit, therefore, that younger cocks should then take their place in the poultry-yard. It is common to make choice of a young cock by pitting one or two against each other, and selecting the most courageous, which is always the favourite of the yard.

Some remarks have been made on the colours of the best hens of the different varieties. As to other qualities, M. Parmentier recommends that they should be chosen of a middling size, robust constitution, large head, bright eyes, and pendant comb. Crowers should be rejected, and those that are of quarrelsome tempers, such hens being rarely good hatchers or layers. Old hens, or those above four or five years old, are of little use when added to a stock; and when the comb and claws are rough, it is a sign that they have ceased to lay.

If left to themselves, hens would produce, like some wild birds, two broods in the year. Early spring, and, after a cessation, the end of summer are the two seasons at which they begin naturally to lay. In the depth of winter, under ordinary circumstances, hens very rarely lay eggs, though, by artificial means, they can be made to do so. If the temperature of the place where they are kept be raised by a stove, or otherwise, they will produce eggs. The fowls of the Irish peasantry, which are usually kept in the cabins of the owners, lay often in winter, in consequence of the warmth of their quarters; and there can be no doubt that warmth affords the most effective means of procuring new-laid eggs in winter, though stimulating food may aid in producing the same result. The fecundity of hens varies considerably. Some lay but once in three days, others every second day, and others every day. In order to induce laying, each hen should have its own nest, made with soft straw, and furnished with a piece of chalk as a decoy. The signs which indicate when a hen is about to lay are well known. She cackles frequently, walks restless about, and shows a brighter redness in her comb and wattles. After the process of laying is over, she utters a loud and peculiar note, to which the other fowls usually respond. Shortly after the egg is laid, it should be removed, for the heat of the hen soon corrupts it. When the eggs are taken away by the poultry-keeper, they should immediately be laid in a cool and dry place. If allowed to absorb damp, they soon spoil; indeed, one drop of water upon the shell quickly taints the whole egg. Various methods have been tried to prevent the absorption of air through the shell, and preserve the freshness of the eggs. A not uncommon plan is to keep them secluded from the air in bran, rye, or ashes, which may do very well where the eggs are to be kept in this way till eaten, but is utterly useless if quantities of them have to be sent to market. We beg to offer a plain piece of advice to cottagers on this subject, which, if properly acted upon, will give them the means of at all times commanding the highest price for *fresh eggs*, although situated a hundred miles or more from the place of sale. *Smear all your eggs with a bit of fresh butter the moment you get hold of them.* Do not load the shell with grease, but merely give a light varnish. The butter must be good. By this simple process of smearing, which does not taint the interior in the slightest degree, the egg is as fresh at the breakfast table when three months old as if just newly laid, and possesses all the delicious milkiness which the freshest eggs possess. Scarcely any thing is more common than to hear complaints of the difficulty of getting fresh eggs, and all a result of the sheer negligence of fowl-keepers. By the plan we mentioned there need never be such a thing as a bad egg heard of.

Hatching.—When eggs are to be hatched, it is necessary to pay attention to the choice of proper ones for the purpose. The company of the male bird renders the hen productive of fecundated eggs, and, as already noticed, it is only eggs of this kind which are available for producing young. The eggs must also be fresh; from the time they are laid, they should lie aside in a cool place. It is said to be possible to ascertain from the appearance of the egg, whether the forthcoming progeny is to be male or female; but we greatly doubt the truth of the popular notions on this subject. When eggs are left to be brought forth by the hen, a certain number is placed under her in the nest, when she is in the full inclination to sit. From nine to twelve eggs are placed, according to the extent of the breast and wings; and the time required for hatching is twenty-one days. Sometimes a hen will desert her eggs, a circumstance which may occasionally be traced to an uncomfortable condition of the skin, caused by vermin or want of cleanliness, and this affords a strong reason for keeping the hen-house clean, and giving the animals the means of purifying their feathers. Occasionally, the hen is vicious, or, in short, a bad sitter, and experience in pitching on the best hatching hens is the only remedy. Sometimes a hen will break her eggs with her feet, and in all such cases, the broken eggs must be removed as soon as observed, otherwise the hen may eat them, and from that may be tempted to break and eat the sound ones, and spoil the whole batch.

It has generally been found, that hens which are the best layers are the worst sitters. Those best adapted have short legs, a broad body, large wings, well furnished with feathers, their nails and spurs not too long or sharp. The desire to sit is made known by a particular sort of clucking; and a feverish state ensues, in which the natural heat of the hen's body is very much increased. The inclination, or, as physiologists term it, the *storge*, soon becomes a strong and ungovernable passion. The hen flutters about, hangs her wings, bristles up her feathers, searches everywhere for eggs to sit upon; and if she finds any, whether laid by herself or others, she immediately sets herself upon them.

With a proper provision of food at hand, warmth, quiet, and dryness, a good hatching hen will give little trouble, and in due time the brood will come forth; one or two eggs may perhaps remain unhatched or addled, but their loss is of little consequence. As soon as the hen hears the chirp of her young, she has a tendency to walk off with them, leaving the unhatched eggs to their fate; it is therefore advisable to watch the birth of the chicks, and to remove each as soon as it becomes dry, which may be in a few hours afterwards. By this means, the hen will sit to hatch the whole; yet she should not be wearied by too long sitting. If all the eggs are not hatched at the end of twelve or fifteen hours after the first chick makes its appearance, in all probability they are addled, and may be abandoned. The chicks must be kept in a warm place during the first day, and at night restored to the mother, who now assumes her maternal duties. The food given to the young chicks should be split grits, which they require no teaching to pick up; afterwards the ordinary food of the poultry-yard, or what the mother discovers for their use, is sufficient. Some give the yolks of hard-boiled eggs or curd, when a nourishing diet seems advisable. The extreme solicitude of the hen for her young, or the brood which may be imposed upon her, is well known. She leads them about in quest of food, defends them by violent gesticulations and the weapons which nature has given her, calls them around her by a peculiar clucking cry, and gathers them carefully under her wings to shelter them from danger, or to keep them warm at night. This maternal care is bestowed as long as the chickens require her assistance: as soon as they can shift for themselves, the mutual attachment ceases, and all knowledge of each other is lost. The young now go to roost, and the mother again begins to lay. Young hens, usually called pullets, begin to lay the spring after they are hatched.

Artificial Hatching.—As heat is all that is necessary to incubation, eggs may be hatched artificially, without the intervention of the hen. This practice was common in Egypt in very early times, and has since been adopted in many other quarters. In London, a year or two ago, a hatching apparatus, called the *Eccaleobion*, was constructed on a large scale, and was most successful in its results. An oven, consisting of eight floors or compartments, was employed to contain the eggs, while they were subjected to heat from steam-pipes. Each compartment held from two to three hundred eggs, and the whole exhibited the hatching process in all its various stages. The regularity with which the temperature was maintained, as well as accommodated to each peculiar stage of the process, brought out the chick with much greater certainty than when the incubation was performed by the hen, which sometimes cannot be kept steadily to the work. A visiter to the Eccaleobion gave the following account in "Chambers's Edinburgh Journal," No. 400, of the management of the chick after hatching:— 'The superintendent of the oven politely exhibited a compartment in which the eggs were chipping. Some had chipped the day before, others that day, and some would not be chipped till the morrow; in a few cases we observed the beak of the chick boring its way through the shell, and getting itself emancipated. When the little creatures are ushered into the world, they are not immediately removed out of the oven, but are allowed to remain a few hours till they become dry; they are then removed and put into a glass-case, on the table at the end of the room. This case is very shallow, and the glass cover can be easily pushed aside to permit the superintendent handling them if required. They are here for the first time fed, though not for twenty-four hours after being hatched; the material scattered among them is small bruised grits, or particles little larger than meal; these they eagerly pick up without any teaching, their instinctive desire for food being a sufficient monitor. After the brood has been kept in the glass-case (which is partially open) for two or three days, and been thus gradually accustomed to the atmosphere, they are removed to one of the divisions in the railed enclosure on the floor. Here hundreds are seen running about, uttering peepy cries, picking up grits, or otherwise amusing themselves, all being apparently in as lively and thriving a condition as if trotting about in a barn-yard. At six in the evening they are put to bed for the night in coops, twelve together in a coop: these coops are small wooden boxes, lined with flannel, and furnished with a flannel curtain in front, to seclude and keep the inmates as warm and comfortable as if under the wing of a mother. At six or seven in the morning they are again allowed to come forth into their court-yard, which being strewed with sand, and provided with food and water, affords them all the advantages of a run in an open ground.

"I made some inquiries respecting the failures in hatching, and deaths, and received the following information: —The eggs are usually purchased from Leadenhall market, and, consequently, not being altogether fresh, or otherwise suitable, one half of them fail in hatching. Once hatched, they are safe, for not more than one dies out of fifty which are brought into existence. If good and suitable eggs could be procured in all seasons, the failures in hatching would be comparatively trifling. Bad eggs, therefore, are the weak point in the establishment; and I should recommend the proprietor to complete his arrangements, by adding an egg-laying department to those which he has for hatching. This might be done by keeping a regular poultry-yard, either in connection with the place or in the country. The apparatus for hatching is capable of producing forty thousand chickens in a year, and, making allowance for failures, the actual produce cannot fall far short of half that number. When three weeks old, as I was informed, the chickens are taken to market, and sold for a shilling each. Thus, we should suppose, the Eccaleobion turns out at least a thousand pounds' worth of chickens annually—no bad revenue, it will be said, after paying expenses, but not greater than the ingenious contriver and proprietor, Mr. William Bucknell, deserves." The writer concludes by calling the attention of the public to the ease with which similar establishments might be got up in all large towns. The price of poultry, he argues, might be greatly lowered in the market, and the dietary resources of the common people materially improved and extended.

Capons.—The best modes of fattening fowls for the table have been adverted to. The process of converting chickens into capons, however, ought also to be noticed here. By removing the reproductive and oviparous organs from the male and hen chickens respectively, a great change is produced on them as regards voice and habits, and they can be made remarkably fat for the table. Capons are chiefly reared in Sussex, Essex, and one or two other counties around London. They can be trained to watch chickens, hatch eggs, and do many useful offices of the poultry-yard. Upon the whole, however, the special benefit derived from rearing capons does not counterbalance the trouble which they give.

Diseases.—Chickens are liable to various diseases, demanding attention from the poultry-keeper. The *pip* is the most common; it consists of a catarrhal thickening of the membrane of the tongue, causing a dangerous and obvious obstruction to respiration. It may be cured in most cases by throwing the fowl on its back, holding open the beak, and scraping or pealing off the membrane with a needle or the nail. The part may be wetted with salt or vinegar afterwards, and a little fresh butter pushed over the throat. Dr. Bechstein recommends giving a mixture of butter, pepper, garlic, and horse-radish, as an internal remedy. But the operation is most effective. *Thirst* sometimes attacks fowls like a fever, and often arises simply from dry food, though more frequently symptomatic of indigestion, or some internal and deep-seated derangement. Careful attention to diet is the first and great point in all such cases. If *constipation* appear to be present, bread soaked in warm milk, boiled carrots or cabbages, earth-worms, chopped suet, or hot potatoes with dripping, will be found useful. A clyster of sweet oil should be tried in severe cases. Where a tonic seems to be required, a little iron rust may be mixed with the food, and will generally relieve atrophy or loss of flesh. Where diarrhœa or scouring is observed, iron or alum may be given in small quantities. There is also a species of influenza, called the *roup*, which is often epidemical in the poultry-yard, and causes much havoc among the young birds. The eyes become swollen, a discharge comes from the nostrils, and the fowl gapes continually, showing much difficulty of breathing. Some observers have ascribed this complaint to worms in the windpipe, and have recommended their extraction by an operation; but warmth, cleanliness, and soft food, and such laxatives as sulphur, with frequent ablutions of the eyes and nostrils, are more likely perhaps, to do good, and are not attended with danger. Where general fever has been observed in fowls, the use of a little nitre has been found very advantageous. Saffron is another remedy very often employed in relieving the symptoms of sickness in fowls.

Many of these remarks will apply equally well to the diseases of geese and the other species of domestic poultry yet to be noticed, and this subject, therefore, need not again be adverted to in detail.

Turkeys.

The turkey, like the common chicken, has been included by naturalists in the *Gallinaceous* family of birds, and possesses the main characteristics common to the whole. It is certainly one of the most valuable fowls which have been naturalized in this country, but is very difficult to rear. The turkey-hen lays from fifteen to twenty eggs, and then sits upon them. She will bring out two broods in a year. The eggs are of a pale yellowish-white colour, finely streaked and spotted with reddish-yellow. They are a most delicious food, much more delicate in their flavour than those of the common nen. In England or Scotland, however, the eggs are seldom to be met with for sale, being deemed too valuable to be used as food. In Ireland they are to be got in the markets in great abundance, especially in the midland counties, where we have bought them at ninepence per dozen. In that country, when the turkey-hen has laid about half a dozen eggs, they afterwards take away one daily, by which means the hens are induced to produce a greater number of eggs than otherwise. This they assist by means of stimulating food, such as hemp-seed and buck-wheat. There is an interval of a day between the laying of each egg. It is said that the first two eggs which she lays are unfruitful. A turkey-hen can seldom hatch more than from sixteen to eighteen eggs. The time of incubation varies from twenty-seven to twenty-eight days, at which time the young begin to pierce their shelly prison, and emerge from it. When they first come forth, they are extremely weak, and much assiduous care is necessary to rear them. The first thing to be attended to is, to remove them to a situation where they are not exposed to the sun's rays, which at first are too powerful for them. A woody place is the most suitable to their natural habits. Nothing is so destructive to them as rain, from which they must be protected.

When young turkeys accidentally get wet, they should be brought into a house, carefully dried by applying soft towels to them, and then placed near a fire, and fed upon bread, which has been mixed with a small proportion of ground pepper or ginger. It should be made up in the form of small peas. If the bread is too dry for this purpose, it may be moistened with a little sweet milk. Should the turkey-poults refuse to eat it, a few of these pellets may be forced down their throats. Even heavy dews prove destructive to them, and frost is no less injurious in its effects. These must therefore be most carefully guarded against, when the hens incubate in March or early in April. Dry and sandy situations are most congenial for breeding turkeys, and especially elevated situations where large woods are contiguous. A single male turkey is sufficient for twelve or sixteen females, although the former number is probably the safest, to prevent sterility in the eggs, which is frequently the case with those of turkeys. Eggs should never be intrusted to the care of a female until she is at least two years of age, and they may be kept for the purpose of incubation till they reach their tenth year. The largest and strongest hens should always be kept for this purpose. During the time the hen is sitting, it becomes necessary to place food near her; as otherwise, from her assiduity, she may be starved to death, as turkey-hens seldom move from their nest during the whole time of incubation.

Where farmers rear turkeys in great numbers, they do not indulge the hen by allowing her to sit as soon as she has done laying, but keep them from her until all the other hens have ceased to lay, as it is of consequence that they should all be hatched about one time. When hens are unhappy during this interval, they may be indulged with hen's eggs. When they have all ceased to lay, each of them is provided with a nest ranged close to the wall, in a barn or other convenient place, and each is supplied with from sixteen to twenty of her own eggs. The windows and doors are then closed, and only opened once in the twenty-four hours for the admission of air, and for the purpose of feeding the hens. They are taken off their nests, fed and replaced, and again shut up. On the twenty-sixth day, the person who is intrusted with the management of the birds examines all the eggs, and removes those that are addled; feeds the hens, and does not again disturb them till the poults have emerged from their shells and have become perfectly dry, from the heat of the parent bird; as to be subjected to cold at this time would certainly kill them. When the young birds are thoroughly dried, two of the broods are joined together, and the care of them intrusted to a single hen; and those which have been deprived of their offspring are again placed on hen's or duck's eggs, and subjected a second time to the tedious operation of incubation, in which case it is not unusual for them to bring out thirty eggs. We cannot recommend this practice in point of humanity; for the poor hens, when they have accomplished their second sitting, are literally reduced to skin and bone, and frequently so weak as hardly to be able to walk.

As before hinted at, great care should be taken of the young turkey-poults; besides warmth, proper food, and shade, the nearer they are to a pure running stream the better, as they drink a great deal, and nothing is of greater importance to their being successfully reared than fresh drink. They must be also carefully protected from strong gusts of wind, and on the slightest appearance of a thunder-storm, should be immediately taken into a house. They should get no food for twenty-four hours after they leave the egg. Their first food should be hard-boiled eggs finely chopped, and mixed with crumbs of bread. Curd is also an excellent food for them. When they are about a week old, boiled peas and minced scallions are given to them. If eggs are continued, the shells should be minced down with their food to assist digestion, or some very coarse sand, or minute pebbles. They should be fed thrice a day; and as they get older, a mixture of lettuce-milk will be found beneficial, together with minced nettles. Barley boiled in milk is another excellent food at this period, and then oats boiled in milk. In short, the constitution of young turkeys requires at all ages every kind of stimulating food. When about three weeks old, their meat should consist of a mixture of minced lettuce, nettles, curdled milk, hard-boiled yolks of eggs, bran, and dried camomile; but when all these cannot be readily obtained, part of them must be used. Fennel and wild endive, with all plants which are of a tonic character, may be safely given to them. Too much lettuce, however, has been found to be injurious. When poults are about a month old, they should be turned out, along with the parent bird, into the fields or plantations, where they will find sufficient food for themselves. Grass, worms, all kinds of insects and snails, are their favourite food, and nature dictates to them such vegetables as are conducive to their general health. As their feet are at first very tender, and subject to inflammation from the pricking of nettles and thistles, they ought to be rubbed with spirits, which has the effect of hardening the skin, and fortifying them against these plants.

The glandulous fleshy parts and barbles of their heads begin to develop when they are from six weeks to two months old. This is a critical period with the poults, and unusual care must be bestowed on them, as they now become weak and often sickly. A little brine mixed with their food will be found very beneficial, or spirits much diluted with water. A paste made of fennel, pepper, hempseed, and parsley, has been found an excellent remedy when afflicted with an inflammation in the wattles, to which they are liable when growing. They are very subject to this if the weather happens to be broken and changeable at the time these tubercles are growing. These parts swell and grow very red, which frequently proves fatal to them. If, therefore, such be the state of the weather at this critical period, the paste above recommended should be given although they are perfectly healthy, which will be found an excellent preventative. When the inflammation becomes very great, recourse is often had to bleeding in the axillary vein, which frequently recovers them.

Soon after the turkey-poults have acquired their first feathers, they are subject to a disease which is very fatal to them, if not attended to. This distemper produces great debility, and the birds appear languid and drooping, and almost totally neglect their food. Their tail and wing-feathers assume a whitish appearance, and their plumage has a bristled aspect. This is occasioned by a disease in two or three of the rump-feathers. On examination, the tubes of these will be found filled with blood. The only remedy for this disease is to pluck them out, when the bird will speedily acquire its wonted health and spirits.

In fattening turkeys for the table, various methods are resorted to. Some feed them on barley-meal mixed with skim-milk, and confine them to a coop during this time; others merely confine them to a house; while a third class allow them to run quite at liberty; which latter practice, from the experience of those on whose judgment we can most rely, is by far the best method. Care should, however, be taken to feed them abundantly before they are allowed to range about in the morning, and a meal should also be prepared for them at midday, to which they will generally repair homewards of their own accord. They should be fed at night, before roosting, with oat-meal and skim-milk; and a day or two previous to their being killed, they should get oats exclusively. We have found, from experience, that when turkeys are purchased for the table, and cooped up, they will never increase in bulk, however plentifully they may be supplied with food and fresh water, but, on the contrary, are very liable to lose flesh. When feeding them for use, a change of food will also be found beneficial. Boiled carrots and Swedish turnips, or potatoes mixed with a little barley or oat-meal, will be greedily taken by them. A cruel method is practised by some to render turkeys very fat, which is termed cramming. This is done by forming a paste of crumbs of bread, flour, minced suet, and sweet-milk, or even cream, into small balls about the bulk of a marble, which is passed over the throat after full ordinary meals.

Pea-Fowl.

The peacock, also one of the Gallinaceous tribe of birds, came originally, it is said, from India, and was well known to the ancient Greeks and Romans, who introduced it into their mythology. The great beauty of its tail, so ample in extent and so rich in colours, rendered it indeed not unworthy of such preferment.

One peacock is usually kept with three or four hens. The female is extremely fastidious about a spot to lay in, and generally leaves any artificial nest for the grass of some neighbouring coppice, where she lays under the branches of a shrub, in a well-concealed situation. One reason for this is the propensity of the cock to break the eggs if he discover them. When the eggs of the pea-hen are gathered in sufficient numbers, whether from a natural or artificial nest, it is a common practice to place them under a common hen, which hatches them in thirty days, and makes an excellent step-mother to the young chicks. These are very tender at first, but soon grow vigorous, even in a chilly climate. Barley-meal paste, mixed with cheese or curd prepared from milk, with alum, ants' eggs, meal-worms, and hard-boiled egg, are among the common articles of diet given to the young. The grown-up pea-fowl feeds on boiled barley or other common grains, and is a dangerous neighbor to corn or wheat fields and gardens. On the other hand, they are voraciously fond of such creatures as frogs, lizards, and the like, and keep grounds clear of such nuisances. In moulting-time, it is requisite to be more careful of these fowls than at other times, and to give them good grain, with a little honey, and fresh water. Though the tongues and livers of peacocks were ranked among the dainties of the Roman epicures, the bird is rarely killed for the table now-a-days. Yet it always bears a high price, being one of the most beautiful of the feathered race, and an object on which the eye ever delights to dwell, though its screaming note by no means gives a corresponding pleasure to the ear.

The Guinea-Fowl.

This stranger is found native in Africa, as its name indicates, and it also exists in an indigenous state in South America. The Guinea-fowl or Pintado is about the size of the common hen, and the male differs very little in appearance from the female. Three species exist in considerable numbers in Europe, namely, the crested, the mitred, and Egyptian varieties. A very beautiful sort is marked by a pure white tint of body but the most familiar hues are dark-gray and black. The bird is less tame than other common poultry, and prefers to live in a half-wild condition in its native regions, perching and living on trees like undomesticated birds. It is a spirited creature, and will battle even with the turkey. The guinea-hens require great attention at the time of laying, making their nests by preference in corners of the woods. The common hen is usually made to rear their broods. In the market, guinea-fowls always bear a high price, both on account of their flesh, which is of a good quality, and because they form a very pretty variety of the poultry stock. Their food is grain, of the various kinds given to ordinary barn-door fowls, with which they assimilate closely in habits.

The Goose.

The goose differs in many respects from the fowls already noticed, being aquatic in its habits. It is marked by a flat bill and webbed feet, characters also possessed by the duck and swan, which, in conjunction with the goose, may be held as forming a distinct family (*Anatidæ*) of the feathered aquatic tribes.

Our common tame goose is the wild species domesticated, known to naturalists by the name of the fen or stubble-goose. Where people have a right of common, or live in the vicinity of marshy heaths, the breeding and rearing of geese will prove very profitable, for in such situations they are kept at a trifling expense; they are very hardy, and live to a great age. If properly kept, and fed regularly, although sparingly, they will lay upwards of a hundred eggs yearly. If these are set under large hens, each having half a dozen, with the assistance of the goose herself, they may be nearly all hatched. For the first three or four days, they must be kept warm and dry, and fed on barley-meal or oat-meal mixed with milk, if it is easily procured; if not, let these ingredients be mixed with water. They will begin to grow in about a week. For a week or two the goslings should not be turned out till late in the morning, and should always be taken in early in the evening. In Ireland the tenantry depend much on the breeding of these birds and turkeys to pay their rent; and with those who are industrious and favourably situated for rearing geese, they even do more in many instances. In the early part of the year they are allowed to feed on grass, on heaths, meadows, and commons; and as most of the peasantry have small bits of corn land of their own, the geese are turned out on the stubble to pluck what grass is left; and they also fatten upon it, and improve the flavour of their flesh.

Although water be the natural element of geese, yet it is a curious fact that they feed much faster in situations remote from rivers and streams. To fatten geese it is necessary to give them a little corn daily, with the addition of some raw Swedish turnips, carrots, mangel-wurzel leaves, lucerne, tares, cabbage leaves, and lettuces. They should not be allowed to run at large when they are fattening, as they do not acquire flesh nearly so fast when allowed to take much exercise. Therefore, those who can only afford to bring up a goose or two, should confine them in a crib or some such place about the beginning of July, and feed them upon the ingredients above recommended, with a daily supply of clean water for drink. If, on the contrary, from a dozen to twenty are kept, a large pen of from fifteen to twenty feet square must be made, and well covered with straw in the bottom, and a covered house in a corner for protection against the sun and rain when required, because exposure to either of these is not good. It will be observed that, about noon, if geese are at liberty, they will seek some shady spot to avoid the influence of the sun; and when confined in small places, they have not sufficient room to flap their wings and dry themselves after being wetted; nor have they room to move about so as to keep themselves warm. There should be three troughs in the pen, one for dry oats, another for vegetables—which ought always to be cut down—and a third for clean water, of which they must always have a plentiful supply. It must be remembered, that the riper the cabbages and lettuces which they are supplied with, the better. In the neighbourhood of large towns, the most profitable way of disposing of geese is in a dead state; as nearly the same sum can be obtained for them as if they were alive, and then you have the feathers, which are valuable, and may be sold to much advantage by themselves when you have collected a stone weight or more.

Geese are kept in vast quantities in the fens of Lincolnshire, several persons there having as many as a thousand breeders. They are bred for the sake of their quills and feathers, as well as for their carcass; it is therefore customary to strip them partially of the fine downy feathers, and leave them to grow afresh, and also to take quills from their wings—both practices barbarous in the extreme, however they may be attempted to be justified. Geese breed in general, only once a year, but if well kept, they sometimes hatch twice in a season. The best method for promoting this is to feed them with corn, barley, malt, fresh grains, and, as a stimulant, they should get a mixture of pollard and ale. During their sitting, each bird has a space allotted to it, in rows of wicker pens placed one above another, and the goose-herd, who has the care of them, drives the whole flock to water thrice a day, and, bringing them back to their habitation, places every bird (without missing one) in its own nest. One gander is generally put to five geese. The time of incubation varies from twenty-seven to thirty days. The goose begins to lay in March, but the time of the month depends upon the state of the atmosphere. When goslings are first allowed to go at large with their dam, every plant of hemlock which grows within the extent of their range should be pulled up, as they are very apt to eat it, and it generally proves fatal to them. Nightshade is also equally pernicious to them, and they have been known to be poisoned by eating sprigs of yew-tree.

Ducks.

Ducks are a kind of fowl easily kept, particularly near ponds or streams of water. In such situations, even the poorest families may have half a dozen of them running about without the least inconvenience. In keeping them in a domestic state, one drake is usually put to five ducks. The ducks begin to lay in February; their time of laying being either at night or early in the morning. They are extremely apt to deposit their eggs at some sequestered spot, and to conceal them with leaves or straw. From eleven to fifteen eggs is the number which a duck can properly cover. The time of incubation is about thirty-one days. The place where they incubate should be as quiet and retired as possible; and if they have liberty, they will give no trouble whatever in feeding, as the duck, when she feels the call of hunger, covers her eggs carefully up, and seeks food for herself, either by going to the streams or ditches in her neighbourhood, or, if such are not at hand, she will come to the cottage and intimate her wants by her squalling When the young are hatched, they should be left to the care of the duck, who will lead them forth in due time; and when she does so, prepare a coop for them, which should be placed on short grass, if the weather is mild; and if cold or stormy, they should be kept under cover. The future strength of the brood will depend much upon the care that is taken of them for the first three or four weeks after they have emerged from the shell. Ducklings will begin to wash themselves the first day after they are hatched, if they find water at hand. Therefore, a flat dish filled with that element should be always within their reach. Many persons are in the practice of clipping the tail, and the down beneath it, in ducklings, if the weather is wet during the first weeks of their existence. This is to prevent them from draggling themselves, which has a tendency to produce intestinal diseases. From a fortnight to three weeks is all that is necessary to confine them to the coop.

The first thing on which ducklings are fed is a mixture of barley, peas or oat-meal, and water. They may afterwards be fed upon a mixture of buckwheat and any of the above-named meals. The greatest attention must be paid to keeping their bed warm and dry; and with young ducks a frequent change of straw is absolutely necessary, as their beds soon get dirty and wet.

Ducks are not such attentive guardians of their young as hens, and therefore it is a common practice to place duck eggs under a sitting hen, and leave her to hatch them as her own progeny. When the young ducks so hatched make their appearance, the hen does not appear aware of the imposition, but takes at once to her duties with all a mother's fondness. The natural desire of the ducklings to plunge into water and swim away from the shore vexes her, but she watches for their return, and does all in her power to provide the means of subsistence. She scrapes for them, which a duck would not; she shelters them under her dry and warm bosom and wings, and altogether makes a better nurse than their own proper parent.

In feeding ducks for use, peas and oat-meal are to be preferred. It is said that barley-meal renders their flesh soft and insipid. Bruised oats should be given to them freely for some weeks before they are killed, which renders their flesh solid and well tasted; and the same general principles recommended in the feeding of geese should be kept in view. It has been found that the offal of butchers' shops feeds ducks quickly, and that this does not impair the flavour of their flesh. In very many instances, ducks are reared in situations where there are no pools of clean water for them to dabble in, and the poor animals are compelled to grub with their bills in all sorts of nauseous puddles, which, of course, makes their flesh rank and offensive. They should in all cases have a pool of clean water to swim in, and are best reared near a natural meadow, where they can search for their appropriate food.

Those who have paid much attention to the management of domestic poultry, assert that geese and ducks should be kept apart from other fowls. The former should have their houses ranged along the banks of a piece of water with a fence, and sufficiently extensive for walks in front, with doors for their access to the water, which can be closed at pleasure.

Swans.

Swans are a class of aquatic fowls kept for ornament rather then use. The flesh, even of the young, is black, hard, and rank, while that of the old is too tough for mastication. The eggs, also, are not peculiarly palatable; and there is little inducement to rear them, in short, if mere pecuniary advantage be looked to, excepting on the score of the skin, feathers, and down, which are articles of considerable value. At the same [illegible] if the swan be not a productive bird, few animated [illegible] can be compared with it as regards ornament. [illegible] size, snow-white plumage, and graceful form, render it a most attractive spectacle upon the bosom of a pool or loch. It is a hardy, long-lived fowl, and associates in pairs. The food of the swan consists usually of seeds, roots, and plants, rendered succulent by water. When fed in a barn-yard, it seldom thrives, being more decidedly aquatic in its habits than ducks or geese. From the colour of the European swan being so uniformly white, a black swan used once to be proverbially spoken of as an impossibility, but black swans have been found of late in Australia.

Pigeons.

Pigeons are among the most ornamental and useful appendages of a rural dwelling. If permitted to fly abroad to seek their food, little expense will be incurred for their keep, while the value of their young will be of some importance to cottagers. The pigeon has a great power of flight, and will go to a distance of many miles in quest of the means of subsistence; but wherever it may fly, it never fails to return home. The leading features of the district around its habitation appear to be impressed on its memory, and, flying at a great height, and with a wonderful power of vision, it sees the well-remembered landmarks, and directs its path homeward. This habit of seeking for the place at which it was reared, makes it difficult to keep pigeons in any new home; the best plan of inducing them to settle in a new abode, is to clip one wing, which prevents their flying; and keep them in a cot near the ground, till they get accustomed to the place.

Many persons keep their pigeons in the space between the garret and roof of their dwelling-house, with holes at which they go out and in; and this arrangement answers very well, for the animal's lodging must be dry and comfortable. A more regular plan is to furnish them with a properly-constructed dove-cot, aloof from any building. The cot should consist of a substantial wooden box, with a sloping roof, and divided interiorly by partitions into as many cells as pairs are to be kept, for each pair requires a distinct cell. Each cell should be twelve inches deep from front to back, and sixteen inches broad; the entrance hole should not be opposite the centre of the cell, but at a side, so that the pigeons may build their nest a little out of sight. In front of each cell there should be a slip of wood to rest and coo upon; but as different pairs incessantly quarrel about the right of walking on these slips, and are apt to fight for the possession of cells, it is best to separate the slips with upright partitions; and it would be an improvement to have two or three small cots instead of one large one. The cot, of whatever size or form, should be elevated on a wall facing the south-east, or otherwise placed at such a height as will be out of the reach of cats and other vermin. The cot should be painted white, as the pigeon is attracted by that colour. Gravel should be strewed on the ground in front of the dove-cot, the birds being fond of picking it; and a little straw or hay is necessary for the nests.—Cleanliness is indispensable to the health of the birds, and a scouring out of the cot should therefore take place regularly. The quantity of dung produced in the nests is very great, and its removal to the compost heap will amply repay the trouble of cleaning.

In commencing to keep pigeons, a pair or two should be procured which have not flown, and they should be shut up for a time, and well fed. Their chief food is grain, and the kind which they prefer to all others is dried tares. Small horsebeans are another favourite article of diet, and very nutritious to them. Wheat, barley, oats, and peas, with rape, hemp, and canary seeds, are also prized by them, but should not be made the constant articles of food under any circumstances.

The house-dove or common pigeon, as is well known, begins to breed about the age of nine months, and breeds every month. During breeding time, they associate in pairs, and pay court to each other with their bills; the female lays two eggs, and the young ones that are produced are for the most part a male and female. When the eggs are laid, the female, in the space of fifteen days, not including the three days during which she is employed in laying, continues to hatch, relieved at intervals by the male. From three or four o'clock in the evening, till nine the next day, the female continues to sit; she is then relieved by the male, who takes his place from ten till three, while his mate is feeding abroad. In this manner they sit alternately till the young come out. Kept with ordinary care, a pair will give to the breeder nine pairs or so in a year, and will continue to do this for four years. The bird lives for eight years, but is useless for breeding long before attaining that age. On the whole, the cottager who keeps a few pairs may have a palatable addition to his diet frequently during the year with very little trouble.

With regard to the best breeds of the common domesticated pigeon, it is difficult to give any useful instructions. They have been cultivated to a great extent, and many distinct varieties have been formed, but the differences rest chiefly in colours, and the special value of each lies in the taste of the *fancier*. The leading varieties of fancy pigeons are known by the names of the English Pouter, the Dutch Cropper, the Horseman, the Unloper, the Dragoon, the Tumbler, the Leghorn and Spanish Runt, the Trumpeter, the Nun, the Fan-tail, and the Capuchin. The peculiarities of some of these breeds are very odd. The tumbler, for instance, derives its name from a practice of tumbling in the air while on the wing. Instead of pursuing a steady straightforward flight, it turns over, or casts somersets backward, whirling round heels over head as expertly as a first-rate rope-dancer does when he makes the back spring. The fan-tail derives its name from the circumstance of its having a remarkably broad tail, which it has the power of spreading out like the tail of a turkeycock. The prime quality of the bird consists in its ability to make its tail touch its head, and surround it with a wide glory of feathers. If it cannot do this, it is valueless to the fancier, no matter how excellent are its other properties. Amusing as this absurdity is, it is not so laughable as the qualities which recommend the English pouter to public favour. This bird, which is a cross between a horseman and a cropper, possesses the remarkable property of blowing out its breast or crop to such an extent that it rises to a level with its beak, and the bird appears to look over the top of an inflated bladder.

Carrier Pigeons.—Pigeons have been put to the remarkable purpose of acting as carriers for letters or other light objects. A particular species, larger than common, is trained for the purpose, and in some countries the rearing of them forms a lucrative employment. The instinct which has rendered the carrier-pigeon so serviceable, is the strong desire manifested by all pigeons to return to the place of its ordinary residence; and man has adopted various precautionary measures in order to make their return on particular occasions more certain. A male and female are usually kept together and treated well; and one of these, when taken elsewhere, is supposed to have the greater inducement to come back. It is even considered by some that the bird should have left eggs in the process of incubation, or unfledged young ones, at home, in order to make the return certain; but probably these are superfluous precautions. It is obvious that the carrier-pigeon can only be put to use in conformity with some contemplated plan, for which the proper preparations have been made. It must have been taken from a place to which it is wished that it should return, and it must, at the moment when its services are wanted, be temporarily at the place from which the intelligence is to be conveyed. It is usually taken to that place hoodwinked, or in a covered baske. · the instinct by which it finds its way back upon its own wings, must of course be independent of all knowledge of the intermediate localities. When the moment for employing it has arrived, the individual requiring its services writes a small billet upon thin paper, which is placed lengthwise under the wing, and fastened by a pin to one of the feathers, with some precautions to prevent the pin from pricking, and the paper from filling with air. On being released the carrier ascends to a great height, takes one or two turns in the air, and then commences its forward career, at the rate of forty miles in the hour, or about a thousand a day.

GOLD FISH.

These beautiful little creatures, which now form pets of the drawing-room, being originally from a warm climate, require to be kept in apartments of a genial temperature. They are usually kept in a crystal globe which stands on a table, and the water should be changed daily. The water must not be given in a cold state, but allowed to stand in a warm room for an hour before being put into the globe: this precaution may not be necessary in summer. The food given may consist of small crumbs of bread, and small flies; the fish are fond of the blows of the blue-bottle flies; a little duckweed may be offered on the surface of the water.

Gold fish breed freely in ponds or tanks in pleasure-grounds, but they require to be removed during severe weather in winter. They thrive well in all seasons in ponds into which a little warm water is constantly flowing. In the beautiful work of Yarrel on British Fishes, the author speaks on gold fish as follows:—"It is well known, that in manufacturing districts, where there is an inadequate supply of cold water for the condensation of the steam-engines, recourse is had to what are called engine-dams, or ponds, into which the water from the steam-engine (or condensed steam) is thrown for the purpose of being cooled. In these dams, the average temperature of which is about eighty degrees, it is common to keep gold fish; and it is a notorious fact, that they multiply in these situations much more rapidly than in ponds of lower temperature exposed to the variations of the climate. Gold fish are by no means useless inhabitants of these dams; they consume the refuse grease, which would otherwise impede the cooling of the water by accumulating on its surface."

CAGE BIRDS.

The birds usually domesticated in cages in Britain are canaries, goldfinches, larks, thrushes, blackbirds, and parrots. The only means by which these or any other species of birds can be reared and preserved in a healthy condition, is to accommodate each as far as possible with the food, space for exercise, and other conveniences which the animal would enjoy in a state of nature. The most difficult thing to afford is space: where a room or aviary can be fitted up with all requisite accommodations—perches to resemble trees and branches, grass, moss, and other plants, patches of gravel or sand, secluded places for nests, a trough of clear water, &c.—the birds will thrive, breed, and be cheerful; but such accommodations can rarely be afforded; and the aviary, for the most part, is only a cage more or less ornamentally formed of wood and wires.

Placed in this state of confinement, no birds could possibly exist unless great care is bestowed in furnishing them with food and fresh water daily, keeping their habitation very clean, and placing them in a cheerful situation in a parlour, where they can enjoy the light. Birds that are produced in confinement are more contented than those who have known freedom; but the latter may be reconciled to this new state, and made to sing with their accustomed gayety. A good plan of reconciling a newly caught bird to the cage is said to be as follows:—For two or three hours leave it in tranquillity, and then plunge it into fresh water. This exhausts it; but on recovery, it arranges its feathers, becomes hungry, and takes at once to its food. The wetting, however, should take place only during sunshine, so that the feathers may be speedily dried.

The food of cage birds is very various. 1. Canaries, goldfinches, and siskins, live only on seeds. 2. Quails, larks, chaffinches, and bullfinches, feed on both seeds and insects. 3. Nightingales, redbreasts, thrushes, and blackbirds, take berries and insects. Referring to these classes of birds, Bechstein observes—"Experience teaches me that a mixture of crushed canary, hemp, and rape-seed, is the favourite food of canaries; goldfinches and siskins prefer poppy-seed, and sometimes a little crushed hemp-seed; linnets and bullfinches like the rape-seed alone. It is better to soak it for the young chaffinches, bullfinches, and others; in order to do this, as much rape-seed as is wanted should be put into a jar, covered with water, and placed in a moderate heat, in winter near the fire, in summer in the sun. If this is done, in the morning, after feeding the birds, the soaked seed will do for the next morning. All of them ought to have green food besides, as chickweed, cabbage-leaves, lettuce, endive, and water-cresses. Sand should be put in the bottom of the cages, as it seems necessary for digestion.

"Amongst those of the second class, the quails like cheese and the crumbs of bread; the lark barley-meal with cabbage, chopped cress, poppy-seed mixed with bread crumbs, and in winter, oats; the chaffinches, rape-seed, and sometimes, in summer, a little crushed hemp-seed. Too much hemp-seed, however, is hurtful to birds, and should only be given as a delicacy now and then, for when they eat too much of it they become asthmatic, blind, and generally die of consumption. Yellow-hammers like the same food as the larks, without the vegetables; the tits like hemp-seed, pine-seed, bacon, meat, suet, bread, walnuts, almonds, and filberts." The same author proceeds to describe two kinds of paste, simple and cheap, and which may be termed a universal food for birds.

"To make the first paste, take a white loaf which is well baked and stale, put it into fresh water, and leave it there until quite soaked through, then squeeze out the water and pour boiled milk over the loaf, adding about two-thirds of barley-meal with the bran well sifted out, or, what is still better, wheat-meal; but as this is dearer, it may be done without.

"For the second paste, grate a carrot very nicely, (this root may be kept a whole year if buried in sand), then soak a small white loaf in fresh water, press the water out, and put it and the grated carrot into an earthen pan, add two handfuls of barley or wheat-meal, and mix the whole well together with a pestle.

"These pastes should be made fresh every morning, as they soon become sour, particularly the first, and consequently hurtful. For this purpose I have a feeding-trough, round which there is room enough for half my birds. It is better to have it made of earthenware, stone, or delft ware, rather than wood, as being more easily cleaned, and not so likely to cause the food to become sour.

"The first paste agrees so well with all my birds, which are not more than thirty or forty, at liberty in the room, that they are always healthy, and preserve their feathers, so that they have no appearance of being prisoners. Those which live only on seeds, or only on insects, eat this food with equal avidity; and chaffinches, linnets, goldfinches, siskins, canaries, fauvettes, red-breasts, all species of larks, quails, yellow-hammers, buntings, blue-breasts, and red-starts, may be seen eating out of the same dish. Sometimes, as a delicacy, they may be given a little hemp, poppy, and rape-seed, crumbs of bread and ants eggs. One of these is necessary for the birds of the third and fourth class.

"Every morning fresh water must be given to the birds, both for drinking and bathing. When a great many are left at liberty, one dish will do for them all, about eight inches long and two in depth and width, divided into several partitions, by which means they are prevented from plunging entirely into the water, and in consequence making the place always dirty and damp. A vessel of the same size and shape will do for holding the universal paste, but then it must have no partitions. Quails and larks require sand, which does for them instead of water for bathing.

"Some birds swallow directly whatever is thrown to them: great care must be taken to avoid giving them any thing with pepper on it, or bad meat. This must be a general rule. I shall also remark, that food sufficient for one day only must be given to birds kept in cages, for they are accustomed to scatter it about, picking out the best, and leaving only the worst for the next morning; this makes them pine, and puts them out of humour."

Canaries.

These birds are the chief pets of the parlour, and the method of treating them requires to be given at some length. Being originally from a warm climate, they are tender, and must be kept in rooms of an agreeable temperature; if exposed to cold either in rooms or the open air, they pine and die. In dry weather in summer, their cage should be hung in the open air, or at least in the sunshine. If the apartment is kept too hot, they will moult at an improper season, and this must be avoided. Only one male should be allowed in a cage. Females for breeding are the better for having a large cage, as it affords them space for exercise. The greatest care must be taken to clean the cage, of whatever dimensions, and to scatter a little fine sand on the bottom of it. Each should be provided with three cross-sticks as perches, a small glass trough for water fixed outside at the extremity of one of the sticks. The water must be changed daily, or even more frequently.

Some persons, from mistaken kindness, offer pieces of nun cake and other inappropriate food to canaries, and the little creatures being fond of these things, they do themselves a great injury by eating of them. A canary in high song will at once be rendered mute by partaking of any improper food of this sort. As already mentioned, the food must be of a simple and natural kind; besides the seeds and other things described, they should be supplied daily with a little green vegetables; such as chickweed in spring, lettuce and radish-leaves in summer, endive, water-cress, and slices of sweet apple in winter. As they like to wash their feathers, a cup of fresh water may be placed in the cage daily. In the moulting season, it is recommended to put a nail into the water they drink, in order to strengthen the system by the slight infusion of iron matter.

The breeding of canaries requires additional accommodations. The breeder must have a large cage, into which the pair of birds is put about the middle of April. At the upper part of the cage, at one end, boxes for the nests are placed, with holes to go out and in by; and in the centre of the cage, near a perch, a net-work bag is hung filled with cotton, wool, moss, hair, and other soft materials, for the birds to use for their nests. The female only builds; and about ten days after pairing, she lays the first egg. She ordinarily lays six eggs, one every day; but each egg is to be taken away as laid, leaving an ivory one only; and when done laying, replace all the six. The period of incubation is thirteen days. When the young are hatched, finely minced egg and bread are placed at the feeding-trough, to enable the parents to carry suitable food to their young.

Blackbirds.

The male blackbird is a handsome creature, lively in manner, and possessing some sweet "wood notes wild," which sound most agreeably from a garden or the outside of a window. The bird requires a large wicker cage, which, whenever weather permits, ought to be hung in the open air. In a state of nature, the black bird eats berries, seeds, insects, larvæ, and worms. It loves to run about a grass-plot in the spring mornings, and pick up any stray worm which is straggling from its hole. This habit suggests the propriety of giving it, when in confinement, both vegetable and animal food. The universal paste will answer; but if too heating, which it is liable to be, give bits of bread, flies, cockchaffers, worms; and failing these, chopped raw meat. A rough bone from the table will also not be inappropriate. A short experience will show upon which kinds of food the creature thrives best, and let that be adhered to. Give also plenty of pure water to drink; and once a week, when the sun shines, set a basin of water in the cage for it to bate in and clean itself. Let the cage be carefully and regularly cleaned.

Parrots.

Under this head may be classed a number of beaked birds of similar character, as parrots, parrakeets, cockatoos, and maccaws, all possessing beautiful plumage of green, yellow, or grayish tints. They are chiefly from South America, and require the warmth of a dwelling-house to keep them alive in this country. All possess harsh voices, and would on that account be considered a positive nuisance by most persons except for the oddity of their being able to repeat certain words; but this is a quality possessed by some in greater perfection than others. Each kind of these birds may be treated much in the same manner. They are allowed a large cage formed of strong wires, with thick round bars to perch upon, and a ring at top to swing from by their hooked beak. All the parts must be of tin, for they would soon pick wood to pieces. In the Zoological Gardens, they are usually seen perched on a cross-bar of tin at the top of a staff, but chained by the leg to prevent their escape.

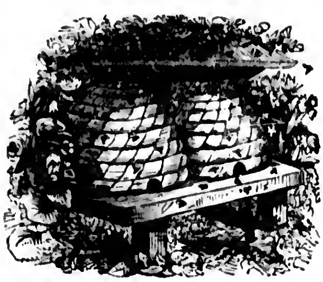
The food offered to parrots, maccaws, &c., is chiefly bread steeped in milk, nuts, or any other simple article. Care must be taken never to give them any thing with salt or pepper. On the subject of feeding them, Bechstein makes the following observations:—"In its native country, the fruit of the palm-tree is its principal food; our fruit it also likes, but white bread soaked in milk agrees with it better; biscuit does not hurt it; but meat, sweetmeats, and other niceties, are very injurious; and though at first it does not appear to be injured, it becomes unhealthy, its feathers stand up separate, it pecks and tears them, above all those on the first joint of the pinion, and it even makes holes in different parts of its body. It drinks little—this is perhaps occasioned by its eating nothing dry. Many bird fanciers say that the best food for parrots is simply the crumbs of white bread, well baked, without salt, soaked in water, and then slightly squeezed in the hand. But though this appears to agree with them pretty well, it is, however, certain that now and then something else ought to be added. I have observed, indeed, that parrots which are thus fed are very thin, have hardly strength to bear moulting, and sometimes even do not moult at all; in that case they become asthmatic, and die of consumption. It is clear that feeding them only on this food, which has very little if any moisture in it, is not sufficient to nourish them properly, at least during the moulting season, and while the feathers are growing again. I never saw a parrot in better health than one which belonged to a lady, who fed it on white bread soaked in boiled milk, having more milk than the bread would absorb, which the parrot drank with apparent pleasure; there was also put into the drawer of its cage some sea biscuit, or white bread soaked in boiling water; it was also given fruit when in season. It is necessary to be very careful that the milk is not sour.

"Some young maccaws are fed on hemp-seed, which must always be of the year before, as the new would be too warm and dangerous. Yet they must not be fed entirely on this food, but there must be added white bread soaked in milk or water, as has already been mentioned, some fruit and nuts, but never bitter almonds, as they will infallibly kill all young animals. In all cases the excrements of the bird will indicate the state of its health, and whether the food ought to be changed or not.

"Although maccaws rarely want to drink, as their food is very moist, yet they must not be left without water, which is generally placed in one of the divisions of their tin drawer. It is also a good thing to entice them to bathe; nothing is more favourable to their health, or better facilitates the painful operation of moulting, or keeps their feathers in better order. A little attention to these favourites, deprived of their liberty, their natural climate, and food, cannot be too much trouble to amiable persons who are fond of them, and to whom these pretty birds become greatly attached."

The cockatoo is generally esteemed as of milder temper than the parrot. Of this species, Buffon observes—"Cockatoos, which may be known by their tuft, are not easily taught to speak; and there is one species which does not speak at all; but this is in some measure compensated for by the great facility with which they are tamed; in some parts of India they are even so far domesticated that they will build their nests on the roofs of the houses; this facility of education is owing to their intelligence, which is very superior to that of other parrots. They listen, understand, and obey; but it is in vain that they make the same efforts to repeat what is said to them; they seem to wish to make up for it by other expressions of feeling and by affectionate caresses. There is a mildness and grace in all their movements, which greatly add to their beauty. In March, 1775, there were two, a male and female, at the fair of St. Germain, in Paris, which obeyed with great docility the orders given them, either to spread out their tuft, or salute people with a bend of the head, or to touch different objects with their beak and tongue, or to reply to questions from their master with a mark of assent, which clearly expressed a silent *yes*: they also showed by repeated signs the number of persons in the room, the hour of day, the colour of clothes, &c.; they kissed one another by touching their beaks, and even caressed each other; this showed a wish to pair, and the master affirms that they often do so even in our climates. Though the cockatoos, like other parrots, use their bill in ascending and descending, yet they have not their heavy disagreeable step; on the contrary, they are very active, and hop about very nimbly."

BEES.



The subject of Bees, which is equally extensive and interesting, has for many ages attracted the attention of mankind. The Sacred Writings, the most ancient of which we have any knowledge, show in numerous places how strongly the fathers of the Jewish people had been impressed by the peculiarities in the natural history of the Bee; and we know that Aristotle and other philosophers of old Greece deemed the subject worthy of years of patient investigation. Virgil, also, and many other Roman writers, dwelt on it with enthusiasm in their writings; while, in much later times, Swammerdam and other distinguished cultivators of science have pursued the same track with undiminished ardour. The most zealous of these inquirers was Francis Huber (born at Geneva 1750, died 1831), who, though labouring under the deprivation of sight, by the aid of his wife formed a most valuable collection of observations on the habits of bees, and to whose work we shall have occasion to refer. Societies have also been formed for the sole purpose of investigating this portion of natural history. A mere summary of the interesting essays, therefore, which this insect, so universally appreciated, has called forth, would occupy a very large space. On the present occasion, an attempt can only be made to cull from the most approved sources such details as may form a complete history of the Bee, though at the same time it must necessarily be a concise one, along with directions for the practical management of this most useful animal.

Bees are arranged by zoologists into the family of the *Apidæ* (from *apis*, a bee), in the order *Hymenoptera* (having four unequal membranaceous wings) of the Insect class. The Social Apidæ form the principal division of the family, their type being the *Apis Mellifica*, the Honey-making, or, in common phrase, the Honey-Bee. It is so called not from an exclusive peculiarity, but because it is the species which has long yielded to man the rich product indicated in its name. As the observations to follow will have reference to the Honey-Bee, it may simply be mentioned that the description of this genus involves all the main features in the natural history of its less important congeners, the Wild or Humble Bees, the special peculiarities of which will be briefly adverted to in the conclusion.

HONEY BEES.

Of the family of the Social Apidæ or Honey-Bees, two species seem to exist in Europe, the one found in the north, and the other in the south; but, making allowance for a slight deepening of tint from brown to red in the rings of the body in the case of the more southerly insect, the description of the common hive bee of Britain will apply to the other in all important respects. A hive of honey or garden-bees contains three orders of inhabitants, the external characters of which differ considerably, while their uses and functions in the community are most markedly distinct. The most important, and by far the most numerous order is that of the *workers*, or *working-bees*, formerly regarded as neuters in respect of sex, but now more properly considered as undeveloped females. The second order is composed of the males of the hive, termed the *drones*. There is usually but one perfect member of the third order present at a time in a hive, and this is the *queen-bee*, the sole female of the community.

The working honey-bee has a body about half an inch in length, blackish-brown in hue, and covered with close-set hairs, which are feather-shaped, and assist the creature materially in collecting the farina of flowers. The *head*, which is a flattened triangle in shape, is attached to the chest by a thin ligament; and the chest or *thorax*, which is of a spherical form, is united in a similar slight way to the *abdomen*. The abdomen is divided into six scaly rings, which shorten the body by slipping over one another to a certain extent. These three external divisions of the insect's body have all of them appendages of peculiar interest and utility. The head is provided with a double visual apparatus. In front are placed two *eyes*, consisting each of numerous hexagonal plates, studded with hairs to ward off the dust or pollen of flowers; and three small eyes are also to be found on the very top of the head, intended, doubtless, both to heighten the general sense of seeing, which the creature so peculiarly requires, and to give a defensive vision upwards from the cups of flowers. The *antennæ*, however, which are two slender tubes springing from betwixt the front eyes, and curving outwards on each side, most probably fulfil many of the purposes of vision in the dark interior of the hive. These instruments have each of them twelve articulations, and terminate in a knob, gifted with the most delicate sensitiveness. By the flexibility of the antennæ, the bee is enabled to feel and grasp any object in its way; and there can be little doubt that it is chiefly by means of these it builds its combs, feeds the young, fills the honey-cells, and performs the other operations of the hive. Bees also use the same instruments for the recognition of one another.

The mouth of the bee is a very complex structure, and one wonderfully fitted for its duties. Its most important parts are the *mandibles*, the *tongue*, the *proboscis*, and *labial feelers*. The mandibles are merely the two sides of the upper jaw, split vertically, and movable to such a degree as to enable the insect to break down food betwixt them, to manipulate wax, and use them otherwise as serviceable tools. They are furnished with teeth at their ends, two in number. The tongue of the bee is extremely small, and indeed is scarcely admitted by some naturalists to exist at all, the proboscis being often signified by that name. Many of the usual functions of such an instrument are indeed performed by the proboscis, a long slender projection composed of about forty cartilaginous rings, fringed with fine hairs. From the base of this, on each side, rise the labial feelers, instruments also fringed or feathered interiorly; and outside of these are the lower jaws, similarly provided with hairs. When the feelers and jaws close in on the proboscis, they form a sheath or defence to it. Naturalists used to term the proboscis a tube; but they now know that it acts by rolling about and lapping up, by means of the fringes around it, every thing to which it is applied. The gathered material is then conveyed into the gullet at its base, whence it passes into the internal organs. Thus we find the mandibles of the upper jaw ready to break and prepare the food for the sweeping-up apparatus of the lower parts. While perfect in action in an expanded state, the whole, moreover, can be so folded together as to form one strong well-protected instrument.

To the trunk or thorax of the bee exteriorly are attached the muscles of the wings and legs. The wings consist of two pairs of unequal size, which are hooked to one another, in order to act in concord and steady the movements in flying. The bee has three pairs of legs, of which the anterior pair are the shortest and the posterior the longest. All of them are formed upon the same principle as the limbs of man, having articulations for the thigh, leg and foot, with some minor joints in the latter part. The hind legs are marked by a special and beautiful provision. This is a cup-like cavity on the *tibia* or fore-leg, intended for the important purpose of receiving the kneaded pollen which the bee collects in its wanderings. The legs are all thickly studded with hairs, and more particular the cavity mentioned, in which the materials require to be retained securely. Another provision of the bee's limbs consists in a pair of hooks attached to each foot, by means of which the animal suspends itself from the roof of the hive or any similar position. Beneath or behind the wings the *spiracles* or air openings are found, which admit air for the purpose of permeating the chest, and probably the whole body, for the oxygenation of the circulating system. Huber completely proved both that respiration is essentially necessary to bees, and that the spiracles are the instruments by which it is effected. He found that they die in an exhausted receiver and become asphyxiated when shut up in numbers in close bottles. They perish in water only if the spiracles are under the surface; and the use of these apertures is then made apparent by the bubbles which escape from them under water. As will be shown, also, bees carefully ventilate their hives. Therefore, though no blood has been detected in bees or other insects, these tiny spiracles are of no slight consequence in the physical economy of the insect, oxygen being apparently not less necessary to the vitality of its circulating fluids than to those of warm-blooded animals.

Besides these appendages and contents of the chest, that region is traversed by the *œsophagus* or gullet, on its way to the digestive and other organs situated in the abdomen. These organs consist of the *honey-bag*, the *stomach*, the *wax-pockets*, and the *intestines*, with the *venom-bag* and *sting*. The honey-bag, sometimes called the first stomach, though digestion never takes place there, is an enlargement of the gullet into a pea-sized bag, pointed in front, with two pouches behind. In this receptacle is lodged the fluid or saccharine portion of the bee's gatherings, and by the muscularity of the coats it can be regurgitated to fill the honey-cells of the hive. A short passage leads to the second or true stomach, which receives the food for the nourishment of the bee, and also the saccharine matter from which the wax is secreted. The small intestines receive the digested food from the stomach, and from them it appears to be absorbed for the purposes of nutrition. Wax, it was once thought, was pollen elaborated in the stomach and ejected by the moth; but it is entirely derived, it is now known, from the honey or saccharine matter consumed by the insect; and John Hunter discovered two small pouches in the lower part of the abdomen, from vessels on the surface of which it is secreted. After accumulating for a time in these pouches, scales of it appear externally below one or other of the four medial rings of the abdomen, and are withdrawn by the bee itself or those around it. Close to the stomach is found the last important organ of the abdomen, the sting. Much beautiful mechanism is observed on a microscopical examination of this weapon, so powerful in comparison to its bulk. It consists of two long darts, adhering longitudinally, and strongly protected by one principal sheath. This sheath is supposed to be first thrust out in stinging, and its power to pierce may be conjectured from the fact that, when viewed through a glass which magnifies a fine needle-point to the breadth of a quarter of an inch, the extremity of the sheath ends so finely as to be invisible. The sheath once inserted, then the two still finer darts follow, and make a further puncture. The use of this is to receive the poison, which is conducted to the end of the sheath in a groove; and in order that the conjoined darts may not be withdrawn too soon for this purpose, they have each nine or ten barbs at the point to retain them. When the weapon is withdrawn, the poison is thus left with a cavity to enter, causing a deeper festering. The insect ejects the poison by means of a muscle encircling the bag at the base of the sting, in which bag the venom is secreted. The chemical composition of the poison has not been discovered, though it has so far the nature of an acid as to redden the vegetable blues. Altogether, Paley is fully justified in pointing to the defensive weapon of the bee as a wondrous union of mechanical and chemical perfection.

The manner in which the bee collects the food which forms the various secretions alluded to is worthy of note. The hairs with which its body and feet are covered, are the main instruments used for this end. By means of the hairs on the feet, the insect usually begins its collection of the pollen in the corolla which it has entered, and, after kneading the dust into balls, finally places it in the baskets of the hind legs. But the creature is not content with the product of this process. Rolling its body round and round, it brushes off the pollen still more cleanly, gathers it into two heaps with its active brushes, and loads its baskets to the brim. Even afterwards, they sometimes fly home like dusty millers, and brush their jackets when unloaded. The pollen is understood to be brought home by the working-bees more peculiarly as food for the young. The fluid secretions contained in the nectarea of flowers, and honey-dew, which is a deposition of certain aphides on plants, serve as other natural varieties of the bee's food; and the insect also drinks large quantities of water.

The senses of bees have been in part touched upon already. The means of *vision* bestowed on them, it was mentioned, consist of the many-lensed eyes in front, and the supplementary organ above. Inquirers have been staggered by the seeming contradictions connected with the vision of the bee. After collecting its store of food, its first movement is to rise aloft in the air, and look for the site of its home. Having determined this in an instant, however distant the hive may be, it goes for the point with the directness of a cannon-ball, and usually alights at its own door, though the whole country be crowded with hives. Yet if the hive, or its door, has been shifted to a slight extent, the insect seems confused, and cannot find its way. The conclusion from this is, that the eyes of the bee have a lengthened focus, suiting them for the main purposes of its existence. But the consequent inability to determine accurately on short distances has been compensated to the creature by the antennæ, which then become a highly serviceable resource. The sense of *taste* in bees has been the subject of much argumentation. Huber was of opinion that it was the most imperfect of their senses, and they have been observed to resort to putrid marshes for water, even when they were not restricted in their choice. Xenophon found his men seriously injured by taking honey produced by bees which had fed on deleterious plants. But, on the other hand, it has been noticed that they reject many substances, and prefer others, when a choice is allowed them; and it has been conjectured that they go to marshes purposely for the salt in their waters. Moreover, what renders the honey deleterious to man, may not be hurtful to bees. Honey, formed from a particular flower in the Jerseys, was found unfit for use from its intoxicating qualities; yet the bees throve wonderfully upon it at the same time. Their taste in selecting the richest flowers is likewise unquestionable. No doubt the sense of *smell* comes into operation on these occasions, as well as the sense of taste. Betwixt the influence and effects of the two, indeed, it is scarcely possible to discriminate. Even in the case of the human being, it is an established fact that the powers commonly ascribed to the sense of taste are to a remarkable degree dependent on the sense of smell. If the eyes be bandaged, and the apertures of the nose well shut up, the most experienced judge will be at a loss to determine between any two kinds of ardent spirits, or other pungent substances. The most nauseous medicines also, much as they may usually seem to affect the taste, will be found almost insipid if the site of the sense of smell be closed up while they are swallowed. In bees, the site of the two senses seems to be almost one and the same. Many experiments of Huber seem to prove that the sense of smell lies in the mouth, and that it is very acute. He found that they hate the odour of turpentine, yet on plugging up the mouth they showed no disgust when placed beside that liquid. He concealed honey at considerable distances, and they in a very short time detected the hidden treasure. The acuteness of their sense of smell, in truth, is sufficiently proved by their admirable skill in tracking out, over hill and dale, the most fragrant flower-parterres and beds of mountain heath. The sense of *hearing* has been denied to bees by many observers, while others describe the antennæ as their organs of hearing. The probabilities are in favour of the latter position. Noise, produced by the wings, and varied to suit particular purposes, is well known to be used as a means of intercommunication; and Huber, though doubtful about the faculty, avers that by a particular sound, emitted from the mouth apparently, the queen will render the whole hive silent and motionless in one instant. A certain sound, too, heard in the hive before swarming, is always followed by definite consequences. Such facts as these go far to establish the possession of hearing by bees; as signals by sound, made when the eyes could not detect the movement attending their production, would otherwise be valueless. The antennæ have been mentioned as possessed, if not of hearing, at least of a delicate sense of *touch*. Huber points out a moonlight night as the best time for observing the uses of the antennæ in this respect. The bees, guarding against the intrusion of moths, have not light enough to see fully, and they circumambulate their door with the antennæ stretched right before them. The instant a moth is felt, it is destroyed. When the queen of a hive is lost, the antennæ forms a curious means of spreading intelligence. Bee after bee protrudes its antennæ, and crossing them with those of its next neighbour, disseminates, in this way, the sad news over the hive. Besides the antennæ, the feelers have been shown by experiment to possess a considerable degree of sensibility, and to serve in part as organs of touch.

Such are the anatomical and physiological characteristics of the common or working-bee. The duties of this order include almost the whole business of the bee community, as will be shown afterwards in detail. Hives differ greatly, of course, in the number of their inmates, taking them even at the same season. Some contain but a few thousands; others from twenty to thirty, forty, and even fifty thousand. Of these the drones compose but a thirtieth part, or little more; all the rest, with the exception of the queen, are workers.

Drones or Males.

The drones differ considerably in outward appearance from the workers. They are bulkier and flatter in body, with a round head, a shorter proboscis, and an antennæ with an additional articulation; they have no basket-cavity on their hind-legs, and their abdomen contains too means of secreting neither honey, wax, nor poison, while the productive organs are there found instead. They are called drones from the peculiarly loud noise which they make with their wings. It has been said that the drone is the male of the hive. He lives but for the reproduction of the race, and when the object of his existence is accomplished, he is doomed to die. The workers, who have their own winter food and that of the coming young to provide, instinctively pass sentence of death, at the fitting time, on a class that live only to feed, and who, if they ever stir from their luxurious nests, go out for pleasure, not toil. With the exceptions specified, the description given of the worker-bee applies also to the drone.

Queen Bees.

The queen-bee is of larger size than either the drone or the worker. She has an elongated body, blackish above and tinted with yellow inferiorly, while the presence of two ovaries, or egg-receptacles in the abdomen, demonstrate her sex. She has also a sting, considerably bent. The Germans call the queen the *mother-bee*; and this is the most appropriate name, since her functions are those of a parent rather than a potentate. Her sole province is to lay the eggs, from which issue those annual multitudes that perpetuate the race in new communities. The progress of all kinds of bees, from the larva state to maturity, will fall to be described in an ensuing section; but it may in the mean time be observed, that the queen-bee usually commences laying eggs on the fifth day of her age, and often continues without intermission from early spring to the end of September, laying in the warmest season about two-hundred eggs a day. Such are the general characteristics and functions of the mother-bee.

We propose now to give an account of the natural and regular operations of a colony of bees, from the moment of their introduction to a completely unfurnished habitation to the establishment of a perfect hive.

PROCEEDINGS OF BEES FROM FIRST SETTLEMENT IN THE HIVE.

The breeding of young bees commences in February, and a hive, however thinned by the previous winter, becomes, under ordinarily favourable circumstances, crowded to excess in midsummer. Besides the developed bees, it abounds in eggs and young ones not matured. That fine instinct which, in the case of bees, occasionally prompts to acts almost above the power of reason, relieves this crowded state of things. The queen-bee, the proper mother of at least the great body of the hive, resolves upon departure with a swarm. The phenomena attending that departure will be noticed under a separate section; in the mean time let it be supposed that the queen has led off a colony, and that by the care of the owner of the bees, the swarm is lodged in a new and empty hive.

The first object of the community is to clean out their new lodging thoroughly, if they find this not done beforehand. The next great object is to block up all the chinks of the hive, smooth its projecting parts, and lay a stable foundation for the future works of the interior. Besides the wax which they use so extensively in their architecture, bees also employ, particularly at first, a remarkable substance called *propolis*, from the Greek words *pro* and *polis* (before the city), as indicating its use on the superficial parts of the hive. Propolis is a grayish-brown resin, of an aromatic odour, and better fitted by its tenacity for cementing than wax. Huber first showed distinctly that the bees gather this from the poplar, alder, birch, and willow trees, but more especially from the first of these trees. The ingenious naturalist alluded to, suspecting Reaumur to be wrong in referring the propolis to the pine, placed near his hives some wild-poplar branches, which the bees soon discovered, and flocked to in great numbers. In the heat of the day, when the vicious matter is ductile, it is thus carried off by the insect. A small thready portion is detached, kneaded with the mandibles, and then, by means of the four feet, placed in the basket of the hind legs, a smart pat or two being given to secure it there. Another portion, similarly kneaded to make it portable, and a little drier, is basketed in the same way, till as much is procured as the insect can carry. Sometimes the patient creature will spend half a hour in the mere kneading of a portion of propolis; and occasionally other bees will come behind and rob the little labourer of its whole load, for a succession of times, without eliciting the slightest symptom of impatience. When a bee reaches the hive with its load, the propolis adheres so firmly, that the insect has to present its limbs to the workers in the hive, who detach it, and immediately use it, while yet ductile, to fill all the crevices of the hive, and smooth the projecting parts, so as to prevent hurts being received in the dark. Another remarkable use is made of the propolis. From the hour of their entrance into the hive, bees are liable to the intrusion of other creatures. A fly they can soon remove, but what are they to do with a snail? They can sting it to death, to be sure, in an instant, but their puny strength is totally insufficient to remove the carcass. In this dilemma, they completely obviate the disagreeable effects of the presence of a large putrefying body, by covering it with propolis, which hardens over the mass, and gives them a pleasant aroma in place of a fœtid odour. With the propolis, moreover, they often narrow the entrance to the hive, forming a secure barrier, when they have reason to dread the intrusion of the death's-head moth, their great enemy in some countries.

In the mean time, while some workers are using the propolis for the purposes first stated, others are commencing the preparation of the cells or combs. The propolis is employed to attach these to the edges of the hive, but wax is the component material of the cells themselves. We shall find, in noticing the after arrangements of the completed hive, that the working-bees are naturally divided into two great classes; but at the outset of their labours, when the cells are being constructed, they form *three* sections, each of which pursues its allotted toil with admirable order and regularity. One section produces the material for the combs, and forms it roughly into cells; the second division follows the first, examines and adjusts the angles, removes all the superfluous wax, and perfects the work; while the third band passes continually out and in, seeking and bringing provisions, chiefly pollen, for the second section, which never quits the hive. The first class flies abroad at intervals, it being necessary that they should have rich saccharine food for the secretion of the wax. As the secretion goes on best in a state of repose, bands of the wax producers, after feeding fully, suspend themselves in clusters from the roof, each hanging from the hind legs of the one above, till the wax scales are formed, and they are prepared to take up the work. This clustering occurs on the very entrance of a swarm into a hive, when a seeming inactivity of several hours takes place, till the production of wax is set a going. It will be seen that the second section, the architects-proper, have the most unremitting toil to perform. They never quit it when once begun, excepting to turn to the little waiters of the third section and indicate their hunger by holding out their trunk, when the caterer either spirts out a drop or two of honey or furnishes pollen from the stores brought in.

Cells.

But if the labour of the architect class be severe, their work, when complete, is a marvel of instinctive ingenuity. Bees always begin their work, in ordinary circumstances, at the ceiling, suspending their structures from it. Their combs, or clusters of cells, are arranged in vertical and parallel strata, with a space of about half an inch betwixt contiguous pairs; and each comb is nearly an inch in thickness. At the outset, when one wax-making bee leaves the suspended cluster alluded to, and lays the foundation of a cell, others follow in rapid succession, not only adding their wax to that of the first, but soon commencing new combs, one on each side; and so the work goes on, in most cases, until the whole roof is covered with foundations. The architects-proper, also, are meanwhile at their finishing work. They have, says Reaumur, to solve this difficult geometrical problem: "A quantity of wax being given, to form of it similar and equal cells of a determinate capacity, but of the largest size in proportion to the matter employed, and disposed in such a manner as to occupy the least possible space in the hive." Wonderful to reflect upon, this problem is solved by bees in all its conditions, in their construction of hexagonal or *six-sided* cells. The square and the equilateral triangle are the only other two figures of cells which could make them all equal and similar without interstices. But cells of these figures would have either consumed more material or have been weaker; and they would also have consumed more space, being less adapted to the form of the bee. In short, the hexagonal form combines all the requisites of economy and capacity. Another wonderful arrangement is seen in the construction of the bottoms of the cells. Each of these is composed of three rhombs, or plates of wax in the shape of card-diamonds, disposed in such a manner as to form a hollow pyramid, the apex of which forms the angles of the bases of three cells on the opposite side, giving to each of them one of the three diamond-shaped plates which is required to form their bases. Now, the three rhombs, composing each cell-bottom, have the two obtuse angles each of 110 degrees, and, consequently, each of the two acute angles of 70 degrees. Koenig, on being desired by Reaumur to calculate the exact angle which would give the greatest economy of wax in a cell of such capacity, found that the angle should be 109 degrees 26 minutes, or 110 degrees nearly. Other geometricians have arrived at similar conclusions. The problem is one of great difficulty, yet the bee practically solves it at once, under the guidance of the Great Geometrician who made both the bee and the law on which it proceeds. Attempts have been made to ascribe the form of the cells to the peculiar shape of the head of the bee, and the instruments which it employs; but all such explanations have been found liable to insuperable objections.

The cells of the bee are extremely delicate, two or three plates or sides being of the consistence only of a common leaf of paper. They are made strong, however, by mutual support and other means. Besides a sort of froth which the insect mixes with the wax, the cells, at first of a dull white, soon appear yellow on the interior, the change arising from the plastering over them of a compound varnish of wax and propolis. Each cell is soldered, too, at its mouth by a similar compound of a reddish colour, having in it more propolis; and threads of the same substance are laid around the walls to bind and strengthen them. It is now to be observed that all cells are not alike. They have four different uses in the economy of the hive, and are constructed variously to suit these. One set of cells is for holding the eggs or embryos of worker-bees; a second for those of males or drones; a third for those of young queens, hence called royal cells; and a fourth set are for the reception of honey and pollen. The first are generally about five lines in depth (or less than half an inch), and two lines and two-fifths in diameter. The cells of the young males are much less numerous, and measure from six to seven lines in depth, by three and a half in diameter. It is worthy of note, that in passing from the construction of worker-cells to those of drones, in the same comb, the architects do not alter the size at once, but gradually, thus disordering in the slightest possible degree the delicate arrangement of the bases of the cells. In shifting from larger to smaller, the same rule is observed. A small number only of royal cells, about ten or twelve, are constructed on ordinary occasions. They are about an inch in depth, and nearly one-third of an inch in width, with walls about an eighth of an inch in thickness. After the breeding season is over, the cells both of worker and male bees are used for holding honey. Those made purposely for that end are chiefly marked by a greater divergence from a horizontal plane, that the honey may be better secured; and it is curious to observe that, in a very warm season, these wise insects give the floor a still greater dip from the mouth inwards. As the store enlarges, they seal up the mouth with a ring of wax, to which they gradually add concentric layers till the cell is filled, when they close it altogether. Pollen is kept in cells of considerable size.

Laying of Eggs.

A very short time elapses ere a great number of cells are constructed; for, in the height of the honey season, a good swarm has been known to build *four thousand* in a day. The queen-mother very soon begins the task of laying eggs. A thousand conjectures have been hazarded as to the mode in which the fecundation of the female bee takes place. No observer has yet been able to discover any contact with the drones in the hive. It was supposed by Swammerdam that a certain aura or odour from the drones was all that was necessary to render the eggs of the queen productive; while M. Debrau imagined that the eggs, as in the case of frogs and fishes, were fecundated by a fluid from the drone after being laid. M. Hattorf thought, again, that the queen was fecundated by herself alone. All these opinions M. Huber refuted in a satisfactory manner, by separations and confinements of the insects in various ways. He at length came to the belief, founded on experiments which appear almost decisive of the question, that the female bee never becomes fruitful in the hive, but requires to go abroad for that purpose; and it has been also thought probable that the fecundation takes place by contact in the air, as is known to occur in the case of winged ants. The number of drones in a hive has been thought a most unintelligible circumstance. Mr. Huber's views explain the matter fully. It is essential that they should be numerous, that the female may have a chance of meeting them abroad; and it is to be observed that she always quits the hive at the hour when the drones leave it, or immediately afterwards. One intercourse is sufficient, according to Huber's experiments, to render the female bee productive for at least two seasons; and if the intercourse takes place at the end of the year, the consequent laying of eggs may be deferred to the ensuing spring. The cold weather has a strong influence in this respect. M. Huber's conclusions may be more fully ascertained by reference to his interesting work.

M. Huber discovered that the queen begins to lay eggs forty-six hours after returning from the flight during which fecundation takes place. For the space of eleven months, under ordinary circumstances, a queen, at her first laying, produces the eggs of worker-bees alone. At the end of the space mentioned, a considerable laying of the eggs of drones commences and soon after the appearance of these, the workers of the hive, with a strange instinct, begin to prepare royal cells for the queen-eggs that are certain to follow. Altogether, the fruitfulness of the female bee is amazing, from one to two hundred eggs a day being the usual amount of her produce. One hundred thousand is said to be no very uncommon number of young for her to give origin to in a season. A swarm consisting of 2000 or 3000 in the beginning of the year, will throw off in June swarms amounting to

40,000 or 50,000; in many cases the first swarm, and in some the cast or second swarm, throw off colonies of 10,000 or 12,000; and yet the original stock is left augmented to the number of 18,000 or 20,000. Occasionally, a first swarm even casts twice.

Transformation of Worker-bees.

A fertilized queen is so impatient to begin her laying of worker-eggs, that, in a new hive, she only waits till a few inches of comb are erected. Before depositing the egg, she carefully examines the cell, and, if satisfied, turns and drops into it from the oviduct an egg of an oval shape and bluish-white tint. Here the egg remains for three days attached by a viscous fluid to the corner of the cell; and, on the fourth, the thin outer shell of the egg bursts, exposing a small lively worm. Now come into play the *nurses* or nursing-bees, one of the two great classes into which Huber and others consider the labourers of the hive to be divided. The other class are the *wax-workers.* Both elaborate honey, but the latter class alone make wax and form combs. Again, the nurses, whose figure may be distinguished from its being more ovoidal than the others, are those who alone take care of the young. As soon as the egg is hatched, they watch over the larva or worm with the tenderest and most incessant care, administering copious supplies of mixed pollen, honey, and water, which the nursling devours with avidity. Like other larvæ, it soon grows so as to cast its cuticle; and, five days after chipping the shell, it has become large enough to fill the cell, lying coiled up like a ring. It now ceases to eat, and the bees seal up the cell with wax. Left to itself, the larva begins the process of spinning a cocoon round its body, which it does in thirty-six hours, the material being a fine silken thread from the mouth of the spinner. In three days more it is converted into the state of *pupa* or chrysalis, when all the parts of the future bee become gradually visible through the transparent covering, assuming a darker hue day by day, and progressing to the state of the complete *imago* or insect. On the twentieth day from the deposition of the egg, the young bee begins to cut through its prison-door with its mandibles, and in half an hour makes its escape. Old writers say that the elder bees fondly caress and feed the new-comer; but later observers, of no mean authority, declare that, on the contrary, they seem to think their duty ended with the closing up of the cell, and leave the young stranger to shift for itself in the busy world. One thing, however, is done by the elder bees. They instantly clean out the vacated cell, and prepare it again for eggs or honey, leaving at the same time the silk cocoon adhering to the walls.

Eggs of Drones—Royal Eggs.

The passage of male eggs through the larva and pupa state is attended with the very same phenomena as in the case of the eggs of workers, with the exception that the process occupies a little more time, twenty-four days in all being spent in the change. The cause of male eggs being laid, in ordinary circumstances, only after eleven months have been passed in the laying of worker-eggs, was explained by Huber. He conceived eleven months to be necessary to perfect the male eggs, and was of opinion that the arrangement of the eggs in the ovaries was such as to permit and even compel the retention of both male and royal eggs until they were fully matured. This idea seems to be confirmed by the ordinary course of things in the hive, but certain anomalous facts startingly contravene it. Huber himself found, that if a young queen had not the opportunity of proving fertile within twenty days of her birth, all her after-product consisted of drones, and drones alone; and, what is still more curious, he discovered that she began to produce these drones at the time when she should have laid worker-eggs, namely, within forty-six hours after fecundation. The gestation of eleven months seemed totally unnecessary in such cases of retarded fecundation. Huber confessed himself incapable of explaining this remarkable circumstance. Though we do not understand it, however, it only tends to make us marvel more and more at the perfection of order in the bee economy. The queen-bee is never voluntarily guilty of that breach of the laws of her being which produces such remarkable effects; and, if artificially confined till she is twenty days old, her violent agitation shows her sense of the departure from the order of nature into which she is forced.

The raising of workers and drones from the egg to the insect state is a simple matter in comparison with the same transition in the case of queen-bees. The royal eggs, which the queen begins to lay twenty days after she has commenced the deposition of male ones, differ in no respect from common eggs. But on the royal larva, when it breaks from its three days' confinement in the shell, the nurses bestow peculiar attentions. They watch it incessantly, and feed it with a rich *jelly*, slightly acescent, and given in such quantities that the royal cell is usually wet with it. In five days the young majesty of the hive has grown, so as prepared to spin its web, and the bees wax up the cell. The cocoon is spun in twenty-four hours; two days and a half of inactivity follow; the larva is then transformed into a pupa, or a *nymph*, as the insect in this state is more often called; and, after other four or five days have passed, the royal insect is complete, the whole time occupied in the metamorphosis being sixteen days.

Young Queens.

We have now arrived at one of the most extraordinary points in the history of the hive. The young queen, or rather queens, do not issue from their cells when perfect, like workers and drones. They are not permitted, unless the old or regnant queen has quitted the hive with a swarm, or the seat of royalty is in any other way vacated. They therefore close the royal cells more firmly, leaving only a small aperture to introduce food; and, acting as if aware that they may need a queen in case of swarming, they at such times will not permit the old queen to approach the cells. Her struggles to do so are often violent, and her dire hostility to her own sex leads her, if she gets near the cells, to destroy them instantly, whether in the state of full insect or nymph. The strength of this instinctive hate is even such, that a young queen no sooner leaves her own cell than she feels its stirrings.

According to Huber, there can only be a single queen in a hive. The mere offspring of two could scarcely coexist in the same hive; and it is wonderful to observe by how many accessory circumstances nature has ensured the death of one or other of any two placed in the same community. The first thought of a young queen, it has been seen, is to kill her yet undeveloped rivals. Nature has given her the chance, for, as more queen-eggs than one are seldom laid daily, one is usually the oldest. If, however, two do quit the cell at the same instant, they rush into combat with the most headlong fury. If a stranger enters a hive, its queen-regnant flies to the field without a moment's hesitation. In short, in all ordinary circumstances, two queens, brought into contact, fight. But they might *both* die in the contest, and the community be left without a queen. Nature demands but one victim, and she has arranged that but one victim shall fall. Bees are only vulnerable in the belly; and Huber observed that, whenever two royal combatants were so locked together that they could mutually plant their stings in the fatal part, their instinct caused them to separate precipitately without harm on either side. The combat only closes when one can get an advantage of position, and kill its rival with safety. Again, the worker-bees might interpose to prevent these mortal combats. On the contrary, their instinct is to prevent the queens from parting, and force on a fatal issue. Alluding to one battle, Huber says that it seemed as if 'the bees anticipated the combat in which these queens were about to engage, and were impatient to behold the issue of it, for they retained their prisoners only when they appeared to withdraw from each other; and if one less restrained seemed desirous of approaching her rival, all the bees forming the clusters gave way to allow her full liberty for the attack; then if the queens testified a disposition to fly, they returned to enclose them." Another remarkable provision for ensuring the existence of but one queen in a hive, is beheld in the peculiar mode in which the royal larvæ spin their cocoons. Other bees spin perfectly close cases; the queen-larvæ spin cocoons which envelop only the head, thorax, and first ring of the abdomen, leaving a part open behind. Huber thus explains this minute but important peculiarity:—"Of several royal nymphs in a hive, the first transformed attacks the rest, and stings them to death. But were these nymphs enveloped in a complete cocoon, she could not accomplish it. Why? Because the silk is of so close a texture, that the sting could not penetrate, or if it did, the barbs would be retained by the meshes of the cocoon, and the queen, unable to retract it, would become the victim of her own fury. Thus, that the queen might destroy her rivals, it was necessary the last rings of the body should remain uncovered; therefore, the royal nymphs must only form imperfect cocoons. You will observe that the last rings alone should be exposed, for the sting can penetrate no other part; the head and thorax are protected by connected shelly plates which it cannot pierce. Hitherto, philosophers have claimed our admiration of nature in her care of preserving and multiplying the species. But from the facts I relate, we must now admire her precautions in exposing certain individuals to a mortal hazard." Examining further into the causes of the open cocoon of the royal nymphs, Huber came to the conclusion that it arose from the figure of their cells, and was designed for the purpose of exposing them to the certainty of destruction.

Loss of a Queen.

If bees, by death or artificial means, are deprived of their queen, the event has a marked influence in the hive. We do not allude to the case in which a stranger kills the queen-regnant; for if such a thing happens, as naturalists conceive it scarcely ever can do under natural circumstances, on account of the wariness of the bees to prevent intrusion, the victorious stranger mounts the vacant throne, and reigns in peace. We refer, however, to the removal of a queen without the introduction of any other. In such a case, the following results ensue, according to Huber:*—"Bees do not immediately observe the removal of their queen; their labours are uninterrupted; they watch over the young, and perform all their ordinary occupations. But in a few hours, agitation ensues; all appears a scene of tumult in the hive. A singular humming is heard; the bees desert their young, and rush over the surface of the combs with a delirious impetuosity. Then they discover their queen is no longer among them. But how do they become sensible of it? How do the bees on the surface of the comb discover that the queen is not on the next comb? It is supposed that the alarming intelligence of the loss is communicated by the strokes on the antennæ, which bees are uniformly observed to give to each other at these times. The insects then appear to seek for their lost queen, some rushing hurriedly out to make the search abroad. At the end of five hours, the commotion greatly ceases, and an instinctive recourse to the means of supplying the vacancy takes place. If they have royal larvæ, they turn their whole attention to them. If they have only the larvæ of working-bees, they immediately select two or three of them, pull down the neighbouring cells at the cost of the lives of the young within them, and construct a royal cell around each of the selected larvæ—the consequence of which proceeding will be immediately explained. If they have no larvæ at all on the loss of their queen, still they build several royal cells, as if so far at least to supply the emergency. If a stranger queen be introduced in such a state of things, within twelve hours after the loss of their own sovereign, the new-comer is treated as an intruder, and the bees surround her so closely that she commonly dies from privation of air, suffocation being the resource of bees in such cases. If the stranger be introduced within eighteen hours, they also surround her, but leave her sooner. To show that they possess memory, it is only necessary now to re-introduce their own queen, when they will show every symptom of recognition and joy. But their memory is short-lived, for, if the stranger be not introduced till twenty-four hours elapse, she receives a treatment very different from that experienced at an earlier period. "I introduced," continues the ingenious naturalist, "a fertile queen, eleven months old, into a glass hive. The bees were twenty-four hours deprived of their queen, and had already begun the construction of twelve royal cells. Immediately on placing this female stranger on the comb, the workers near her touched her with their antennæ, and, passing their trunks over every part of her body, they gave her honey. Then these gave place to others that treated her exactly in the same manner. All vibrated their wings at once, and ranged themselves in a circle around their sovereign. Hence resulted a kind of agitation which gradually communicated to the workers situated on the same surface of the comb, and induced them to come and reconnoitre, in their turn, what was going on. They soon arrived; and having broke through the circle formed by the first, approached the queen, touched her with the antennæ, and gave her honey. After this little ceremony they retired, and, placing themselves behind the others, enlarged the circle. There they vibrated their wings, and buzzed without tumult or disorder, as if experiencing some very agreeable sensation. The queen had not yet left the place where I had put her, but in a quarter of an hour she began to move. The bees, far from opposing her, opened the circle at that part to which she turned, followed her, and formed a guard around. She was oppressed with the necessity of laying, and dropped her eggs. Finally, after an abode of four hours, she began to deposit male eggs in the cells she met with.

"While these events passed on the surface of the comb where the queen stood, all was quiet on the other side. There the workers were apparently ignorant of a queen's arrival in the hive. They laboured with great activity at the royal cells, as if ignorant that they no longer stood in need of them: they watched over the royal worms, supplied them with jelly, and the like. But the queen having at length come to this side, she was received with the same respect that she had experienced from their companions on the other side of the comb. They encompassed her, gave her honey, and touched her with their antennæ; and, what proved better that they treated her as a mother, was their immediately desisting from work at the royal cells: they removed the worms, and devoured the food collected around them. From this moment the queen was recognised by all her people, and conducted herself in this new habitation as if it had been her native hive."

Making of a Queen

If one queen is not so introduced to supply the loss of another, and no royal larvæ exist, one of the most

* In this article we refer very frequently, it will be perceived, to Huber. The truth is, an examination of many late works has proved to us that in their best parts, they give but a transcript of his views and experiments. This is no reproach, being a natural consequence, merely, of Huber's wonderful acuteness and accuracy. Our quotations are made from a well-executed translation, published at Edinburgh by Mr. John Anderson, in 1806

wonderful phenomena of the hive takes place. It has been stated that bees, on losing their queen, build a royal cell around an ordinary worker-bee larvæ, or several of them, if the larvæ are abundant. These, by peculiar feeding, are formed and developed into *queens*, thus proving that the worker-bees, commonly viewed at one time as neuters, are in reality undeveloped females. This remarkable discovery was made by Schirach. Having used smoke about a hive, he so annoyed the queen that she flew away, and the circumstance of the bees immediately building royal cells around common larvæ, when they had no royal larvæ, revealed to him the truth. Huber proved the same thing by the succeeding experiment:—"I put some pieces of comb, containing worker's eggs in the cells, of the same kind as those already hatched, into a hive deprived of a queen. The same day several cells were enlarged by the bees, and converted into royal cells, and the worms supplied with a thick bed of jelly. Five were then removed from these cells, and five common worms, which, forty-eight hours before, we had seen come from the egg, substituted for them. The bees did not seem aware of the change; they watched over the new worms the same as over those chosen by themselves; they continued enlarging the cells, and closed them at the usual time. When they had hatched on them seven days, we removed the cells to see the queens that were to be produced. Two were excluded, almost at the same moment, of the largest size, and well formed in every respect. The term of the other cells having elapsed, and no queen appearing, we opened them. In one was a dead queen, but still a nymph; the other two were empty. The worms had spun their silk cocoons, but died before passing into their nymphine state, and presented only a dry skin. I can conceive nothing more conclusive than this experiment. It demonstrates that bees have the power of converting the worms of workers into queens, since they succeeded in procuring queens by operating on the worms which we ourselves had selected." This curious provision seems intended to preserve the communities of bees, in any emergency, from the danger of wanting that all-important member, the queen; and it is reasonably conjectured that the evolution of a queen from a worker-larvæ is dependent on the effects of the royal food upon the ovarian system.

Fertile Worker-Bees

Another most remarkable fact observable in the economy of the hive was discovered by M. Riem. Common worker-bees, that naturalist proved, sometimes lay fertile eggs. It was reserved for Huber to determine this, and also to explain the cause. He in the first place found that, in a hive deprived of its queen, the eggs of drones were laid. Though he did not put faith in what had been said by some naturalists respecting the existence of *small* queens, he nevertheless satisfied himself, by directing a careful examination to be made of each individual bee in the hive, that no queen was among them, every one having the little basket on the hind leg, and a straight sting. Thus convinced of the reality of Schirach's discovery, Huber, having detected several workers laying eggs, examined them, and found the ovaries partially developed. He now bethought him that the only known cause of such development is the use of the food or jelly given to the royal larvæ. Led into this train of thought, he speedily discovered that all the fruitful worker-bees are born in hives where no queen exists, and where worker-larvæ are transformed to queens; and he further found that they are always born in cells adjacent to those of the larvæ-queens. Continued investigation brought him to the belief, finally, "that when bees give the *royal treatment* to certain worms, they either by accident or by a particular instinct, the principle of which is unknown to me, drop some particles of royal jelly into cells contiguous to those containing the worms destined for queens;" whence the expansion of the ovaries to a certain degree. That expansion is imperfect. As in the case of retarded fecundation in queens, the fruitful worker-bees produce nothing but drones. In this fact, it seems to us, may possibly be found the principle of the unexplained instinct in question. May the instinct which leads them to create queens from worker-larvæ, not also prompt them so to dispense the royal food to common larvæ as to supply the hive with new drones for the new queens? This end is at least gained by the mode in which the worker-bees become productive. Ovaries, in a rudimental state, have been found by late observers in all working-bees.

Mutilations of Queens.

Before leaving the particular subject of queens, the remarkable effects of mutilations upon them may be mentioned. Huber cut off one antenna from a queen, without any marked effects; but when he cut off both, the case was different. "From this moment there was a great alteration in her conduct. She traversed the combs with extraordinary vivacity. Scarcely had the workers time to separate and recede before her; she dropped her eggs without taking care to deposit them in any cell. The hive not being very populous, part was without combs. Hither she seemed particularly earnest to repair, and long remained motionless. She appeared to avoid the bees; however, several workers followed her into this solitude, and treated her with the most evident respect. She seldom required honey from them, but, when that occurred, she directed her trunk with an uncertain kind of feeling, sometimes on the head and sometimes on the limbs of the workers, and if it did reach their mouths, it was by chance. At other times she returned upon the combs, then quitted them to traverse the glass sides of the hive: and always dropped eggs during her various motions. Sometimes she appeared tormented with the desire of leaving her habitation. She rushed towards the opening, and entered the glass tube adapted there; but the external orifice being too small, after fruitless exertion, she returned. Notwithstanding these symptoms of delirium, the bees did not cease to render her the same attention as they ever pay to their queens, but this one received it with indifference. All that I describe appeared to me the consequence of amputating the antennæ." Another similarly mutilated queen was placed beside her; they had both lost their combativeness. Finally, on being again left alone, the poor mutilated queen quitted the hive, unheeded, and abandoned to her fate. This evidence of the high value of the antennæ was gained on the whole in a manner which even a Huber's ardour for science can scarcely excuse.

Massacre of the Drones.

Another of the great natural phenomena of the hive is the massacring of the drones. It was at one time asserted that the worker-bees did not use their stings against the stingless males, but merely pushed them out to die; this idea, however, resulted from the massacre being always committed at the bottom of the hive whither the poor drones retire in clusters in July and August, as if aware of the doom impending over them. As usual, by one of his ingenious expedients, Huber discovered the truth. Six swarms were put on glass tables, beneath which the watchers placed themselves. "This contrivance succeeded to admiration. On the 4th of July, we saw the workers actually massacre the males, in the whole six swarms, at the same hour, and with the same peculiarities. The glass table was covered with bees full of animation, which flew upon the drones as they came from the bottom of the hive; seized them by the antennæ, the limbs, and the wings, and after having dragged them about, or, so to speak, after quartering them, they killed them by repeated stings directed between the rings of the belly. The moment that this formidable weapon reached them was the last of their existence; they stretched their wings and expired. At the same time, as if the workers did not consider them as dead as they appeared to us, they still struck the sting so deep that it could hardly be withdrawn, and these bees were obliged to turn round upon themselves before the stings could be disengaged.

Next day, having resumed our former position, we witnessed new scenes of carnage. During three hours, the bees furiously destroyed the males. They had massacred all their own on the preceding evening, but now attacked those which, driven from the neighbouring hives, had taken refuge among them. We saw them also tear some remaining nymphs from the combs; they greedily sucked all the fluid from the abdomen, and then carried them away. The following days no drones remained in the hives.

These two observations seem to me decisive. It is incontestible that nature has charged the workers with the destruction of the males at certain seasons of the year. But what means does she use to excite their fury against them? This is a question that I cannot pretend to answer. However, an observation that I have made may one day lead to the solution of the problem. The males are never destroyed in hives deprived of queens; on the contrary, while a savage massacre prevails in other places, they there find an asylum. They are tolerated and fed, and many are seen even in the middle of January. They are also preserved in hives, which, without a queen properly so called, have some individuals of that species that lay the eggs of males, and in those whose half-fecundated queens, if I may use the expression, propagate only drones. Therefore, the massacre takes place in none but hives where the queens are completely fertile, and it never begins until the season of swarming is past."

Swarming.

We have now only another of the great natural operations of the hive to advert to, before coming to the consideration of the artificial provisions which have been discovered and employed by man for augmenting the usefulness of this interesting insect. Swarming is the operation referred to, which usually takes place, in temperate climes, in May and June, though additional swarms, and swarms from swarms, are commonly later. In noticing the proceedings of a community from its first settlement, it was mentioned that the old queen led off the first swarm, and did so as if under alarm at the number of royal embryos, usually from twelve to twenty, which were in progress to maturity, and which the worker-bees would not allow her to approach. Other causes also operate, beyond doubt, in a certain degree. The increased heat of the hive from crowding, for example, in all likelihood influences the movement. Bees cannot do without freedom of respiration and fresh air, and it has surprised many observers to find the air usually pure, and below 80 degrees, in a hive ordinarily filled. The insects, however, have been discovered to manage this by active ventilation in their own way. A number of them are always to be seen near the inner, and sometimes the outer side of the opening of the hive, vibrating their wings with great rapidity, and sending the entering air backwards in a smart current. One band relieves another at this task. These means of ventilation, however, seem to become comparatively ineffective when the hive gets over-crowded. The heat often rises to about 100 degrees, the bees are driven to the door in clusters, while the warmth makes the hive visibly moist. At the same time, the old queen's alarm at the growth of the royal young seems to have its influence. She would fain kill them, but the worker-bees lose all respect for her, biting and beating her off with violence. The way in which they defend the royal young at swarming time is indeed most remarkable. If, at any other season, they bring up queens from worker-larvæ, the first queen that leaves the cell is allowed to kill the rest at pleasure. But when casting colonies, the workers, as if from the sense that various swarms may be cast off, and various queens required, will not permit the old queen to touch the young, whom nature has given them the strange power of keeping alive, for better security, in their cells. Nor will they allow the first young one to whom they grant freedom to touch the rest. Huber illustrates this subject beautifully. Suppose an old queen to have left a very populous hive, as described with a swarm. "After the departure of the colony, the remaining workers set another queen at liberty, and treat her with equal indifference as the first. They drive her from the royal cells; she also, perpetually harassed, becomes agitated, departs, and carries a new swarm along with her. In a populous hive this scene is repeated three or four times during the spring. The number of bees being then so much reduced, they are no longer capable of preserving a strict watch over the royal cells several females are therefore enabled to leave their confinement at once; they seek each other, fight, and the queen at last victorious reigns peaceably over the republic.

"The longest intervals we have observed between the departure of each natural swarm have been from seven to nine days. This is the time that usually elapses from the period of the first colony being led out by the old queen until the next swarm is conducted by the first young queen set at liberty. The interval between the second and third is still shorter; and the fourth sometimes departs on the day after the third. In hives left to themselves, fifteen or eighteen days are usually sufficient for the throwing of the four swarms, if the weather continues favourable, as I shall explain.

"A swarm is never seen except in a fine day, or, to speak more correctly, at a time of the day when the sun shines and the air is calm. sometimes we have observed all the precursors of swarming—disorder and agitation—but a cloud passed before the sun, and tranquillity was restored; the bees thought no more of swarming. An hour afterwards, the sun having again appeared, the tumult was renewed; it rapidly augmented, and the swarm departed.

"Bees generally seem much alarmed at the prospect of bad weather. While ranging in the fields, the passing of a cloud before the sun induces them precipitately to return. I am led to think that they are disquieted by the sudden diminution of light. For if the sky is uniformly obscure, and there is no alteration in clearness or in the clouds dispelling, they proceed to the fields for their ordinary collections, and the first drops of a soft rain do not make them return with much precipitation.

"I am persuaded that the necessity of a fine day for swarming is one reason that has induced nature to admit of bees protracting the captivity of their young queens in the royal cells. I will not deny that they sometimes seem to use this right in an arbitrary manner. However, the confinement of the queen is always longer when bad weather lasts several days together. Here the final object cannot be mistaken. If the young females were at liberty to leave their cradles during those bad days, there would be a plurality of queens in the hive, consequently combats; and victims would fall. Bad weather might continue so long that all the queens might at once have undergone their last metamorphosis, or attained their liberty. One victorious over the whole would enjoy the throne; and the hive, which should naturally produce several swarms, could give only one

Thus the multiplication of the species would have been left to the chance of rain or fine weather, instead of which it is rendered independent of either by the wise dispositions of nature. By allowing only a single female to escape at once, the formation of swarms is secured. This explanation appears so simple, that it is superfluous to insist farther on it."

Our author adds, that another important circumstance resulting from the captivity of queens is, that they are in a condition to fly when the bees have given them liberty, and are therefore capable of profiting by the first moment of sunshine to depart at the head of a colony.

Dangers during Swarming.

The capture of the queen, when a swarm has settled on some bush or tree, is, it should be added, the first step towards lodging a swarm in a new hive. If she be placed in it, with two or three bees, the rest will soon follow. A strong glove will enable any one to handle the bees without risk, as they are less disposed to sting when they are swarming than at other times. It sometimes happens, however, that a swarm may settle on the person of any individual who may be near it, in which case presence of mind is absolutely necessary for the preservation of life. The following anecdote, related by Thorley, is strikingly illustrative of what has now been advanced:—

"One of my swarms settled among the close twisted branches of a codling tree; and not to be got into a hive without help, my maid-servant being in the garden, offered her assistance to hold the hive while I dislodged the bees. Having never been acquainted with bees, she put a linen cloth over her head and shoulders to guard and secure her from their swords. A few of the bees fell into the hive, some upon the ground, but the main body upon the cloth which covered her upper garments. I took the hive out of her hands, when she said that the bees had got under the covering, and were crowding up towards her breast and face, which put her in a trembling posture. When I perceived the veil was of no farther service, she gave me leave to remove it. This done, a most affecting spectacle was presented, filling me with the deepest distress and concern, as I thought myself the unhappy instrument of drawing her into so imminent hazard of her life. Had she enraged them, all assistance had been vain, and nothing less than her life would have atoned for the offence. I used all the arguments I could think of, begging her, with all the earnestness in my power, to stand her ground, and keep her present posture. The bees had now got in a great body upon her breast, about her neck and up to her chin, and I began to search among them for their queen. I immediately seized her, taking her from among the crowd, along with some of the commoners, and put them together into the hive. Here I watched her for some time; and as I did not observe that she came out, I conceived that the whole body would quickly abandon their settlement; but instead of that, I soon observed them gathering closer together, without the least signal for departing. Upon this I immediately reflected that either there must be another sovereign, or that the same was returned. I directly commenced a second search, and in a short time, with a most agreeable surprise, found a second or the same. She strove, by entering farther into the crow , to escape me; but I re-conducted her, with a great number of the populace, into the hive. And now the perilous scene began to change to one indefinitely more pleasing and agreeable. The bees, missing their queen, began to dislodge and repair to the hive, crowding into it in multitudes, and in the greatest hurry imaginable; and in the space of two or three minutes the maid had not one single bee about her, neither had she so much as one sting, a small number of which would quickly have stopped her breath."

ARTIFICIAL MANAGEMENT OF BEES.

The artificial management of bees forms, in some measure, a branch of the present subject perfectly distinct from the consideration of the natural operations of bees, of their various classes, of the phenomena attending their transformation, and of their social economy in general. Many able writers of recent days have given to the public their experience of the best modes of preserving these insect communities, and rendering them most productive. And, in the first place, the local situation of an apiary, or accumulation of beehives, has been held of especial consequence.

Site of Apiaries.

The hive must be sheltered in a particular manner from the action of high winds. A wall or hedge is not sufficient to yield the requisite protection; houses or lofty trees are necessary to insure it. The reason of this is, that the bees, returning homewards, require a calm air at a considerable height above their dwellings, otherwise, when they attempt to alight, they are dashed to the ground and killed, their exhausted strength disabling them from coping with a wind of any force. A low position, enclosed with woods, suits them best. Bees drink much, and a fountain or brook is essential to them; deep pools or cisterns very often cause their death by drowning. Shallow troughs, filled with moss or floating wood, are recommended as a substitute for shallow rills. It is an error, according to the experienced bee-keeper De Gelieu, to suppose that hives should be placed full in the sun. Bees, he says, live and thrive in shady places of moderate and uniform temperature, and hence their partiality for forests. Besides, exposure to all the extremes of the solar heat melts and spoils the honey. At least, if exposure to the sun be beneficial at all, that exposure should last only for a comparatively short time, or from about ten o'clock till noon. Hives should not be placed on upper floors, on account of the increased danger from wind. At the same time, a bee-house ought to be so made as to cause a free passage of air, though not of strong currents, at all periods, with openings both anteriorly and posteriorly. A covered shed or verandah is perhaps the best form of a bee-house, yielding both a shade and shelter from the wet. Where hives are simply placed on open stands, these should be about sixteen inches from the ground, and each three or four feet apart. Shifting is condemned by almost all bee observers as very hurtful to the bees.

Hives.

The important question of the size, form, and materials of the hive, has of course received much attention. Whatever be the form of hive adopted, it is found that bees accommodate their labours to it, and fashion their combs of honey accordingly.

Straw hives, or *skeps*, as they are called in Scotland, of which a sketch is afforded by our frontispiece, are the hives most commonly used in cottage-gardens; and being easily and cheaply constructed, they still maintain their place, though much better habitations could be suggested. They are of a roundish form, ordinarily measuring about twelve inches deep and nine inches wide in the lower part. Made of unbroken rye-straw, or any other straw of a strong and elastic fibre and well bound, they will, if tolerably well sheltered, last many years. It is customary to place sticks across the interior, from an idea that such are necessary for supporting the combs; but Mr. Taylor, in his *Bee-Keeper's Manual*,* combats this opinion. "The sticks," observes that intelligent writer, "are only an annoyance to the bees; and there is little fear of the combs falling, except in

* This is a valuable practical treatise, which it affords us pleasure to recommend. It was published by R. Groombridge, Paternoster Row, London, in 1839.

very deep hives: at any rate it may be prevented by contracting the lower part a little. The best way of doing this is by working a wooden hoop inside the bottom band of the hive, as recommended by Dr. Bevan, who says, 'It should be perforated through its whole course, and the perforations made in an oblique direction, so distant from each other as to cause all the stitches of the hive to range in a uniform manner.' The hoop gives greater stability to the hive, preserves the lower edge from decay, and affords facility in moving it. I advise a circular piece of wood (turned with a groove at the edge, to retain it in its place) to be worked into the crown, having through it an inch and a half hole. With a little ingenuity, the bees may be fed through this opening—a better method than the ordinary one at the bottom of a hive. A piece of wood or tin will commonly cover the hole; but at times, and especially in winter, it may be used for the purpose of ventillation, and allowing escape to the impure air of the hive. In this case, a bit of perforated tin or zinc should be placed over it, which, when stopped up by the bees, can be replaced by a clean one. An earthen pan is a common cover to a straw hive, and this may be slightly raised by wedges on the four sides, to permit a small space underneath. Of whatever material the outer covering consists, it must project so far on all sides as to protect the hive from the least moisture. This cannot be too much guarded against; and whether of wood or straw, all hives ought to be well painted at the beginning, and periodically afterwards."

Wooden Hives.—These are superior to straw skeps, the square shape being better adapted for the deposit of combs than the round form. Mr. Taylor's observations may be likewise quoted on this important point. "It matters not much of what wood the boxes are made, provided it is sound, thoroughly seasoned, and well put together. Different opinions are entertained as to the best size of bee-boxes, but I think that much must depend on the number of bees they are to contain, and on the honey locality; there must also be a reference to the proposed mode of working them; for, where no swarming is permitted, a larger hive may be advantageously used. A good size is twelve inches square, and nine inches deep withinside; the thickness throughout being not less than an inch. The top of the box ought to project on all sides nearly three-quarters of an inch, for better protection and appearance, and as affording convenience for lifting. On the top a two-inch hole should be cut in the centre, for placing a bell-glass, and for the purpose of feeding; and another hole to receive a ventillator may be made near the back window, that position being better for inspection, and less in the way of the bees, than the centre of the hive, which is, or ought to be, the seat of breeding, and should not be disturbed. A window may be placed at the back and front, five inches high and six or seven inches wide. The best and neatest way of securing the windows that I have seen, is by a sliding shutter of zinc. Round the window there must be a projecting moulding, mitred at the corners. On one side the piece of moulding is movable, and to the back of this is screwed a plate of sheet zinc. This passes into a rabbet to receive it, cut, on the remaining three sides, at the back of the lower edge of the moulding. To prevent any wet from lodging at the bottom moulding, an opening or two may easily be cut through, on the under side, to allow its escape. For the sake of uniformity of appearance, blank windows may be made opposite to the real ones. Hives of this kind require to be placed under some cover or shed, as a protection from wet and a hot sun."

To these explanations it should be added that the hive of either form must be placed on a clean wooden floor or board; and if there be several hives together, each should have its own separate floor. Do not cement the hives to the board, that being a duty which the bees will themselves perform; all that may be given is a slight luting of clay, or any easily removable material. The entrance to the hive requires to be small, a little larger than a shilling, but rather wider than deep, and ought to be at the lower edge of the hive, on the side which is exposed. Numberless have been the plans invented to enlarge hives as they may be required, both to permit of the greater accumulation of honey, and to render swarming unnecessary. Capes or hoods are the simplest of these inventions. In order to use capes, hives must have a stoppered hole at the top. A small additional hive of light structure is placed over this at the proper time, the stopper being removed. This serves as a second magazine for honey. Storyed hives are merely hives made originally with one or two storys, for the same end. Wildman's hive, the Grecian hive, and Lombard's hive, are specimens of hives made on this principle. Collateral hives, again, such as Nutt's, effect the same ends by being placed side by side, and giving increased accommodation, when necessary, either for swarms or stores. But of all such hives, our readers will probably prefer to know the one used by Huber. We quote an account of it given in the *Naturalist's Library*. Huber's leaf-hive, as he called it, "consists of eight frames, each 18 inches high [a height of 14 inches is preferable] and 10 inches wide inside, having the uprights and top cross pieces one and a half inch broad, and one thick, so that the eight frames, when placed close together, constitute a hive 18 inches high, 12 inches between end and end, and 10 inches between back and front, all inside measure. The frames are held together by a flat sliding-bar on each side, secured by wedges and pins. To the first and eighth of these frames is attached a frame with glass, and covered with a shutter. The body of the hive is protected by a sloping roof, and the entrance is made through the thickness of the floor-board. We dislike the sliding-bars, with their pins and wedges, which are so far inconvenient, that in drawing them out, all the frames are liable to open, and the observer is exposed to some hazard of annoyance, from the bees issuing out at every joint; and we have substituted for them hinges on one side, and a hook-and-eye on each frame on the other; we can thus open any particular leaf without meddling with the rest. In taking honey from this hive, the bee-master has the whole interior completely under his eye and at his disposal, and can choose what combs best suit his purpose, both as to quantity and quality; taking care, however, to do so only at such periods as will leave the bees time to replenish the vacancy before the termination of the honey season. It is also well adapted for artificial swarming. By separating the hives into halves, the honey, brood-combs, and bees, will, generally speaking, be equally divided; and by supplying each half with four empty frames, we shall have two hives, one half empty, equal in number of bees, of brood, and even of stores. One of the new hives will possess the queen; and if the operation has been performed at the proper time—that is to say, a week or ten days before the period of natural swarming—the probability is, there will be royal brood coming forward in the other; at all events, there will be plenty of eggs and larvæ of the proper age for forming an artificial queen."

Use of Capes.—It will be observed from these quotations, that experienced apiarians, who work on a large scale, now employ, for the most part, hives so contrived as to remedy all the inconveniences resulting from the straggling of swarms and the old custom of killing by brimstone. As the use of single straw hives, however, formed upon the simplest plan, still prevails among those who have but one or two hives in all, the cape may be regarded as the easiest means of affording enlarged accommodation in such cases, and the mode of taking away the honey from it is very plain and easy. It is only necessary to remove the cape, invert it, and cover it with a handkerchief, leaving a little opening on one side. A few taps will cause the bees to quit the cape and return to the hive, after which the honey can of course be readily removed. This may be done frequently in the same season. De Gelieu mentions that in one season he drew from one of his straw hives that did not swarm seventy-two pounds of fine honey-comb, by merely emptying the capes as they were filled.

Union of Swarms.

It is strongly recommended by experienced men, that swarms should be more often united than they are. Five thousand bees are estimated to weigh a pound; and, according to most bee-keepers, a swarm ought to weigh nearly four pounds. As a hive often casts off successive colonies, each far below this weight, it then becomes proper to unite two or more of them; seeing that one strong population supports itself better, and is incomparably more profitable, than several feeble colonies, which must be frequently in want of assistance. To those who keep bees on a small and cheap scale, convenience also dictates the junction of swarms in such cases. De Gelieu thus describes his mode of practice:*—"When two small swarms come off the same day, I gather them separately, and leave them at the foot of the tree or bush on which they have alighted. Towards evening I spread a table-cloth on the ground, on which, by a smart and sudden movement, I shake all the bees out of one of the hives, and immediately take the other and place it gently over the bees that are heaped together on the cloth, and they instantly ascend into it, flapping their wings, and join those which, not having been disturbed, are quiet in their new abode. Early next morning I remove this newly united hive to the place it is destined to occupy. This double population works with double success, and in the most perfect harmony; and generally becomes a powerful colony, from which a great profit is derived. Two feeble swarms may be united after the same manner, although one of them may have come off some days later than the other, and the first may have constructed combs; taking care, however, not to make the first one enter the second, but the second the first, as the bees will ascend more readily to join those that have already begun to make honey and to hatch brood; and next day they will proceed together with increased ardour with the work which the first had already begun, and which will now advance more rapidly from the increase of the labourers. It is to be understood that, after this union, the hive should be placed early next morning in the same place where the oldest of the swarms has already passed some days." On many occasions, the circumstance of two queens passing out at once is the cause of a colony going off in two halves, and the removal of one of the queens is necessary, to facilitate the cordial junction into one community. Artificial swarming may be effected by expelling a body of bees, and lodging them in a new hive with a quantity of comb removed with them. Tobacco smoke is used for the expulsion.

Summer Management of Bees.

The feeding of bees at different seasons is an important point to the bee-keeper. In summer they feed themselves, and of course a good supply of the requisite material is then essential to their well-doing. The most highly cultivated districts are not so favourable to bees as those in which wild heaths, commons, and woods prevail; or where white clover, saint-foin, buck-wheat, mustard, and cole-seed, are produced in abundance. Bee-keepers, however, may do something to further the supply of summer food. Mr. Payne recommends the planting of quantities of the common kinds of crocus, single blue hepaticas, black hellebore, and some other early flowering plants. Various kinds of thyme and mignonette may be grown to purpose, and the bees are especially fond of the salvia nemorosa and the snowberry plant. But on the natural products of the country, generally speaking, bees must rely for summer food, if the weather be such as to permit of their gathering it. Should a succession of coarse bad weather occur, however, at the beginning of summer, and particularly after a swarm has entered a new hive, most apiarians think it essentially necessary to give honey, or syrup of sugar and water, to the newly hived stock. If no proper brook or fount be at hand, water should always form a part of the summer provision. The bees being at full work in this season, the door of the hive should be opened to its whole extent, and not closed, as is more or less requisite at other times. In the hives formed upon improved plans, ventilators constitute a part of the apparatus, and thermometers are introduced to regulate their use. Though these are valuable adjuncts certainly, they are not indispensable; seeing that the bees, as already mentioned, contrive to ventilate to some extent for themselves. Where artificial ventilation can be effected, it is recommended that the temperature should be maintained at from 65 to 80 degrees of Fahrenheit. It is recommended, on evenings when the moths are numerous, to place a small grating before the hive; and it will also be advisable to destroy any wasps, spiders, earwigs, or other insects settled near the hives.

Autumnal Management.

The autumnal period has long been the most calamitous for bees, not through the injuries of enemies or weather, but from the improper management of bee-keepers. After the carcasses of the drones, strewn in multitudes before the hive, have indicated that, with the beginning of August, has come the close of the rich honey season, the bee-keeper deems it time to take from the hive the reward of his care and attention. The use of storied hives or extra boxes, renders it easy to take away a portion of honey early in the season, and this is called *virgin honey*. Even with a common straw-hive, it has been found possible to take away the honey, and retain the bees in the hive. Wildman, the famous experimenter on bees, recommended that the hive should be taken into a dark room, and there struck repeatedly till the bees are forced to ascend into an empty hive. The combs are then cut out with a thin knife, and the bees finally returned to the old hive. But this plan is seldom pursued, being at once dangerous and destructive to the brood combs.

It is generally reckoned advantageous to change the pasturage for a week or two before taking the honey-harvest. About mid-autumn, the ordinary food of bees begins to fail and their stock of honey to decrease daily. By a removal of three weeks to a healthy district, a hive not only loses nothing, but frequently gains as much as ten or twelve pounds of honey in ordinarily favourable circumstances. So well is this known by bee-keepers near Edinburgh, that one shepherd on the healthy Pentland hills receives in charge several scores of hives annually, for the heath-feeding.

Honey-Harvest.

After the autumnal accession of honey has been obtained, and the bees have been brought home again, the question comes to be, in what manner the harvest should be reaped. By partially depriving each of a portion of comb, and leaving some for food? By suffocating one-half the communities, taking their entire honey, and leaving the other hives with their honey untouched, to serve as stock? Or finally, by removing the bees from

* The work we here quoted is entitled "The Bee Preserver;" translated from the French of Jonas de Gelieu, by a lady in Edinburgh, and published by John Anderson junior, Edinburgh, 1829.

one-half the hives to the other half, forming united stocks, and acquiring all the honey of the evacuated ones? These three plans are known by the several names of *partial deprivation* (commonly and most easily practised with improved hives, as already described), *suffocation*, and *union of stocks*. "The practice of partial deprivation," says the *Naturalist's Library*,* "has never yet become general, because it is liable to frequent failure, even in improved hives, and because the full benefit is not derived from it at the very commencement of the system. The liability to failure, the first of the objections stated, is owing, in most instances, not to the *mode*, but to the *period* of the operation. According to the too common practice of those who are friendly to deprivation, a portion of honey is abstracted from the hives about the beginning or middle of September; and the owner compliments himself on his moderation, in being content with a part instead of the whole, and on his humanity in saving the lives of his industrious favourites; while in nine instances out of ten he finds, on the arrival of March, that his moderation and humanity have been altogether unavailing, and that he has saved them from a violent death by suffocation, only to expose them to the more tardy but not less cruel death by starvation. Whereas, if deprivation take place soon after the swarming season, as already recommended, and is managed with discretion, the issue will be very different, and ultimately more profitable to the owner, than the almost universally practised mode by suffocation, which is too well known to need description. The latter system may yield a greater return in proportion to the hives operated upon; but in the former, there is a much greater number of hives available. For example, suppose two apiaries, each containing five stock-hives at the end of July, exclusive of as many swarms recently thrown. The owner of the one, practising the depriving system, takes from each of his stocks 10 pounds of honey, making an amount of 50 pounds as his honey-harvest. The owner of the other, and abettor of suffocation, proceeds in September to smoke his five old hives, and receives from each 25 pounds of honey, making an amount of 125 pounds as his honey-harvest—between two and three times the quantity of the other. In the following year, the depriver has his five old stock-hives, and the five swarms now become stock-hives; from the whole ten he now takes a hundred pounds of honey, while at the same time his apiary is augmented by the addition of ten new swarms, making twenty for the following year; while his rival possesses only his former number of five, yielding 125 pounds. In the next year, that is, two years from the commencement of the comparative trial, the depriver has twenty stock-hives, yielding 200 pounds, and so on by a geometrical ratio; while the other remains at his original 125 pounds. This calculation is made on the supposition that each owner takes but one swarm from each stock, and without making any allowance for losses and failures, which will affect the produce of both in honey and bees, but to which both are liable."

The writer of this comprehensive treatise proceeds to point out the advantages of the humane principle of sparing the lives of these useful insects. "It is pitiable to reflect, that the small degree of additional trouble required in uniting them, should prove so effectual an obstacle to this conservative practice. Yet the operation with each hive so treated, need not occupy more than fifteen or twenty minutes. In the evening, when all are quiet, turn up the hive which is to be operated upon, fixing it in a chair from which the stuffed bottom has been removed; place an empty hive above it, wrap a cloth round the point of junction, to prevent the bees from coming out and annoying the operator; then, with a short stick or stone in each hand, beat round the sides, but *gently*, for fear of loosening the combs. In five minutes, the panic-struck insects will hastily mount into the empty hive, with a loud humming noise, expressive of trepidation. The hives are then separated—that containing the bees is placed on its usual pedestal, and the other containing the honey is carried off. The union is next to be effected. Turn up the stock-hive which is to receive the addition to its population; with a bunch of feathers, or a small watering-pan, such as is used for watering flower-beds, drench them with a solution of ale and sugar, or water and sugar, made a little warm. Do the same to the expelled bees; and then, placing these last over the stock, mouth to mouth, a smart rap on the top of the hive will drive them down among the bees and combs of the undermost hive. Place this last on its pedestal, and the operation is completed. The strong flavour of the solution will prevent them from distinguishing between friend and stranger; and their first movement, after recovering from their panic, will be to lick the liquid from one another's bodies. This mode of operating is applicable to all kinds of hives." With regard to the two queens, one would assuredly kill the other in a very short time; but the best way is to remove one of them before union.

One argument employed by advocates of the plan of suffocation by introducing the fumes of brimstone or other noxious effluvia, is, that by the union of stocks, you have an immense number of mouths to feed, of which the killing plan relieves you. Only inexperienced bee-keepers, however, could use this reasoning. De Gelieu having discovered the remarkable fact, that the increase of numbers in the winter hives is far from producing a proportionate increase of consumption. From fifteen to twenty pounds of honey, or from three to four pots, are requisite for the winter maintenance of a single hive of ordinary strength, with which the plan of union has not been practised. De Gelieu placed such a hive, with such a store, beside one into which three full communities had been introduced, and he found, on weighing the latter in the spring, that its inhabitants had scarcely used one pound of honey more than those of the single-stocked hive. The experimenter even went further. To a hive already amply stocked, he added the swarms of four other hives, and found on weighing it in the spring, that "the total diminution of honey did not exceed three pounds more than took place in ordinary single hives." Had they not been thus united, he says, each of these stocks would have cost him much more money than they were worth, and, indeed, the most of them "would to a certainty have perished." The cause of this strange fact by which nature seems to point to the plan of autumnal unions as the best possible for both bees and bee-keepers, is yet unknown.

The combs, by whatever process procured, should be deprived of the honey at once, while a natural warmth remains in them. Various kinds of drainers have been used for separating the honey, and keeping it as much as possible from the external air. The honey which runs off naturally without breaking down the combs, and passes through muslin, is held to be the finest. A second kind is cured by cutting the combs in pieces, and letting the honey pass through a drainer, under exposure to a gentle heat. A third quality is procured by subsequently putting the combs in a vessel placed on a fire; the product, strained through canvas, is used in feeding bees. The separated wax of the combs is introduced into a woollen bag, firmly tied at the mouth, and put into boiling water. The pure wax oozes through, and is skimmed off the surface, where it floats. It is then to be allowed to cool slowly. The best honey is supposed to be that formed from heath. The famous bees of Hymettus were nourished by that plant.

* "Naturalist's Library," conducted by Sir William Jardine. Entomology vol vi.—*Bees*. Edinburgh: W. H. Lizars. 1840. This beautiful miscellany requires no panegyric from the writer of these pages.

Honey is used as condiment at the table, and is also employed in medicine. In ancient times in Britain, it formed the basis of a beverage called *Mead*, and from the common practice of drinking it for a month after a wedding, came the expression *honeymoon*. In course of time mead was superseded by beer, wine, and other liquors, but is still allowed by writers on diet to be wholesome as a drink, and certainly less pernicious than the ordinary kinds of intoxicating fluids. As some bee-keepers, to whom our pages are addressed, may wish to attempt the manufacture of mead for domestic use, we offer the following as one of the best methods for its preparation, from the Encyclopædia Britannica:—"Into twelve gallons of water put the albumen [or white] of six eggs, mixing these well together, and to the mixture adding twenty pounds of honey. Let the liquor boil an hour; and when boiled, add cinnamon, ginger, cloves, mace, and rosemary. As soon as it is cold, put a spoonful of yeast to it, and barrel it, keeping the vessel filled as it works; when it has done working, stop it up close; and when fine, bottle it off for use."

Winter and Spring Management.

In winter and early spring, bees require to be tended with great care. In the case of those hives which have been entirely deprived of their honey, systematic feeding is of course indispensable in winter; but few bee-keepers of any experience ever willingly follow any other plan than that of leaving to bees a winter supply of their own produce. Some bee-keepers remove their hives into the house in winter; but this is an unwise practice, as the bees must then be kept continually in confinement. Though the door of the hive should be carefully narrowed or shut up in very cold weather, at which time every bee that issues perishes, yet advantage should be taken of every fine day to let them abroad. Where feeding is necessary, the following rules have been laid down for the management of common hives in winter and early spring. Bees must be fed only when the weather is fine and warm, to prevent the temperature of the hive from being injured; and a large quantity should never be given at once, for the bees are so greedy of food, that they will rather fill the brood cells with it than relinquish their treasure. The quantity of food which ought to be given to a hive may be calculated in the proportion of two pounds a month; but if the weather be very cold, a less quantity will suffice. When a hive is fed in the spring, it should always be after sunset, when the bees have returned from the fields; otherwise the most disastrous consequences may ensue, from the robberies committed by the bees of other hives. If they are fed in the morning, it must be before sunrise, and the entrance instantly stopped to keep out depredators; for, as the bees leave the hive on the very first appearance of day-light, a later period would prevent the return of all those who had left the hive previous to the entrance being secured.

Relative to the substances which are proper for the feeding of bees, many different opinions exist; but the following may be considered among the most beneficial as well as economical articles of diet:—To two quarts of good ale put one pound of moist sugar; boil them until the sugar is wholly dissolved, carefully skimming it; when it is cold, it will be found of the consistency of honey, and it may be given to bees in the following manner:—If the bees are in the plain cottage hive, an eek of the same diameter as the hive must be provided, and from three to four hands in height. When the sun is set, and the bees have retired, let the hive be gently raised, and the eek placed on the stool; then, having filled a soup-plate with the food, place it on the eek, and put down the hive. To prevent the bees being drowned in the liquid, it is necessary to place some straws over the plate, and over the straws a piece of paper, either thickly perforated or cut into nicks; these nicks, however, must not run parallel with the straws, but either across or diagonally; the entrance must then be closed, and the plate removed on the following morning, and the whole of the liquid will be transferred into the combs.

Diseases and Enemies of Bees.

Bees, according to the conclusions of De Gelieu, after sixty-four years' experience, have "no real disease; they are always in good health as long as they are at liberty, and when they are warm enough, and have plenty of food." In early spring, however, they are found liable to an affection called dysentery, which is known by the marks on the board of dark-coloured evacuations, by the offensive smell, and by the frequent deaths. This disease certainly results, in most cases, from long confinement in a damp and impure air. By lifting the hive to expel the vitiated air, scraping, washing, and drying the board, and removi[illegible] the dead bodies, the complaint, says Mr. Taylor, [illegible] remedied even in the most extreme cases. [illegible]ved with honey and water, has been recom[illegible] a cure; but the experienced apiarian [illegible]ceives all dietetic remedies to do more [illegible]ood. A little chloride of lime, he suggest[illegible] beneficially in washing the board. One point [illegible]oticed here, that exposure to the sun is held [illegible] injurious to the hives in winter. This caution is necessary, as bee-keepers, when they suspect dampness, might fall into an error on this score.

A few of De Gelieu's hints respecting the chief foes of the bee-tribe may be useful to bee-keepers. After observing that the possessors of bees, often from an ignorant excess of care, are among their greatest enemies, he says—"Ants are their least dangerous enemies; true, the bees cannot sting them to death, because they are small and well defended with armour, but they seize hold of them with their teeth, and carry them to a distance. Had they not this means of getting rid of them, their colonies could not exist in the vast forests full of ant's nests, and where they thrive so well, in spite of the horrible massacres that annually take place.

"Moths are little known, and never injurious, in the high valleys, nor on the mountains; but they attack and destroy a vast number of hives in the plains or in the vineyards, where they are a great scourge. As soon as a moth has penetrated a weak hive, it establishes itself in a comb, envelopes itself in a silken web, multiplies rapidly, consuming the wax, and spreading its destructive galleries from side to side, until, arriving at a certain point, the evil has scarcely a remedy.

"The only means of saving the colony is to imitate the surgeon, who cuts off a diseased limb to save the other—every bit of infected comb must be cut out, leaving only those occupied by the bees. And the bees must then be liberally fed, by giving them every evening as much honey as will maintain them until the fields shall yield them a sufficient quantity. Thus I have preserved hives whose circumstances seemed to be desperate.

"Spiders annoy the bees much. The bees get entangled in their webs, and are not able to extricate themselves. Here cleanliness is the best protection; therefore care should be taken to sweep the webs away from the hive and its avenues as fast as they appear.

"Birds eat a prodigious quantity of bees, especially in spring, when the trees are in blossom; and the poultry, also, that roam about or near the water where the bees go to quench their thirst, gobble up a great many.

"Mice, especially the red mouse, or *sorex araneus*, sometimes penetrate a hive in the winter time, either from the entrance being left too wide, or by gnawing a hole for themselves in the straw. They eat the honey, and even the bees, when clustered together on the side of the hive,

IMAGE EVALUATION TEST TARGET (MT-3)

6"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in which position they are unable to defend themselves, and scarcely even see the enemy.

"Wasps are also reckoned among the numerous enemies of bees. I have, however, seldom seen a hive destroyed by wasps; although they are larger, stronger, and armed with a formidable sting, and an impenetrable cuirass, they seldom dare enter a well-stocked hive. Once attacked, they soon fall beneath the united efforts of these brave citizens, who sacrifice themselves to defend the place of their nativity. Wasps only appear in great numbers when the fruit is ripening, and then they range unceasingly round the hives, and enter the weak ones, or those of which the too spacious lodging bears no proportion to the number of its inhabitants. There are three ways of providing against the attacks of wasps. The first is, to unite weak hives by doubling or tripling the population, thereby enabling them to defend themselves. The second is, to contract the entrances as soon as the swarming time is over, after the massacre of the drones; and the third is, to destroy their nests.

"The bees are continually fighting between themselves, and robbing each other: avarice, not necessity, leads them to do so, it being almost always the strongest and best provisioned hives that pillage the weak ones. When once a bee has been able to introduce itself into a hive, and carry away a load of honey without being arrested, it will return a hundred times the same day; and, making it known to its companions, they will then come in hordes, nor cease their pillage till there is nothing left to take. In one day the whole of the honey will be carried off, and with a determination which one can scarcely have an idea of without seeing it. This kind of pillage is most frequent in the spring and autumn, and it is easier to prevent than to stop it; and, for this purpose, the entrance of the hives ought to be straitened in proportion to the population."

WILD BEES.

Besides the garden or hive-bees, as already mentioned, there are various other species of bees, which have never been domesticated by man, though many of them construct hives and produce honey. Of such of these wanderers of the wilds as are indigenous to Britain, it may be interesting, more especially to the young, to learn some brief particulars. The most common species of the wild or *humble* bee (*bombus*) is an insect at least double the size of the hive-bee, with a black head and body, having yellow rings crossing the latter anteriorily and superiorily, and white and black rings alternating at the posterior extremities.

Both on account of their peculiar habits and selected places of residence, this and another wild species called the moss bee, are unfitted for domestication. Few of them survive the rigours of winter, but one, a female, that does escape, manages, for a season, the resuscitation of the breed. Abroad, it flies in early, and, alone and unaided, sets laboriously to work in constructing its nest, piercing the earth or moss, as its instinct may be, and excavating a small chamber wherein to lay its eggs. It does not make wax and cells for the young. These come to maturity in the cocoons which they spin for themselves in the larva state; and when they emerge, these cocoons form stores for food. The solitary bee feeds alone in its earliest progeny, but these soon multiply around it, enlarge the cells, gather honey, and feed the increasing young. The wants of the young go on increasing for a great part of the summer, and the quantity of honey they consume is very large: towards the middle or latter part of September, however, the energies of the bees begin to wax fainter, and little further progress is made in adding to the colony, or in collecting honey. Cold and showery days begin, even by this time, to thin the number of the insect population, who are now seen creeping slowly, with damp and heavy wings, upon the stalks and petals of flowers, where they were formerly seen actively buzzing about in search of honey. The stores of the honey-cups have not outlasted the wants of the young unfledged bees, of which they were the proper food; and if the nests be examined now, these cups are found quite empty. The bees which survive the accidents of rain, cold, and frost (for they are now frequently overtaken by frosty nights in their languid journey homeward), by degrees forsake the nest and its furniture, leaving the latter a prey to mice, beetles, or other animals. To shelter themselves for the winter, they seek out some dry bank (not preferring one exposed to the sun), where they penetrate to the depth of eighteen inches or two feet into the earth, pushing up the earth behind them, and leaving no visible track by which they have descended. In these situations they are often found by labourers and others in digging the earth; and such people are often greatly puzzled to imagine how the insect can have reached such a depth. Persons who have attended to the habits of wild bees can often fix on the spots where they take refuge, digging for and finding them with the greatest certainty.

The experiment of domesticating the different kinds of wild bees has been tried; and it was found, that by removing their nest cautiously in an evening, and placing it in a quiet situation, in a garden or other place where they could be observed, they went on with their works without apparent alarm or interruption. During the whole summer, they continued to prosecute their occupations with the same industry as other bees; but about September, as we have mentioned, the hive began to turn languid, and the numbers which appeared going and coming about the entrance became daily smaller. It was imagined they had taken refuge within the hive; but when this was opened, after all seemed to have ceased their labours, every thing was found empty and deserted; there was neither bees nor honey; the stronger and younger insects, no doubt, having gone to make burrows for themselves in the earth, and the older ones having gradually fallen victims to the accidents of approaching winter.

Our wild bees, therefore, appear to possess their brief lives but for self-enjoyment, or rather to form one of that order of beings created by the great Author of all as if for the purpose of leaving no corner of the universe without its utmost allotment of sentient and enjoying things. And surely, in copse and forest, by dale and mead, on river-bank and mountain-side, there is enough and to spare of the food which it seeks for the humble bee. Though our British wild bees may not be convertable to man's uses, however, there are wild bees which are not so situated. In Cashmere, there are several kinds of bees, which have the habits requisite for domestication; and that country, with the north of India, appears to be the native soil of these genera of honey-bees. The inhabitants have a way of domesticating them which might be imitated with success in this country. In building dwelling-houses, they leave certain cavities in the wall, with a very small aperture to the outside, like the entrance to a hive, but quite open inwards; this inner part is covered afterwards with a frame, having a door which opens at pleasure; into these cavities, which are much superior, in the essential respects of warmth and security, to our bee-hives, the insects are admitted: and here they carry on their labours during the summer. The people of the house, by opening the interior door, can see them at work whenever they please, and can remove a honey-comb at any time without distressing the hive; the only precaution necessary being to blow in at the back part as much smoke as will make the bees fly out at the front entrance. English travellers have seen the operation performed, and the bees quietly return. This plan of lodging bees might be followed here to great advantage, if not in dwelling-houses, at least in the offices about farms, where a bee-hive would be at once cheaper, more secure, and more ornamental, than the masses of straw now used; which, besides affording no security against human plunderers, are the haunts of all sorts of vermin.

In the warm regions of the south of Europe, a black species of wild bee is found, which, according to the naturalist Reaumur, constructs its nest in a remarkable manner by boring into timber. "She usually selects the putrescent uprights of arbours, espaliers, or the props of vines; but sometimes she will attack garden seats, thick doors, and window-shutters; the piece that she chooses is usually cylindrical, and perpendicular to the horizon. Her strong maxillæ are the instruments she employs in boring it; beginning on one side for a little way, she points her course obliquely downwards, and then forwards in a direction parallel with its sides, till she has bored a tunnel of from twelve to fifteen inches in length, and seven or eight lines in diameter. A passage is left where she enters or first begins to bore, and another at the end of the pipe. As the industrious animal proceeds in her employment, she clears away the wood that she detaches, throwing it upon the ground, where it appears like a small heap of sawdust. Thus, we see, she has prepared a long cylinder in the middle of the wood, sheltered from the weather and external injuries, and fit for her purposes. But how is she to divide it into cells? What materials can she employ for making the floors and ceilings of her apartments? The sawdust is at hand, and this supplies her with all that she wants to make this part of her mansion complete. Beginning at the bottom of the cylinder, she deposits an egg, and then lays in a store of pollen, mixed with honey, sufficient for the nutriment of the little animal it is to produce. At the height of seven or eight lines, which is the depth of each cell, she next constructs, of particles of the sawdust glued together, and also to the sides of the tunnel, what may be called an annular stage or scaffolding. When this is sufficiently hardened, its anterior edge affords a support for a second ring of the same materials, and thus the ceiling is gradually formed of these concentric circles, till there remains only a small orifice in its centre; and this is also filled up with a circular mass of agglutinated particles of the sawdust. This partition exhibits the appearance of as many concentric circles as the animal has made joinings, and is about the thickness of a French crown-piece; it serves for the ceiling of the lower, and the floor of the upper apartment. One cell being completed, she proceeds to another, which she furnishes and finishes in the same manner; and so on till she has divided her whole tunnel into apartments, which are usually about twelve." At the proper season the young come forth, each in its turn, from these long and ingeniously contrived tunnels.

Bee-Hunts in the Wilds of America.

In some countries the honey-bee still roams in an undomesticated state, taking up its abode in the hollows of trees or other suitable places of shelter, and annually throwing off swarms which seek new habitations. In the western parts of North America, colonies of bees enjoying this wild freedom are frequently observed by travellers; and the discovery of their rude hives, for the sake of their store of honey, forms a kind of profession to a class of persons known by the name of bee-hunters. On the subject of these sports, Washington Irving speaks as follows, in his "Tour in the Prairies of the Far West:"—

"The beautiful forests in which we were encamped abounded in bee-trees; that is to say, trees in the decayed trunks of which wild bees had established their hives. It is surprising in what countless swarms the bees have overspread the Far West within but a moderate number of years. The Indians consider them the harbinger of the white man, as the buffalo is of the red man; and say, that in proportion as the bee advances, the Indian and the buffalo retire. We are always accustomed to associate the hum of the bee-hive with the farm-house and the flower-garden, and to consider those industrious little animals as connected with the busy haunts of men; and I am told that the wild bee is seldom to be met with at any great distance from the frontier. They have been the heralds of civilization, steadfastly preceding it, as it advanced from the Atlantic borders; and some of the ancient settlers of the West pretend to give the very year when the honey-bee first crossed the Mississippi. The Indians, with surprise, found the mouldering trees of their forests suddenly teeming with ambrosial sweets; and nothing, I am told, can exceed the greedy relish with which they banquet, for the first time, upon this unbought luxury of the wilderness. At present the honey-bee swarms, in myriads, in the noble groves and forests that skirt and intersect the prairies, and extend along the alluvial bottoms of the rivers. It seems to me as if these beautiful regions answer literally to the description of the land of promise—'a land flowing with milk and honey;' for the rich pasturage of the prairies is calculated to sustain herds of cattle as countless as the sands upon the sea-shore, while the flowers with which they are enamelled render them a very paradise for the nectar-seeking bee.

"We had not been long in the camp, when a party set out in quest of a bee-tree, and being curious to witness the sport, I gladly accepted an invitation to accompany them. The party was headed by a veteran bee-hunter, a tall lank fellow, in homespun garb that hung loosely about his limbs, and a straw hat, shaped not unlike a bee-hive; a comrade, equally uncouth in garb, and without a hat, straddled along at his heels, with a long rifle on his shoulder. To these succeeded half a dozen others, some with axes, and some with rifles; for no one stirs from the camp without fire-arms, so that he may be ready either for wild deer or wild Indian. After proceeding some distance, we came to an open glade on the skirts of the forest. Here our leader halted, and then advanced quietly to a low bush, on the top of which I perceived a piece of honey-comb. This, I found, was the bait or lure for the wild bees. Several were humming about it, and diving into its cells. When they had laiden themselves with honey, they would rise up in the air, and dart off in one straight line, almost with the velocity of a bullet. The hunters watched attentively the course they took, and then set off in the same direction, stumbling along over twisted roots and fallen trees, with their eyes turned up to the sky. In this way they traced the honey-laden bees to their hive, in the hollow trunk of a blasted oak, where, after buzzing about for a moment, they entered a hole about sixty feet from the ground. Two of the bee-hunters now plied their axes vigorously at the foot of the tree, to level it with the ground. The mere spectators and amateurs, in the mean time, drew off to a cautious distance, to be out of the way of the falling of the tree and the vengeance of its inmates. The jarring blows of the axe seemed to have no effect in alarming or agitating this most industrious community. They continued to ply at their usual occupations—some arriving full-freighted into port, others sallying forth on new expeditions, like so many merchantmen in a money-making metropolis, little suspicious of impending bankruptcy and downfall: even a loud crack, which announced the disrupture of the trunk, failed to divert their attention from the intense pursuit of gain: at length down came the tree with a tremendous crash, bursting open from end to end, and displaying all the hoarded treasures of the commonwealth. One of the hunters immediately ran up with a wisp of lighted hay, as a defence against the bees. The latter, however, made no attack, and sought no revenge: they seemed stupified by the catas trophe, and, unauspicious of its cause, remained crawling and buzzing about the ruins, without offering us any molestation. Every one of the party now fell to, with spoon and hunting-knife, to scoop out the flakes of honeycomb with which the hollow trunk was stored. Some of them were of old date, and a deep brown colour; others were beautifully white, and the honey in their cells was almost limpid. Such of the combs as were entire were placed in camp-kettles, to be conveyed to the encampment; those which had been shivered in the fall were devoured upon the spot. Every stark bee-hunter was to be seen with a rich morsel in his hand, dripping about his fingers, and disappearing as rapidly as a cream tart before the holiday appetite of a schoolboy. Nor was it the bee-hunters alone that profited by the downfall of this industrious community. As if the bees would carry through the similitude of their habits with those of laborious and gainful man, I beheld numbers from rival hives, arriving on eager wing, to enrich themselves with the ruins of their neighbours. These busied themselves as eagerly and cheerily as so many wreckers on an Indiaman that has been driven on shore—plunging into the cells of the broken honeycombs, banqueting greedily on the spoil, and then winging their way full-freighted to their homes. As to the poor proprietors of the ruin, they seemed to have no heart to do any thing, not even to taste the nectar that flowed around them, but crawled backwards and forwards, in vacant desolation, as I have seen a poor fellow, with his hands in his pockets, whistling vacantly and despondingly about the ruins of his house that had been burned. It is difficult to describe the bewilderment and confusion of the bees of the bankrupt hive, who had been absent at the time of the catastrophe, and who arrived, from time to time, with full cargoes from abroad. At first they wheeled about in the air, in the place where the fallen tree had once reared its head, astonished at finding all a vacuum. At length, as if comprehending their disaster, they settled down in clusters on a dry branch of a neighbouring tree, from whence they seemed to contemplate the prostrate ruin, and to buzz forth doleful lamentations over the downfall of their republic. It was a scene on which the 'melancholy Jacques' might have moralized by the hour."

In various parts of Africa, hunting for the nests of wild bees is similarly pursued by the natives of that extensive continent. In Alexander's "Expedition into the Interior of Africa," we find the following notice of a hunt of this kind:—"One of the Hottentots observed a number of bees entering a hole in the ground, which had formerly belonged to some animal of the weasel kind. As he made signs for us to come to him, we turned that way, fearing he had met with some accident; and when the people began to unearth the bees, I did not expect that we should escape without being severely stung. But they knew so well how to manage an affair of this kind, that they robbed the poor insects with the greatest ease and safety. Before they commenced digging, a fire was made near the hole, and constantly supplied with damp fuel to produce a cloud of smoke. In this the workmen were completely enveloped; so that the bees returning from the fields were prevented from approaching, and those which flew out of the nest were driven by it to a distance. Yet the rest of our party, to avoid their resentment, found it prudent either to ride off, or stand also in the smoke. About three pounds of honey were obteined, which, excepting a small share which I reserved till tea-time, they instantly devoured in the comb; and some of the Hottentots professed to be equally fond of the larvæ. The honey appeared unusually liquid, and nearly as thin as water, yet it seemed as sweet, and of as delicate a taste, as the best honey of England. Whilst I was engaged in the chase one day on foot with a Namaqua attendant, he picked up a small stone, looked at it earnestly, then over the plain, and threw it down again. I asked what it was; he said there was the mark of a bee on it; taking it up, I alao saw on it a small pointed drop of wax [properly excrement], which had fallen from a bee in its flight. The Namaqua noticed the direction the point of the drop indicated, and walking on he picked up another stone, also with a drop of wax on it, and so on at considerable intervals, till, getting behind a crag, he looked up, and bees were seen flying across the sky, and in and out of a cleft in the face of the rock. Here, of course, was the honey he was in pursuit of. A dry bush is selected, fire is made, the cliff is ascended, and the nest is robbed in the smoke."

Park, in his Travels, mentions, that the African wild-bees are often a formidable enemy to the caravans of the travellers crossing tha desert. The following incident, as he relates, took place near Doofroo:—"We had no sooner unloaded the asses, than some of the people, being in search of honey, unfortunately disturbed a large swarm of bees. They came out in immense numbers, and attacked men and beasts at the same time. Luckily most of the asses were loose, and galloped up the valley; but the horses and people were very much stung, and obliged to scamper off in all directions; in fact, for half an hour, the bees seemed completely to have put an end to our journey. In the evening, when they became less troublesome, and we could venture to collect our cattle, we found many of them much stung and swelled about the head. Three asses were missing; one died in the evening, and one next morning. Our guide lost his horse, and many of the people were much stung about the hands and face."

Honey-bees exist in great numbers in Australia. In the account of an expedition in that country by Major Mitchell, that gentleman observes—"We were now 'in a land flowing with milk and honey;' for the natives, with their new tomahawks [illegible]ted it in abundance from the hollow branches of t[illegible]; and it seemed that, in the season, they could find it almost everywhere. To such inexpert clowns, as they probably thought us, the honey and the bees were inaccessible, and indeed invisible, save when the natives cut it out and brought it to us in little sheets of bark, thus displaying a degree of ingenuity and skill in supplying their wants, which we, with all our science, could not hope to attain. They would catch one of the bees, and attach to it, with some rosin or gum, the light down of the swan or owl: thus laden, the bee would make for the branch of some lofty tree, and so betray its home of sweets to its keen-eyed pursuers, whose bee-chase presented indeed a laughable scene."

THE DOG—FIELD SPORTS.

The dog is an animal which seems to have been destined by the Creator to be the friend and assistant of man. Throughout the dangers and difficulties which beset the human being, particularly in an inartificial state of society, the dog has ever proved himself the kindly defender of his life and property, as well as a powerful and essential auxiliary in subduing other animals to his purpose. Without the assistance of the dog, man would not even yet have obtained a beneficial dominion over the various races of wild animals of the earth, or been able to watch with sufficient care those creatures formed for his food.

According to naturalists, the dog belongs to the family of the *Canidæ* (from *canis*, Latin for dog, hence, *canine* species), in the order *Carnivora*, class Mammalia. In the same family are united the wolf, fox, and jackal, and these so nearly approach the dog in physical construction, and certain habits and qualities, that some authorities are inclined to consider them of the same species. The resemblance in some respects, and great dissimilarity in others, between dogs, wolves, foxes, and jackals, is, however, not more remarkable than the general similarity of dogs to each other, as far as an apparent unity of species is concerned; while, at the same time, there is a striking difference of form and character between opposite breeds. One dog is large, another small; one is smooth in the skin, another rough; one has a long head, in another the head is short; one has an exquisite sense of smell, another has comparatively little of that power; and so on. We have an animal which watches our flocks; another which tracks and hunts down noxious wild beasts; another which destroys and digs out vermin from the earth; another which guards our houses and lives while we are asleep; another which seeks out for game in our field-sports; another which will plunge into the deepest waters, and save us from being drowned; besides many other varieties, all less or more distinct in character. The difference is so very remarkable, that the *varieties* would be entitled to be classed as of different *species* of animals, unless for the fact that they all breed together, and perpetuate mixed or mongrel varieties. This circumstance led Buffon and other naturalists to infer that all dogs whatsoever are but of one species; the physiological theory being, that no two different species can produce fertile descendants. Buffon further concluded, from a course of observations, that all are sprung from one common root, the shepherd's dog; and that climate, food, and peculiar training, have been the causes of the departure from the primeval stock. The line of argument adopted in support of this theory is, that in the animal, as in the vegetable kingdom (see article Fruit-Garden), improved or very remarkable varieties can be produced by selecting kinds, and breeding from them alone; as, for example, taking the two largest dogs of a breed, and breeding from them; then taking the two largest which this pair produces, and breeding from them also; and so on, till a large variety of dogs is ultimately formed. And further, that if each generation be trained in a particular way, the variety will come to possess properties agreeable to the kind of cultivation bestowed upon it. Such, there is reason to believe, is the true explanation of the extraordinary differences of size and character in the canine species. We must view these dissimilarities as a result of a course of treatment from the earliest period of civilization till modern times. The ancient Egyptians, and after them the Greeks, are recorded to have paid considerable attention to the training of dogs, and, as is well known, this formed a favourite study in connection with the field-sports of later ages. Doubts may very naturally be entertained respecting the power of transmitting acquired qualities from one generation to another, of any species of animals; but investigations into the subject afford some remarkable proofs of what can be accomplished by means of careful training or teaching.

EFFECTS OF TRAINING.

In the latter part of the last century, one Bisset, a native of Perth, by trade a shoemaker, having applied himself with great perseverance to the teaching of animals, succeeded in making a set of cats play in harmony on the dulcimer, uniting their voices to the tones of the instrument; and this singular orchestra was exhibited, to the perfect satisfaction of the public, for a succession of nights, in the Haymarket theatre. He it was who trained that "learned pig," of which our fathers used to speak so highly, the animal having been exhibited in every part of the empire. At a somewhat earlier period, a Saxon peasant boy trained a dog to the pronunciation of words. The boy had observed in the dog's voice an indistinct resemblance to certain sounds of the human voice, and was thus prompted to endeavour to teach him to speak. The animal was three years old at the beginning of his instructions—a circumstance which must have been unfavourable to the object; yet, by dint of great labour and perseverance, in three years the boy had taught it to articulate thirty words. It used to astonish its visiters by calling for tea, coffee, chocolate, &c.; but it is proper to remark, that it required the words to be pronounced by its master beforehand, and it never appeared to become quite reconciled to the exhibitions which it was forced to make. The learned Leibnitz reported on this wonderful animal to the French Academy, attesting that he had seen the dog and heard it speak; so that there does not appear the slightest ground for doubting the fact, such as it was. All doubt on the question of possibility may, indeed, be considered as set at rest by the recent exhibition of the educated dogs in London—animals which could play at dominoes and chess, and even indicate when their adversaries made false moves. These creatures were visited and *played with* by thousands, and we never have heard that a deception of any kind as to the reality of their acquired powers was detected.

Laying aside such extraordinary examples as these, the ordinary training conferred on horses, dogs, and other domesticated animals seems to be sufficient to establish the general fact of animal educability. We have no more forcible illustrations of the principle than in the uses which are now made of certain of the canine tribe in rural sports. The pointer, setter, springing spaniel, and all that class of dogs, are understood to be descended from one stock, the Spanish spaniel, with a slight crossing from the fox-hound, for the sake of increasing the speed. The original animal may be considered as a record of the original powers, to which every thing else must be regarded as an addition made by human training. Now, the original animal is only gifted by nature with a fine scent for game, and a disposition to make a momentary pause on seeing it, for the purpose of springing upon it.* Man has converted this inclination to a temporary pause into a habit of making a full stop, and the animal, instead of gratifying its destructive tendency by flying upon the game, has been trained to be contented with witnessing a vicarious execution by the gun of his master.

It is a mistake to suppose that only the spaniel tribe is capable of serving sportsmen in the capacity of pointers and setters. There are other classes of dogs which perseverance would enable, to a certain extent, to act in the same way. Gervase Markham, who wrote on sports in the sixteenth century, speaks of having seen dogs of the bastard tumbler kind adapted to act as setters, though not so well as those of the spaniel kind. Mr. Blaine is of opinion that this power can be cultivated in most dogs.† It has even been elicited in another and very different class of animals—the hog. Some years ago, Mr. Toomer, gamekeeper to Sir Henry Mildmay, bethought him of teaching a pig to act as a pointer, having been struck by the scenting powers of the animal in its search for palatable roots under ground. He began by allowing a young female pig to accompany his pointers, in their breaking lessons, to the field. Within a fortnight, to his own surprise, she was able to hunt and point partridges and rabbits. There being an abundance of creatures near the keeper's lodge, her education advanced rapidly by frequent exercise and in a few weeks she was able to retrieve game as well as the best pointer. *Slut*, as this extraordinary animal was called, was considered to have a more acute scent than any pointer in the charge of the keeper; and it was a kennel of the highest character. They hunted her principally on moors and heaths; and it often happened, that when left behind, she would come of her own accord and join the pointers. "She has often stood a jack snipe when all the pointers had passed it: she would back the dogs when they pointed, but the dogs refused to back her until spoke to—Toomer's dogs being all trained to make a general halt when the word was given, whether any dog pointed or not, so that she has been frequently standing in the midst of a field of pointers. In consequence of the dogs being not much inclined to hunt when she was with them (for they dropped their sterns, and showed symptoms of jealousy), she did not very often accompany them, except for the novelty. Her pace was mostly a trot; she was seldom known to gallop, except when called to go out shooting: she would then come home off the forest at full stretch, and be as much elated as a dog at being shown the gun. She always expressed great pleasure when game, either dead or living, was placed before her. She has frequently stood a single partridge at forty yards' distance, her nose in a direct line to the bird; after standing some considerable time, she would drop like a setter, still keeping her nose in an exact line, and would continue in that position until the game moved; if it took wing, she would come up to the place, and draw slowly after it; and when the bird dropped, she would stand it as before."*

These facts, together with what common observation presents to us in domesticated parrots, blackbirds, ravens, magpies, monkeys, &c., place the educability of animals upon a basis, in our opinion, not to be shaken. But the most wonderful thing, and the most convincing part of the proof, remains, in the fact of the transmission of *acquired qualities* by animals to progeny. The habit which education has conferred upon the pointer appears in his puppy, who may be seen earnestly standing at swallows and pigeons in a farm-yard, before he has ever once seen such a thing done by his seniors, or received the least instruction. Here only the object is amiss; the act itself is perfect. As may be readily supposed, the puppy of a race of English pointers can be trained to the whole business of the field in one-tenth of the time which the most experienced breaker would require to effect any improvement upon the simple instinct of the *pause* in an original Spanish spaniel. On the subject of the hereditary transmission of acquired qualities by animals, we have some curious information from the venerable naturalist, Mr. T. A. Knight.

In a communication to the Royal Society, in 1807, Mr. Knight cited several instances of domesticated animals inheriting the acquired habits of their parents. "In all animals," he says, "this is observable; but in the dog it exists to a wonderful extent; and the offspring appears to inherit not only the passions and propensities, but even the resentments, of the family from which it springs. I ascertained that a terrier, whose parents had been in the habit of fighting with polecats, will instantly show every mark of anger when he first perceives the scent of that animal, though the animal itself be wholly concealed from his sight. A young spaniel brought up with the terriers showed no marks of emotion at the scent of the polecat, but it pursued a woodcock, the first time it saw one, with clamour and exultation: and a young pointer, which I am certain had never seen a partridge, stood trembling with anxiety, its eyes fixed and its muscles rigid, when conducted into the midst of a covey of those birds. Yet each of these dogs are mere varieties of the same species, and to that species none of these habits are given by nature. The peculiarities of character can therefore be traced to no other source than the acquired habits of the parents, which are inherited by the offspring, and become what I call *instinctive hereditary propensities.*"

It appears from another communication made by Mr. Knight to the same society, in 1837, that he had then been pursuing investigations on this subject for nearly sixty years. He proceeds in that communication to give a general account of his investigations:—"At the period," he says, "at which my experiments commenced, well-bred and well-taught springing spaniels were abundant, and I readily obtained possession of as many as I wanted. I had, at first, no other object than that of obtaining dogs of great excellence; but within a very short time, some facts came under my observation which very strongly arrested my attention. In several instances, young and wholly inexperienced dogs appeared very nearly as expert in finding woodcocks as their experienced parents. The woods in which I was accustomed to shoot did not contain pheasants, nor much game of any other kind, and I therefore resolved never to shoot at any thing except woodcocks, conceiving that by so doing the hereditary propensities above mentioned would become more obvious and decided in the young and untaught animals; and I had the satisfaction, in more than one instance, to see some of these find as many woodcocks, and give tongue as correctly, as the best of my older dogs.

* Thoughts and Recollections, by one of the last Century London: Murray. 1825.

† Encyclopædia of Rural Sports, 792

* Daniel's Rural Sports.

"Woodcocks are driven in frosty weather, as is well known, to seek their food in springs and rills of unfrozen water, and I found that my old dogs knew about as well as I did the degree of frost which would drive the woodcocks to such places; and this knowledge proved very troublesome to me, for I could not sufficiently restrain them. I therefore left the old experienced dogs at home, and took only the wholly inexperienced young dogs; but, to my astonishment, some of these, in several instances, confined themselves as closely to the unfrozen grounds as their parents would have done. When I first observed this, I suspected that woodcocks might have been upon the unfrozen ground during the preceding night; but I could not discover (as I think I should have done had this been the case) any traces of their having been there; and as I could not do so, I was led to conclude that the young dogs were guided by feelings and propensities similar to those of their parents.

"The subjects of my observation in these cases were all the offspring of well-instructed parents, of five or six years old or more; and I thought it not improbable that instinctive hereditary propensities might be stronger in these than in the offspring of very young and inexperienced parents. Experience proved this opinion to be well founded, and led me to believe that these propensities might be made to cease to exist, and others to be given; and that the same breed of dogs which displayed so strongly an hereditary disposition to hunt after woodcocks, might be made ultimately to display a similar propensity to hunt after trufles; and it may, I think, be reasonably doubted whether any dog, having the habits and propensities of the springing spaniel, would ever have been known, if the art of shooting birds on the wing had not been acquired.

"I possessed one young spaniel, of which the male parent, apparently a well-bred springing spaniel, had been taught to do a great number of extraordinary tricks, and of which the female parent was a well-bred springing spaniel; the puppy had been taught, before it came into my possession, a part of the accomplishments of its male parent. In one instance I had walked out with my gun and a servant, without any dog; and having seen a woodcock, I sent for the dog above mentioned, which the servant brought to me. A month afterwards, I sent my servant for it again, under similar circumstances, when it acted as if it had inferred that the track by which the servant had come from me would lead it to me. It left my servant within twenty yards of my house, and was with me in a very few minutes, though the distance which it had to run exceeded a mile. I repeated this experiment at different times, and after considerable intervals, and uniformly with the same results, the dog always coming to me without the servant. I could mention several other instances, nearly as singular, of the sagacity of this animal, which I imagined to have derived its extraordinary powers in some degree from the highly cultivated intellect of its male parent."

To conclude these preliminary observations on dogs. A gentleman of our acquaintance, and of scientific acquirements, obtained some years ago a pup which had been produced in London by a female of the celebrated St. Bernard's breed. The young animal was brought to Scotland, where it was never observed to give any particular tokens of a power of tracking footsteps until winter, when the ground became covered with snow. It *then* showed the most active inclination to follow footsteps; and so great was its power of doing so under these circumstances, that when its master had crossed a field in the most curvilinear way, and caused other persons to cross his path in all directions, it nevertheless followed his course with the greatest precision. Here was a perfect revival of the habit of its Alpine fathers, with a degree of specialty as to external conditions, at which, it seems to us, we cannot sufficiently wonder

We thus see that not only does what metaphysicians call the *law of habit* exercise a sway in the intellects of animals, but that modification which takes place in human communities, and passes under the comprehensive name of civilization, also affects the lower tribes of creation. A race of animals, like a race of men, is civilizable; and we cannot doubt that the same softening influences which have produced the advanced nations of Europe, have operated upon the animals existing in the same countries, and made them very different from what they were in early times. It cannot escape remark, that the whole principle of civilization acquires strength from having its basis thus widened. We become the more confident in the improvability of our own species, when we find that even the lower animals are capable of being improved, through a succession of generations, by the constant presence of a meliorating agency.

GENERAL CHARACTER OF DOGS.

The dog has six incisory or cutting teeth in both jaws; beyond which there are, on each side, both above and below, a canine tooth; and still farther into the mouth are six cheek-teeth, or molars, in each side of the upper jaw. The three first are sharp and cutting, which Cuvier calls false molars. The next tooth on each side is a carnivorous tooth, furnished with two cutting lobes, beyond which the other two teeth on each side are flat. There are seven cheek-teeth, on both sides, in the under jaw; four of these are false molars, a carnivorous tooth, with the posterior part flat, and behind it two tuberculous teeth. The muzzle is elongated, subject to great variety of length in different varieties. The tongue is smooth and soft; the ears erect in the wild varieties, and in some of the tame ones, but, in the latter kinds, for the most part pendulous. The fore-feet are provided with five toes, and the hind-feet with four toes, furnished with rather longish nails, obtuse at their points, and not retractile. The females are provided with both inguinal and ventral teats. The pupils of the eyes are circular.

The female goes with young sixty-three days, and generally produces from three to five at a birth, and sometimes even twelve, which are at first blind, in which state they continue for from nine days to a fortnight. About the end of two months, their faculties begin to develop themselves. They shed their first teeth at the end of six months, which are replaced by others that do not exfoliate. At twenty months, or two years, dogs arrive at their full vigour.

The males continue to propagate for nearly their whole lives, while the female discontinues having young ones at about the age of eight or nine years.

The average age to which dogs live is about fourteen years; they frequently, however, live to sixteen, and even have been known to attain the age of twenty years. In their latter days, dogs frequently suffer greatly from decay, and various diseases. They are extremely subject to rheumatism, from their liability to exposure to rain, and damp beds.

Until dogs have attained seven or eight years, their teeth are white, smooth, and acutely pointed; but after this age they become yellow spotted, and their points assume an uneven and jagged appearance. At this time, also, the hair of the muzzle and around the eyes assumes a hoary appearance, and becomes whiter as they increase in years.

The dog is naturally carnivorous, but when domesticated, he does not refuse farinaceous food. He uses grass as a vomit; and drinks by lapping with his long flexible tongue. He does not sensibly perspire by the skin; the superfluous moisture of the body escapes at the mouth by panting, when heated, and by the extraordinary diuretic habits of the animal. The sense of smell is different in different varieties, but in all is sufficiently strong and refined to enable the dog to seek out and follow his master even among a crowd. His sense of hearing is also quick. He expresses anger by growling or barking, but also barks when joyful; and shows delight by the wagging of his tail. He sleeps very lightly, so as to be awakened by the slightest noise; and during his slumbers he is apt to dream, as is indicated by starting, whining, and short barks.

The most remarkable feature in the character of the dog is his attachment to man. In wild unpeopled countries, dogs are known to live in hordes, and seek their prey like other untamed animals; but brought into connection with human society, the dog leaves his own species without regret, and is only happy when belonging to a master to whom he can be faithful as a friend, servant, or companion. In this condition of domestication his ambition seems to be the desire to please; he is seen to come crouching along, to lay his force, his courage, and all his useful talents, at the feet of his master: he waits his orders, to which he pays implicit obedience: he consults his looks, and a single glance is sufficient to put him in motion: he is more faithful than even the most boasted among men: he is constant in his affections, friendly without interest, and grateful for the slightest favours: much more mindful of benefits received than injuries offered, he is not driven off by unkindness: he still continues humble, submissive, and imploring; his only hope to be serviceable, his only terror to displease: he licks the hand that has just been raised to strike him, and at last disarms resentment by submissive perseverance.

More docile than man, as Buffon observes, more obedient than any other animal, he is not only instructed in a short time, but he also conforms to the dispositions and manners of those who command him. He takes his tone from the house he inhabits; like the rest of the domestics, he is disdainful among the great, and churlish among clowns. He knows a beggar by his clothes, by his voice, or his gestures, and forbids his approach. When, at night, the protection of the house is committed to his care, he seems proud of the charge; he continues a watchful sentinel; he goes his rounds, scents strangers at a distance, and gives them a warning of his being upon duty. If they attempt to break in upon his territories, he becomes more fierce, flies at them, threatens, fights, and either conquers alone, or alarms those who have most interest in coming to his assistance; however, when he has conquered, he quietly reposes upon his spoil, and abstains from abusing—thus giving at once a lesson of courage, temperance, and fidelity.

CLASSIFICATION OF VARIETIES.

Cuvier, the eminent French naturalist, formed a classification of dogs, founded on the shape of the head, and length of the jaws and muzzle. These he has separated into three great groups, as follows:—

I. Matins.—These have a head more or less elongated; the parietal bones insensibly approaching each other, and the condyles of the lower jaw placed in a horizontal line with the upper cheek-teeth.

II. Spaniels.—The head moderately elongated; the parietal bones do not approach each other above the temples, but diverge and swell out, so as to enlarge the forehead and cavity of the brain. In this group are included all the varieties of dogs which are of the greatest utility to man, and also the most intelligent.

III. Dogues.—The muzzle more or less shortened; the skull high; the frontal sinuses considerable; the condyle of the lower jaw extending above the line of the upper cheek-teeth. The cranium is smaller in this group than in the two previous, owing to the formation of the head.

Following this arrangement, the three groups have, for convenience, been divided into distinct sections, as follows:—

Division I.—Head Elongated.

Section 1. Wild and half-reclaimed dogs, which hunt in packs.

Section 2. Domesticated dogs, which hunt in packs or singly, principally by the eye, although sometimes by the scent.

Section 3. Domesticated dogs, which hunt singly, and always by the eye.

Division II.—Head less Elongated than former Division.

Section 4. Pastoral dogs, or such as are employed in domestic purposes.

Section 5. Water-dogs, which delight in swimming, having their feet in general semi-webbed.

Section 6. Fowlers, or dogs whose natural inclination is to chase and point birds, and hunt singly by the scent.

Section 7. Hounds, which hunt in packs, by the scent.

Section 8. Mongrel hounds, which hunt singly, either by the scent or eye.

Division III.—Head much Shortened.

Section 9. Watch-dogs, which have no propensity for hunting.

We shall now present a short notice of the different varieties of breeds in each of the several divisions and sections.

Division I.—Dogs with Lengthened Heads.

Section 1. Half-reclaimed dogs, which hunt in packs.

The *Dingo*, or *Australian Dog*.—The head of this dog is not unlike that of a wolf, on which account Bewick calls it the New South Wales wolf. The muzzle is long and pointed, with short erect ears. He is two feet six inches in length, and about two feet in height. His fur is composed of a mixture of silky and woolly hairs, and is of a deep yellowish-brown colour; and his tail is long and bushy, resembling that of a fox. This dog is of a ferocious disposition. Pennant mentions one which was brought to this country, and that leaped on the back of an ass, and had nearly destroyed it before a rescue could take place.

The *Dhole* is the native wild-dog of India, and bears a strong resemblance to the dingo, but without the bushy tail of that species; he is of a uniform bright-red colour. Differently from other dogs which hunt in packs, according to the account given by Captain Williamson, this species always hunts mute, and only utters a soft whispering sound when in high chase, and near his prey. The dhole is exceedingly swift of foot, and soon overtakes most animals which are the objects of his pursuit. It is said they are exceedingly fond of the flesh of the tiger, and that, in consequence, this animal is prevented from propagating to that extent which would soon overrun and lay waste all the countries which it inhabits. This predilection is confirmed by Bishop Heber, who states, upon the authority of the peasants of Khayra, which borders the frontiers of China, that a tiger is often killed and torn to pieces by the wild dogs, which give tongue like foxhounds or harriers. It is in the unfrequented wilds of the western frontiers of India that the dhole takes up his abode, lurking amongst the extensive jungles which cover mighty tracts of that territory.

The *Pariah* is the common village dog of India. He has a small sharp head, with short pricked ears, a slender body, and particularly drawn up about the abdominal region; his chest is deep, his limbs light, and his colour is of a reddish-brown. The native Indians use these in hunting the tiger and wild boar. They are very fierce, and follow their game with much avidity.

The *Ekia* is the native dog of Africa, and in all likelihood sprung from the same stock as the dhole. They are said to be of various colours, as black, brown, white and yellowish. They are eaten by the negroes. The African wild dogs, like those of India, hunt in packs.

The South American Dog is not unlike the dingo, and is about the size of the springer, with short and pricked ears, like most other wild dogs. The hair on his tail is long and bristly; he is of a brownish-gray colour on the back, with sandy-coloured spots on the legs and flanks. In general aspect, he greatly resembles the wolf, but is much smaller in size.

There is another South American dog called the Alco, of which there are two varieties. The head of the Alco is very small, and the ears pendulous, thus differing from almost all other wild dogs. The back is somewhat curved, and the tail rather short. It is said that the Spaniards found this dog among the natives on the first discovery of America. Herrera says, that Columbus found in America many dogs which did not bark. But there is reason to suppose that whatever may have been the original types of the South American dogs, they have been greatly altered by intermixture with descendants of those introduced at the conquest by the Spaniards.

The *North American Dog.*—We have no very distinct account of this variety, but it is said to resemble the dingo in its pricked ears and general conformation. It is remarkable for the acuteness of its scent, and very expert in the detection of its prey, or animals which it may be trained to pursue.

Section 2. Domesticated dogs, which hunt in packs or singly, principally by the eye, although sometimes by the scent.

The *Irish Greyhound* ranks among the noblest of the canine race; his mien is striking, full of dignity, and his conformation beautiful. In his general shape he bears a strong resemblance to the common greyhound, but is much taller, and more robust. He is not fitted for pursuing the more speedy animals of the chase. His use in early times was to free the country of wolves and wild boars, which abounded in England and Ireland. The hair is short and smooth, and the colour of these dogs is fawn or pale cinnamon. The Marquis of Sligo had some of this breed, which were of various colours; some were brown and white, and others black and white. The ordinary height of the Irish greyhound is about three feet, although they have been known to reach four feet. Goldsmith, who had seen several of this breed, says they were about four feet high, and as tall as a calf of a year old.

The *Albanian Dog.*—This variety is about the size of a full-sized mastiff. His hair is very fine and close set, and of a silky texture, variously clouded with brown; his tail is long and bushy, and carried like that of a Newfoundland dog; his muzzle is pointed, and rather long; his legs are strong and muscular, which fit him well for hunting the wild boar, in which sport he was much used in ancient times; he was also used in hunting wolves, and in protecting sheep-folds from thieves.

The *French Matin* has an elongated head, and flat above; his ears are erect, and slightly pendulous towards the tips; the hair of a yellowish fawn-colour, with darker, oblique, and parallel indistinct rays traversing the whole of his fur. His height is about two feet, and his length three feet. He is strong, muscular, and active, and very courageous. He evinces great eagerness in hunting the wild boar and wolf, in which sport he is frequently employed. Pennant thinks this variety is a descendant of the Irish greyhound.

The *Scottish Highland Greyhound.*—This dog will either hunt in packs or singly. He is an animal of great size and strength, and at the same time very swift of foot. In size, he nearly equals the Irish greyhound. His head is long, and the nose sharp; his ears short, somewhat pendulous at the tips; his eyes are brilliant and very penetrating, and half concealed by the long crisped hairs which cover his face and whole body. He is remarkable for the depth of his chest, and tapers gradually towards the loins, which are of great strength, and very muscular; his back is slightly arched; his hind quarters are powerfully formed, and his limbs strong and straight. The possession of these combined qualities particularly fit him for long endurance in the chase. His usual colour is a reddish sand-colour, mixed with white; his tail is long and shaggy, which he carries high, like the staghound, although not quite so erect. It is this noble dog which was used by the Scottish Highland chieftains in their great hunting parties, and is supposed to have descended in regular succession from the dogs of Ossian.

The *Russian Greyhound* is nearly as large as the Irish greyhound, resembling him in shape as nearly as possible, but covered with long bushy hair, his general colour is a dark reddish-brown. He is sometimes hunted in small packs, and as frequently single, in which case he not unfrequently will kill a wolf, deer, or wild boar, without any aid whatever. When used in coursing, he is taken to the field in slips, in the same manner as is practised with greyhounds.

Section 3. Domesticated dogs, which hunt singly, and always by the eye.

The *Gazehound.*—This is a dog, the breed of which is now lost. It was hunted in the same manner as the greyhound, and took foxes and hares by running them down. It is said by Bewick that it was employed in stag-hunting, which we think is rather doubtful, as, although the stag is an animal of great speed, yet the contest between it and a dog possessing the swiftness of a greyhound would be but very unequal. No representation of this dog has been preserved, which is much to be regretted, as we are but imperfectly acquainted with its appearance.

The *Greyhound* is the fleetest of all dogs, which is in consequence of his peculiar conformation. His head is long, tapered, and shaped like that of a snake; his neck long and slender; his ears somewhat erect and pricked, slightly pendulous at their tips; the tail ought to be very fine, pointed, and the hair on it very short; the chest should be wide and deep; the belly drawn up, with strong loins, and with large and prominent hip-muscles. This dog is by no means so intelligent as many other varieties, and he is, in consequence, much less susceptible of education. He has, however, very fine feelings, and seems to be much alive to caresses, which excite him to such a degree as to produce a quick pulsation of the heart. This may be felt beating against his side with much vigour. He is one of the most elegantly formed of all the canine species.

The *Scotch Greyhound.*—This dog is formed exactly like the common greyhound, and differs from it merely by being of a larger size, and in the hair being longer and hairy. Its general colour is reddish-brown, or of a sand colour.

The *Italian Greyhound.*—This dog is merely a miniature of the common greyhound, being only about half the size of that dog. It has a very fine skin of a silky texture, and is so tender as to be easily injured by cold or wet. It is used only as a *pet*, being quite valueless in all other respects.

The *Turkish Greyhound* is still smaller than the Italian greyhound, being little more than half its bulk, and is entirely divested of hair, except on the tail, where it is few and scattered. Its usual colour is blackish lead colour. It abounds in Turkish towns, where it forms a dreadful nuisance to travellers.

Division II.—Head less elongated than former division.

Section 4. Pastoral dogs, or such as are employed in domestic purposes.

The *Shepherd's Dog.*—This dog is covered with long, flowing, somewhat woolly, hair; his muzzle is long and pointed, and his ears erect, and slightly bent downwards at the tips; his tail is long and bushy, and the usual colour of his f is black and white, or varied with black and gray; the backs of his fore-legs have also long hairs. The peculiar and highly useful qualities of this dog seem to be rather intuitive than acquired; indeed, nothing can hardly exceed the quickness with which he can be taught any lesson; and certainly no other dog has the same patient perseverance and courageous fidelity, and at the same time possessed of the greatest discrimination. The labour of a shepherd, with the assistance of this faithful and intelligent animal, is comparatively an easy task; and it is hardly possible to fancy a more arduous employment than it would be, if divested of the services of the dog: for without him, how could he collect extensive flocks scattered over high and widely-spread mountain ranges? The shepherd's dog is possessed of great sagacity, gratitude, and self-denial, as is well known from innumerable anecdotes.

The *Cur* or *Watch Dog* differs from the shepherd's dog in being nearly smooth; he is stronger in his make, and has half-pricked ears, and his tail is rather short, and slightly feathered beneath. He is a trusty and useful servant to the farmer and grazier, and is chiefly employed in driving cattle; and being larger and stronger than the shepherd's dog, from which he is sprung, he is better qualified for the grazier and farmer. He bites with great keenness, and always makes his attack at the heels. His sagacity is very great, and he soon knows his master's fields, and watches with great assiduity the cattle which are in them.

The *German Dog* is a small-sized animal, with bushy turned-up tail, bushy neck, small muzzle, and is generally of a cream colour, but also sometimes black. His manner is brisk, and his character that of great fidelity. He is seen all over central Germany, where he appears to be employed chiefly as a mery companion to man, and also for watching. A few are beginning to be seen in England.

SECTION 5. Water-dogs, which delight in swimming, having their feet in general semi-webbed.

The *Pomeranian* or *Wolf Dog* has the hair on the head short, as is also that on the feet and ears; but it is long and silky on the body and tail, which last is curled up in a spiral form. His colour is white, black, gray, or sometimes yellowish; his head is long, and his muzzle pointed; his ears are short and pricked. He is possessed of intelligence nearly equal to that of the shepherd's dog.

The *Siberian Dog* has much the appearance of the Pomeranian dog, and is very nearly allied to him, except that he is covered with long hair even on the head and paws. In their native country, four of these dogs are attached by pairs to a sledge, and in front of them is placed a leader, on the proper training of which much of the useful services of the others depend. These sledges are just large enough to contain one person, who directs them with his voice, and in which he is partially assisted by a stick. The reins are fastened to the dogs' necks by a collar. These dogs, thus yoked, have been known to drag a sledge from seventy to eighty miles in a day; and so powerful is their scent, that they contrive to keep or the beaten track by that means alone, even although it be hid by showers of snow.

The *Greenland Dog* is of a large size, strong in the bone, and its fur consists of long, thick-set, woolly-like hair; his muzzle is sharp, and his ears short and pricked; his tail is thick, very bushy, and spirally twisted.

The *Iceland Dog* is shorter in the hair than the above variety; his ears are pricked, but slightly bent downwards on the tips. His general colour is white, with patches of black differently disposed.

The *Esquimaux Dog*.—This highly useful variety is described by M. Desmarest as having the head shaped like that of the wolf dog, the tail is spreading and curved, and the ears erect. The hair is thinly scattered, and consists of two sorts, the one silky, the other thick and fine, and somewhat curled, and so detached from the other that it may be pulled off in flakes from the animal.

The *Hare-Indian Dog* has a narrow, elongated, and pointed muzzle; his ears are broad at the base, and pointed towards the tips, and perfectly erect; his legs are long and slender, and his tail thick, bushy, and curved slightly upwards, but by no means so decidedly curved as that of the Esquimaux dog. His body is covered with long straight hairs, the ground colour of which is white, marked with large irregular patches of grayish-black, intermingled with various shades of brown. Dr. Richardson says it has neither courage nor strength for pulling down any of the larger animals.

The *Newfoundland Dog*.—This beautiful and intelligent dog is remarkable for the symmetry of his form and the acuteness of his understanding. He measures, from the tip of the nose to the point of the tail, six feet and a half, the length of the tail itself being two feet; from the one fore foot to the other, over the shoulders, five feet eight inches; the girth behind the shoulders, three feet four inches; the length of his head is fourteen inches. He has webbed feet, in consequence of which he is a dexterous swimmer. His hair is long, flowing, and slightly curled, and his tail very bushy, particularly in the lower side, and he carries it in a very graceful manner. The docility of the Newfoundland dog is very great; there are innumerable most striking anecdotes of his sagacity and benevolence of disposition, particularly with reference to his saving persons from drowning. During the gale on Thursday, June 11, 1829, a vessel was driven on the beach at Lydd; no boats could get off to the assistance of the crew, who were, however, all saved and brought ashore through the activity of a fine Newfoundland dog. The surf was rolling furiously, and eight poor fellows were crying for aid, which the spectators could not afford them, when one man directed the attention of his dog to the vessel, and the intelligent animal at once swam towards it, and the crew joyfully made fast a rope to a piece of wood, which the dog seized and swam with to his master on shore; a line of communication was thus formed, and the eight mariners rescued from a watery grave.

The *Russian Dog* is somewhat larger and stronger than the Newfoundland dog; he is a cross between that variety and the Siberian dog, and has now become a distinct race. His head is large, with his ears pendulous and rather full-sized; his tail is curled over his back; his hair is very long and shaggy, consisting of black and white patches.

The *Great Rough Water-Dog* is web-footed, swims with great ease, and dives with much dexterity; his hair is long and curly, and he is of various colours; his legs and feet are also thickly covered with thick and bushy hair.

The *Large Water-Spaniel* is about the size of the English setter, but of a stronger make. His face is smooth, as also the front of his legs, while the rest of his body is covered with small crisp curls, usually of a dark liver-brown colour. This dog is very valuable in the sport of shooting wild fowl.

The *Small Water-Spaniel*, or *Poodle*.—This is a breed between the large water-dog and the springer: he is thickly covered with fine hair, all of which is in distinct small curls, more like an effort of art than of nature. It is one of the most active of dogs. Its general colour is white, and sometimes it has various black patches. It dives with much dexterity, and will leap from a very great height into the water; we have seen one leap over Tyne Bridge at Newcastle, a height of nearly fifty feet.

The *Shock Dog* is the smallest of the water-dog varieties, and is probably bred between the smaller Spaniel or King Charles's dog and the poodle. Its hair is extremely long and flowing, so much so that its ears and eyes are nearly concealed from view by it. It is used as a lapdog.

SECTION 6. Fowlers, or dogs whose inclination is to chase and point birds, and hunt singly by the scent.

The *Springer.*—This variety is shaped much like the English setter, but shorter in the body and legs in proportion to his size, being about two-fifths less than that dog; the hair is long and shaggy, and the ears very long and pendulous, and covered with long waved hairs. He is usually of a white colour, with patches of liver-colour or chestnut. He is, however, sometimes black, and at other times entirely of a liver-coloured brown.

The *Cocker* is about a third less than the springer, and like it in all respects. It is used as well as that variety for raising woodcocks and snipes, in which exercise they are both very expert.

The *King Charles's Dog* is still less than the cocker, and distinguished by the very great length of his ears. Its hair is silky, and this, with its gentleness and small size, has rendered it a favourite pet of ladies of fashion. Of late it has been fashionable for ladies to carry these little creatures in their arms while walking in the streets of London. They are sold at a high price.

The *Comforter* is another diminutive variety of this race, chiefly used as a lapdog. It is supposed to be a cross between the Maltese and King Charles's dog.

The *Maltese* and *Lion Dogs* are descendants from nearly the same stock.

The *Alpine Spaniel*, or *Great St. Bernard Dog*, exceeds other varieties of the spaniel for size and beauty. Its usual height is two feet at the shoulders, and he is six feet in length from the nose to the tip of the tail. Two of these dogs are sent out from the monastery of the Great St. Bernard, situated among the Alps of Switzerland, to scour the mountains during snow-storms, in search of lost or wearied travellers—the one with a warm cloak fastened to his back, and the other with a basket tied round his neck, containing a bottle with some cordial, and bread. In this employment they manifest great judgment, and seem to understand perfectly the import of their mission. They are frequently of the greatest use in meeting the travellers who in those stormy and dangerous regions often fall victims to the inclemency of the weather. It is said that if they meet with a traveller who has sunk under the fatigue and inclemency of the blast, they will lie close to him, until by their warmth they restore heat and energy to the animation which is nearly suspended, and thus frequently will save the life of the sufferer. Should they discover a traveller to have fallen into some deep pit or fissure, whence he is unable to ascend, and if they are unable to render him any assistance, they will return to the convent and give the alarm to the monks, and then conduct them to the place where the unfortunate traveller is immured.

The *Old English Setter.*—It is supposed that this breed was produced between the large water-spaniel and the Spanish pointer; they were much more curled than the present breed of setters, and were very steady in the field, but not so rapid in their movements.

The *English Setter* is a mixed breed between the water-spaniel, Spanish pointer, and the springer, which has attained a very high degree of perfection as a sporting dog. He is one of the most beautiful, lively, and active of dogs.

The *Spanish Pointer* is the stock from which the English pointer has sprung. He is one of the most staunch of all dogs used in the sports of the field, although he is considered too heavy for the present improved mode of sporting, and has now nearly become extinct in Great Britain.

The *English Pointer* was obtained by a cross of the Spanish pointer and fox-hound, and is unrivalled for the rapidity of his movements in the field, and the beauty and symmetry of his form. Since his first production, he has been improved by being re-crossed with the harrier. He is subject to considerable variety in point of size.

The *Small Pointer.*—This is a diminutive breed, being only about two feet from the point of the nose to the tip of the tail, and scarcely a foot in height, and is a complete and beautiful miniature of the large pointer. They have proved themselves excellent sporting dogs, but their small size renders them unfit for use in rough land.

The *Russian Pointer* is much like the Spanish pointer in shape, but his hair is long and hairy.

The *Dalmatian* is a handsome animal, beautifully spotted black on a white skin. In his native country he is employed as a pointer, but imported into England he has there lost all qualities for sporting, and is kept merely as an attendant on carriages. While most other dogs attach themselves to man, this one seems to care for nothing but horses. He lives by choice in the stable, and is happiest when running at the heels of the horses; even his own species he abandons in following out his prevailing taste. He barks little, and is docile.

SECTION 7. Hounds which hunt in packs by the scent.

The *English Terrier.*—This beautiful dog is too well known to require any description. He is possessed of great courage, and is famous for killing all kinds of vermin, and is a useful attendant upon a pack of fox-hounds, for getting into the earth when the fox has taken his hole, and driving him out. His hair is smooth. His general colour is black, with tanned cheeks, and the inside of his legs are of the same colour. They are now to be met with of a brown, and even white colour, but these have unquestionably an admixture of some other breed in them.

The *Scotch Terrier.*—This breed has short wiry hair, very rough, and is much shorter in the legs than the English terrier. His usual colour is sandy, but he is to be found black, and also gray. He bites with great keenness and is a bold and determined dog. He will attack dogs of any size; and when he fixes on an animal, he maintains his hold with great pertinacity. He is much used as an attendant upon packs of fox-hounds, and forms an excellent killer of vermin.

The *Talbot* is one of the primitive breeds of British dogs, and is the same which was used by the ancient Britons in the chase of the deer and other wild animals. It is now, we believe, extinct, or at least not in common use.

Bloodhound.—This is a powerful and sagacious animal, generally of a dark colour, with brown markings, and is endowed with a keen scent. On being led upon the footsteps of any animal or man, he will follow them up with unerring precision. This has led to the breed being employed for tracking criminals, or the unhappy victims of oppression. By the Spaniards a breed was taken to Cuba to track the natives, and this race of animals still exists in that island. A correspondent in a newspaper thus speaks of them :—

"At a period not very remote, the unfortunate negroes in the Spanish settlements were frequently torn to pieces by the Cuba bloodhounds. In fact, under the title of Chasseurs, the Spaniards maintained regular regiments of these dogs and their attendants. In pursuing or hunting the runaway negroes, the chasseur is generally accompanied by two dogs, and armed with a *couteau de chasse*, or straight sword; and we are informed that these bloodhounds, when well and properly trained, on coming up with the object of pursuit, will not kill him unless resistance is offered, but bark at and terrify him till he stops, when they crouch near him, and, by barking, give their keepers notice, who approach accordingly, and secure their prisoner.

"Dallas, in his account of the Maroon War in Jamaica, mentions an importation of these Cuba bloodhounds, in order to assist the regular troops in reducing the refractory Maroons. It may seem strange that dogs were called to the assistance of well-disciplined soldiers, but, in order to elucidate the subject, it must be observed, that the armed Maroons, under the conduct of various cunning leaders, particularly of Cudjoe, Smith, and Johnson, aware of their own inferiority in point of that organization which constitutes the strength and essence of a regular army, cautiously avoided meeting their opponents on the plain; on the contrary, they retired to the impenetrable fastnesses of the woods and mountains, and by means of ambuscades, contrived so to harass the troops, that the governor of Jamaica ultimately procured a company of these dogs and their attendants from Cuba, which arrived at Jamaica under the command of Don Manuel de Sejas; and a tolerable idea of these dogs may be formed from a review which took place immediately after their arrival. General Walpole, who conducted the war against the Maroons, being anxious to review these chasseurs, left head-quarters the morning after they landed, accompanied by Col. Skinner, and arrived in a post-chaise at Seven Rivers. Notice of the general's approach having been given, the chasseurs were taken to a distance from the house, in order to advance when he arrived. The Spaniards were drawn up in a line at the end of a gentle declivity, and consisted of upwards of forty men, with their dogs in front unmuzzled, and held by cotton ropes, as it was intended to ascertain what effect would be produced on the dogs if actually engaged under a fire of the Maroons. The Spaniards, upon the word being given, fired their fusees, when the dogs pressed forward with almost ungovernable fury, amidst the shouts of their keepers, whom they dragged along with irresistible impetuosity. Some of these ferocious animals, maddened by the shout of attack, and held in check by the ropes, actually seized upon the gun-stocks in the hands of the chasseurs, and tore pieces out of them. The unfortunate Maroons, who had successfully opposed all the efforts of regular troops, were panic-struck on the arrival of the bloodhounds, and surrendered without once daring to come in contact with animals which at best could oppose but a feeble resistance to fire-arms."

The *Staghound* is the largest of all the British dogs of the chase; he has a noble and dignified aspect, and possesses great sagacity and endurance in the chase; this dog is also supposed to be a direct descendant of one of our original British dogs.

The *Foxhound* has a much larger muzzle than the staghound, and his head is small in proportion to the size of his body; his ears are very long and pendulous, although less so than those of the staghound and bloodhound. Though a determined enemy of the fox, this active hound is by no means destitute of warm affections. A foxhound bitch, belonging to the Kivington Hunt, near Bolton, on the 8th November, 1792, during the chase, pupped four whelps, which she carefully covered in a rush aisle, and immediately afterwards joined the pack. In a short time after, she pupped another, which she carried in her mouth during the remainder of a hard chase of many miles, to the great astonishment of a number of spectators, after which she returned to the place where she had dropped the four.

The *Harrier*.—This dog is used in hare-hunting, and was originally obtained by a double-cross between the small beagle and southern hound. He is very eager in the pursuit of the hare. There are few instances of any of the deer tribe being hunted with success by dogs of so small a description as harriers.

The *Beagle* is the smallest of the dogs of the chase. He is possessed of a very acute sense of smelling, and pursues the hare with unwearied steadiness; and what he wants in speed and strength he makes up by his perseverance.

The *Otter-Hound* is a cross between the large southern hound and the large rough terrier. He has a large head, with pendulous ears, and his whole fur is of a [illegible] texture, and rather long; his colour is either sandy or black. Otter-hunting was a favourite sport in ancient times, but is now nearly lost in this country.

The *Bull-Terrier* is a cross between the bull-dog and the terrier, as its name implies, and has now assumed the character of a distinct breed. It is much used by the gentlemen of the fancy as a fighting dog.

SECTION 8. Mongrel hounds, which hunt singly either by the scent or eye.

The *Lurcher* is a cross between the greyhound and harrier, and re-crossed with the terrier. His limbs are strong; his head less sharp than that of a greyhound; his ears are short, erect, and half-pricked; and his hair coarse and wiry. He is much used by poachers, and is famous for killing rabbits, as he has a fine scent, and runs his game without giving tongue.

The *Leymmer* and the *Tumbler* are imperfectly known dogs, which are now nearly if not entirely extinct. They hunted both by the scent and eye.

The *Turnspit* is a small dog with a long body and short crooked limbs, and was much used in turning the spit before the invention of jacks. Breeds between this now useless variety of dogs and mongrel terriers and hounds, appear to form the nondescript and ugly races of animals which haunt the streets of our large towns, but whose numbers are now diminishing by the proper interference of the police.

Division III.—With Short Heads.

SECTION 9. Watch-dogs, which have no propensity for hunting.

The *Mastiff* has a large flat head, and a short and blunted muzzle; his lips are full, and hanging considerably over the lower jaw; his ears, although rather small, are pendulous. He has a sullen and grave aspect, and is excellent as a watch-dog; his voice is loud and deep-toned. He is a dog of large size, and is supposed to have been produced between the Irish greyhound and bull-dog. Like the dog next mentioned, he is ferocious in disposition, and of little practical use.

The *Bull-Dog*.—This dog is remarkable for the depth of his chest and the strength of the whole muscles of his body. His head is large, flattened above, and his muzzle much blunted, with the under jaw projecting considerably beyond the upper one; his eyes are set far apart, and project considerably from his head; his power of smelling is less acute than any other of the canine race, on which account he is a dangerous dog, for he has frequently been known to lay hold of his master without discriminating the difference between him and a stranger. He is the boldest and most obstinate of all dogs, and has been known to hold his adversary so determinedly that his legs have been cut off without making him desist.

Many instances have been recorded of the invincible courage of the English bull-dog, but we scarcely recollect one in which so much unconquerable spirit and tenacity of life have ever been displayed, as on the following occasion:—A short time since, a large dog of this species, from some cause that was not observed, suddenly flew at a fine cart-horse that was standing at the end of the Salthouse Dock, Liverpool, and fixing his lacerating teeth in his shoulder, defied every effort to get him off. At first he was beaten with cart-whips and sticks, with such fury as seemed to break his bones; but this being unavailing, a carpenter with an adze in his hand came up and beat him with the blunt iron head of the instrument, till it was thought he had pounded him to a jelly; but the dog never moved a tooth. A man then took out a large pointed clasp-knife, with which he stabbed him repeatedly in the back, loins, and ribs, but with no better success. At length one of the spectators, who appeared to have more strength of sinew and arm than the rest, squeezed the ferocious beast so tightly about the throat, that at length he turned up the white of his eyes and relaxed his jaws. The man threw him off to a distance, but the dog immediately went round the crowd, got behind the horse, and again seized him by the under part of the thigh. As no terms could now be kept with this untameable brute, he was again loosened and thrown into the dock to drown. He instantly, however, rose to the surface, when a sailor struck him a supposed deadly blow on the head with a handspike, which again sent him to the bottom. He arose once more, and was again sent down in the same manner. And this process was repeated five or six times. At length one of the bystanders, who either possessed or assumed some right or property in the dog, overcome by his amazing tenacity of life, and weary of persecution, got him out, and walked off with this prodigy of English courage, to all appearance very little the worse for the horrible punishment he had undergone.

Since the very proper disuse of bull-baiting, this ferocious variety of the dog has fortunately diminished in number.

The *Pug Dog* is descended from the bull-dog, by a cross with the small Danish dog, and resembles the former so much in appearance that he may be considered as a miniature of that variety. He is a useless dog, and with generally a bad temper, has no good quality to recommend him.

GENERAL MANAGEMENT OF DOGS.

As formerly mentioned, dogs are very susceptible of education, and will fall into such habits as are impressed upon them by a course of training. Whatever be the peculiar variety of dog kept in or about a dwelling-house, it is important that he be at least taught good manners; as for example, to be silent and lie down when bidden, to refrain from leaping on the knees of persons visiting the family, and not to sit staring at meals, watching every bit that is put in the mouth. To make a dog behave properly in these and other points, he must be carefully taught when young, and for this purpose his master requires to employ a judicious mixture of severity and gentleness. He must be made fully aware that he must do as he is bid; that if he do not he will be punished, but that if he obey he will be rewarded. As all dogs are very tractable in such matters, they will soon learn to know the meaning of a look, a sign, or a word, and will act accordingly. As very few persons take the trouble to teach domestic dogs either one line of conduct or another, we see on all occasions instances of the natural consequences of neglect.

Breeding.

The best dogs are produced from parents not less than two years old, to which period a valuable bitch should be reserved. During her heats before this time she should be locked up, and be treated with a little cooling medicine. All who are interested in preserving the breed of their dogs, should on no account suffer a cross. In every instance let the male and female be of the true breed designed, not mixed or deteriorated. If a slight alteration of character be desirable, breed from the nearest varieties. Breed always from the healthiest and best shaped animals. Mongrel breeds are good for nothing.

Breeders of sporting dogs require to pay marked attention to these principles. According to the author of the "Oakleigh Shooting Guide," the theory respecting pointers is, "that the further any dog is removed from the original Spanish pointer the worse the dog is; and consequently that all attempts to cross the pointer with any other blood must necessarily deteriorate the breed. The greyhound is seldom or never crossed to give him additional fleetness, nor the hound to improve his nose; why, then, should the pointer be crossed with dogs which, in so far as the sports of the field are concerned, scarcely inherit one quality in common with him? Attempts, however, are constantly made to improve the pointer by a cross with the blood-hound, fox-hound, Newfoundland dog, or mastiff, sometimes with a view of improving his appearance, and bringing him to some fancied standard of perfection, but in reality inducing a deformity. The best pointer is the offspring of a pointer bitch by a pointer dog; such a one is nearly broken by nature. The Spanish [or true] pointer seldom requires the whip; the hound pointer has never enough of it." The same writer continues—"Dogs should be constantly shot over during the season by a successful shot, and exercised during the shooting recess by some person who understands well the management of them, otherwise they will fall off in value—the half-bred ones will become unmanageable, and even the thorough-bred ones will acquire disorderly habits."

It appears that female dogs, before or during a state of heat, are liable to receive mental impressions of the appearance of male dogs with which they have been in company, and these remembrances will affect their progeny even for years afterwards. We beg to refer to "Blaine's Encyclopædia of Rural Sports," p. 412, for some interesting information on this subject.

Whelps, at a month old, are deprived of their dew claws; and if the tail be too long, a small piece may be pinched off. The ears of some dogs are also pared about this period. It is not customary to cut male dogs, except those which are intended for pets; the operation renders the animal a much more docile and agreeable companion. There is a prejudice of very old standing, that dogs have a worm beneath their tongue, and that the removal of this, called *worming*, deprives the animal of the power of biting, should it become rabid. No worm exists; and it is doubtful if the process is of any use. That which is called a worm is merely a minute ligament or fibrous cord in the bridle beneath the tongue; and when the bridle is cut, the ligament may be drawn forward and separated at both extremities; the contraction of the ligament, on extraction, resembles the movement of a worm, and hence the origin of the term.

Feeding.

Some of the most troublesome traits in the dog's behaviour arise from mismanagement in feeding. If a dog be half-hungered, he cannot be blamed for watching the breakfast or dinner table. We advise all who indulge themselves with keeping dogs, not to leave their feeding to the chance scraps of either the kitchen or the parlour. Give the dog his own regular meals, and with food suitable to his wants or the duty he has to perform. The food should be chiefly flesh of some kind, boiled and cold; if given raw, it has a tendency to foster ferocity of disposition, and will cause the animal to be offensive in smell. No pet-dog, especially, should ever be allowed to eat raw meat. Any common pieces of flesh or tripe will answer for dog's meat. Some persons give liver, which is decidedly bad; it relaxes the bowels, and is otherwise objectionable. Besides the piece of boiled meat considered necessary, give dogs a few bones from the dinner table; they are fond of these, and they are useful in cleaning and preserving their teeth, and keeping their bowels in order. If the dogs will take it, they should also be given a little farinaceous food, as morsels of bread or a little oatmeal porridge with milk.

The nature of the dog leads him to feed well when food is offered to his appetite, and to feed seldom. Once a day, therefore, is in ordinary circumstances sufficiently frequent for his meals. Present him with his allowance in the morning or forenoon, and give him no more till next day. He, however, requires to drink frequently; and it is a leading rule in keeping a dog, to have at all times a pan of clean cold water ready for his use. Change the water daily, or oftener.

For the feeding of hounds, Daniel recommends that flesh-meat should be alternated with a diet of oatmeal porridge, made with broth in which meat has been boiled. Greens boiled in their meat is also proper. "A horse killed and given to the hounds whilst warm, after a very hard day, is an excellent meal; but they should not hunt till the third day after it. The bones broken are good for poor hounds, as there is great proof in them. Sheep trotters are very sweet food; and bullock's paunches may also be of service, in a scarcity of horse-flesh. Hounds should be sharp-set before hunting; they run the better for it." The same excellent authority continues to observe that hounds should be fed once when returned from the fatigues of the chase, and again sometime afterwards. "It is the best plan to feed twice the hounds that have been out. Some hounds will feed better the second time than the first; besides, turning them out from the lodging-house refreshes them; they stretch their limbs, and the litter being shaken up, and the kennel cleaned out, they settle themselves better on the benches afterwards. At all times, after being fed, the hounds should be turned into the grass court to empty themselves; it will not a little contribute to the cleanliness of the kennel."

Lodging—Kennel Treatment.

Dogs require to be lodged in a dry situation, at a moderate temperature. The practice of keeping dogs out all night during frosty weather, or of putting them into cold coach-houses, is most inhumane and disgraceful. Dogs kept for watching the outside of premises should be provided with a comfortable dog-house of wood, bedded with clean straw, and sheltered from cutting winds. A dog kept in a dwelling-house should have an appointed place, as in a lobby, for sleeping; its birth should consist of a basket, open box, or small house, according to the taste of the animal. A spaniel will not go into a dog-house; a terrier prefers it. In any case the berth should be laid with a piece of carpet or blanket, which must be frequently washed and dried.

Damp is seriously injurious to dogs. It produces rheumatisms, which show themselves by lameness in the shoulders, and other disorders detrimental to their usefulness. It is therefore of great importance to build kennels in airy situations, and to keep them dry and airy. The best kennels are paved with tiles or stone, but on the floors there are raised benches, littered with straw in winter, on which the dogs repose. The straw should be daily changed, nothing being of so much consequence as cleanliness, both for the sake of general health, and preserving the powers of scent of the animals. For this latter purpose, some keepers of packs of hounds have a change of rooms, one being used while the others are becoming sweet after cleaning. On this subject Daniel observes: "The excellent sense of smelling, so peculiar to the hound, is what our sport entirely depends on; care, therefore, must be taken to preserve it, and the utmost cleanliness is the surest method: to keep the kennel sweet cannot be too much recommended, and is on no account to be neglected. The exactness of the master in this particular will ensure that of the feeder.

"Hounds that come home lame should not be taken out the next hunting day, since they may appear sound without being so. At the beginning of a season the eyes of hounds are frequently injured; such hounds should not be hunted; and if their eyes continue weak, should lose a little blood. Such as have sore feet should have them well washed out with brine or pot-liquor. Hounds unable to work should be permitted to run about the house; it will be of great use to them; and such as are ill or lame ought to be turned into a kennel by themselves; here it will be more easy to give that attention both to their medicine and food which is requisite."

Hounds which are properly disciplined are obedient in a very extraordinary degree to the orders of the huntsman. "To see," says the writer of the article *Hunting*, in the Encyclopædia Britannica, "sixty couples of hounds, animals all hungry as tigers, standing aloof in their yard, and without even hearing, much less feeling, the whip, not daring to move until the order is given to them. And what is the order given? Why, at the words 'come over, bitches,' or 'come over, dogs,' every hound of each individual sex comes forward, as the sex it belongs to may be called for, leaving those of the other sex in their places. Then the act of drawing them to the feeding troughs is an exceedingly interesting sight—often, with the door wide open, having nothing to do but to call each hound by its name, which of course he answers readily to. The expression of countenance, too, at this time is well worthy of notice; and that of earnest solicitation, of entreaty, we might almost say of importunity, cannot be more forcibly displayed than in the face of a hungry hound awaiting his turn to draw. He appears absolutely to watch the lips of the huntsman, anticipating his own name."

Health—Disease.

All dogs whatsoever, but those designed for field sports in particular, require to be kept in what is called "condition," that is, neither too fat nor too lean, but the body in that hardy and active state that will enable the animal to perform its duties. If loaded with flesh or fat it will not possess wind, or a due power of quick breathing, for any length of time in the chase. Colonel Cook observes, on what constitutes a proper condition—"The ribs should be visible and the flank moderately hollow, but the loins must be well filled up in a dog in perfect condition. When dogs exhibit general fullness and too much flesh, commence by physic and a regular course of exercise, which should be mild at first, but increased until it is severe. Avoid too great a privation of food, otherwise the conditioning process will be retarded."

To keep a dog in a state of good health, he must not only be regularly fed and admitted freely to water, but be allowed plenty of exercise daily in the open air, and kept in a cleanly condition. If his bowels appear relaxed, he is not in sound health; and as a preventative of this, let his food, as already said, be substantial, and consist partly of bones; let him also have access to grass; every proper kennel has a grass-yard to which the dogs can resort. In the pan of water used by house-dogs, put a piece of brimstone; it slightly affects the water by lying in it, and helps to keep the animals cool.

All dogs are liable to be troubled with fleas, which they get from the ground; the skin also contracts dirt, and from that or other causes becomes offensive in smell. The remedy is cleanliness. Every lap or house-dog should be washed at least once a week with soap and water. Some dogs have a great dislike to washing, but it must nevertheless be performed. After washing thoroughly, rub the animal dry with a hard cloth, and comb and brush it. If there be fleas, a small-toothed comb will remove them, and they should be killed as they appear. Wash and dry delicate dogs before the fire.

On the subject of physicking as a preventative of disease, or when there are symptoms of diseased skin, a little sulphur and antimony is recommended, mixed with the meat, or done up as a bolus or pill, and in this latter form pushed over the throat. "Once a week or fortnight," says Daniel, "during the hunting season, hounds should have one pound of sulphur given them in their meat; and when the season is over, half a pound of antimony should be added to the sulphur, and well mixed with the meat. This cools, and is doubtless of service to them."

Mange.—This is a cutaneous disease in dogs, very closely resembling itch in the human species, but more inveterate, and is hereditary as well as contagious. Mr Blaine, in his "Encyclopædia of Rural Sports," thus speaks of this nauseous complaint:—"Of all the causes which beget mange, and they are not few, the acrid effluvium from their own secretions is the most common; when it is generated by numbers, particularly when it is confined within a limited space, it is sure to appear. Close confinement of any dog will commonly produce it, and more certainly so if it be at the same time fed on salt provisions; thus there are few dogs on ship-board that do not contract it except such as are allowed full liberty of the deck. Food too nutritive in quality, and too considerable in quantity, is productive of mange; and, on the contrary, food in a great measure withheld, or being very poor in quality, is equally a parent of the disease." The same authority gives several receipts of medicine to be employed; the leading are—powdered sulphur, four ounces; muriate of ammonia (sal-ammoniac) powdered, half an ounce; aloes powdered, one drachm; Venice turpentine, half an ounce; lard or other fatty matter, six ounces; the whole to be mixed and administered in boluses. In all bad cases, however, we should recommend no one to attempt doctoring his dog, but to apply to a regular practitioner.

Distemper.—The disease called the Distemper is most common among dogs which are much kept in the house and subjected to artificial treatment. The disorder is epidemical, affects the constitution, and is very difficult of removal. W. H. Scott, in his work on "British Field Sports," thus describes the symptoms of distemper in a young dog:—"Sudden loss of usual spirit, activity, and appetite; drowsiness, dullness of the eyes, and lying at length with the nose to the ground; coldness of the extremities, ears and legs, and heat of the head and body; sudden emaciation, and excessive weakness, particularly in the hinder quarters, which begin to sink and drag after the animal; an apparent tendency to evacuate from the bowels, a little at a time; sometimes vomiting; eyes and nose often, but not always, affected with a catarrhal discharge. In an advanced stage of the distemper, such symptoms will occur as spasmodic and convulsive twitchings, the nervous and muscular systems being materially affected; giddiness and turning round, foaming at the mouth, and fits. The disease is then often taken for incipient madness, into which it might not improbably degenerate." The same authority adds—"I have found daily mild doses of from two to three grains of calomel alone, lapped by the animal in milk, continued for four or five days, with intermissions when necessary, fully sufficient to carry it safely through the disease, even when the fever has been very high. James's powder has, however, always proved the most certain remedy." To aid recovery nourishing diet should be given. In cases of severity consult the veterinary surgeon.

Madness.—Canine madness, rabies, or hydrophobia, is the most fatal malady to which dogs are subject, and for which, as far as we have heard, there is no certain cure. Blaine considers that rabies is never produced spontaneously in dogs or any other animals, but is invariably the effect of inoculation by a bite from a dog already mad. But as the disease must have commenced spontaneously in some dog at first, we do not understand why it may not do so again; in short, the doctrine, in the exclusive form in which it is put, seems untenable. Rabies is little known in hot or cold countries; it is common chiefly in temperate regions, but shows itself principally in summer, when it may be supposed to be excited by a feverish condition of body.

The leading symptom of the rabid state is an apparent discomfort and unsettledness of purpose, with a desire to gnaw and eat any thing within reach, as straw, wood, coal, or any other rubbish; as the disease advances, the animal snaps and bites at everybody, or any animal near it. This is, however, no effect of bad temper; the dog has no wish to go out of his way to bite; he is under the influence of a derangement which makes him catch only at what is near. Like the unnatural appetite he possesses, the snapping propensity may also partly arise from the irritated state of the stomach and intestines, both of which are greatly inflamed. The throat is likewise livid, and by a constriction of parts, soon prevents the animal from swallowing. That the rabid dog has a terror of water (hence the origin of the name *hydrophobia*), is now beginning to be doubted; and at all events it is not an invariable symptom, for mad dogs have been known to lap water the day before their death. In the later stages of the disease paralysis ensues, and from the fourth to the seventh day the dog expires. It is humanity to shoot the animal before this final catastrophe.

With respect to the production of rabies in the human species, there have latterly been some very grave doubts. An idea has been started, and supported with considerable plausibility of argument by certain medical practitioners, that hydrophobia in the human being is merely a nervous affection, very much if not almost altogether arising from the influence of the imagination; the person bit fancies he is going mad, and mad he becomes. It is very desirable that the medical world should investigate and arrive at some determinate conclusion respecting this remarkable doctrine; meanwhile, till the matter is settled one way or other, we must speak of rabies in the human subject as a real disease, against which every reasonable precaution should be adopted. On being bit, it is always safe to wash the wound immediately, and have the parts burnt with a hot iron, or cut out. In every case let a skilled surgeon be immediately consulted—one who will not hesitate to act with promptitude and decision.

Many cures have been mentioned for the bite of a mad dog. We shall notice a few. The following, according to Blaine, is the famous Herefordshire cure, commonly called *Webb's drink*:—"Take the fresh leaves of the tree box, two ounces; of the fresh leaves of rue, two ounces; of sage, half an ounce; chop these finely, and after boiling them in a pint of water to half a pint, strain and press out the liquor; beat them in a mortar, or otherwise bruise them thoroughly, and boil them again in a pint of new milk, until the quantity decreases to half a pint, which press out as before. After this, mix both the boiled liquors, which will make three doses for a human subject. Double this quantity will form three doses for a horse or cow; two-thirds of it is sufficient for a large dog, calf, sheep, or hog; half the quantity is required for a middle-sized dog; and one-third for a smaller one. These three doses are said to be sufficient; and one of them is directed to be given every morning fasting." Blaine has not much confidence in this remedy, but allows it is worth trying.

Mr. Murray, known as a lecturer on chemistry, mentions, in a letter to a newspaper, the following remedy:—"Let a mixture of two parts of nitric and one part of muriatic acid, both by measure (evolving chlorine in a concentrated form), be applied to the wound as soon as possible, and more than once." He adds, that he has found this a preventive.

M. Buisson, a Parisian physician, declares that madness from the bite of a rabid dog may be thoroughly cured by fumigating the patient in a hot vapour bath, and afterwards keeping up the copious perspiration in bed; this he recommends to be done for several successive nights.*

FIELD SPORTS.

Conducted on principles of moderation, humanity, and fair play, the sports of the field may be said to be those exhilirating and healthful pursuits by which the tribes of

* See an account of Buisson's proceedings in "Chambers's Edinburgh Journal," No. 257.

wild animals are made subservient to man's use, or removed from a sphere in which they are inconvenient and unsuitable. In taking amusement from such sports, it is the glory of the true English gentleman to avoid every proceeding which can give unnecessary pain to the animals over which he claims dominion, and to discountenance by every means in his power such odious abuses of sport as baiting, worrying at the stake, or any other method of protracting the death of the creatures who have the misfortune to be objects of the chase.

Our space will permit us only to notice the leading field sports of Britain in past and present times.

FALCONRY.—DEER HUNTING.

Falconry was the favourite field sport of the middle ages, as shooting with the gun is the predominant one of the present day. It appears, in this country, to have declined and gone out of use in the seventeenth century, in consequence of the gun having then become, by the addition of the lock and flint, a much more ready means of bringing down game than the use of hawks had ever been. Falconry, while it existed, was the peculiar sport of kings, and princes, and nobles, many of whom were painted in life with their hawks seated on their wrist, and were sculptured on their tombs after death with the same creature placed at their feet, thus marking the special regard in which they held the animal which was the means of giving them so much amusement.

The sport, we need scarcely remark, was founded on the natural instinct of the rapacious order of the feathered creation, as the chase may be said to be founded on the instinct of the dog to pursue the hare, fox, and other animals. The rapacious order of birds, of which the eagle, falcon, and owl, are the three principal types, are formed in such a way as evidently fits them for pursuing, seizing, and destroying the smaller birds; a part in creation which at first sight appears to involve much cruelty, but which has been clearly shown to be intended to save rather than to produce pain, and to be indispensable to a system of things in which one leading feature is, that there shall always be as many living creatures as can possibly be supported. The falcon family were alone employed for purposes of sport, as alone possessing the required docility, and of this family two or three species were more frequently used than any other. Of those possessing long wings, the falcon proper and the gerfalcon; and of the short-winged, the goshawk and sparrow-hawk, seem to have been the favourite kinds. Species called the hobby, the kestral, the merlin, and buzzard, were the next in request. The female, which is in all the varieties of this tribe considerably larger than the male, was alone employed in sport, and the common names of all the species apply to that sex, the male having usually some distinctive appellation: thus the male of the gerfalcon was called the *jerkin*, of the falcon proper the *tierce gentle*, of the goshawk the *tiercel*, and of the sparrow-hawk the *musket*.

These birds naturally choose retired habitations. The falcon, in particular, builds her nests amongst cliffs in wild and unpeopled regions. In order to fit birds for the sport of falconry, it was necessary to take them from the nest at a very early stage of their existence (then technically called *eyasses*), or to ensnare them in their more mature age, and then train them for the purpose. A falcon in its natural state was said to be a *haggard;* hence, apparently, the term by which we still express a wild or agitated aspect. The first step in training the falcon was to *man* it, or accustom it to the presence of human beings. Feeding was the grand source of the power which its keeper acquired over it. When it did as required, it was fed, and thus taught to know that it had done right—and not otherwise. If extremely refractory, a stream of cold water was directed at its head, as an admonition that nothing was to be gained by such conduct. From the very first, the animal was accoutred with certain paraphernalia, the *names* of which at least must be familiar to most readers. First, its head was covered by a leathern *hood* fitting close all around, so as to shut up its eyes, and calculated, by a slit behind, to be readily slipped on and off. On the top of the hood there was a tuft of feathers, which usually has a graceful effect in the old pictures representing ladies or gentlemen travelling with their hawks upon their wrist. Leathern straps, called *jesses*, a few inches in length, were fitted to the legs of the bird by a button slipping through a slit or loop. Close beside the end attached to each leg was a small spherical *bell*, like that of a child's rattle, and composed of silver for clearness of sound, the one being in some nice instances made a semitone higher than the other. The other end of the jesses were furnished each with a ring, which could be readily fitted upon the swivel designed to connect them both with the *leash*, a long slender strap, sometimes prolonged by a *creance* or common cord, and designed as a tether by which to restrain the animal, at the same time that it should be allowed considerable room for free motion. Two great objects in training were to teach the bird to fly at its proper game, and to habituate it to come back to the hand of its master, after on any occasion having been let free in pursuit of its prey. For the first of these ends, in the case of long-winged birds, an implement termed the *lure* was used. It consisted either of a stick or of a cord, on the end of which were fixed pieces of flesh, with a bunch of the feathers of the prey which it was designed that the bird should fly at, or perhaps an actual resemblance of the prey in its entire form. The falcon being set loose by one man, another stood at a distance waiving the lure around his head, thus tempting the animal to advance and strike at it. A whistle was the implement used to *reclaim* or bring back the hawk. When a hawk was to be kept on the hand, strong gloves were worn for protection from its talons. It may here be remarked, that the training of falcons was altogether a most laborious business, and that trained birds were accordingly to be only purchased at a high price. At the beginning of the seventeenth century, a trained goshawk and tiercel brought one hundred marks, and it was considered a favour to part with them. The extreme labour attending the training of the animals must have been sufficient in early times to confine the sport to persons of birth and fortune, if there were no other cause; and it must also have conduced to the rapid decline and extinction of the sport, after a ready means of killing wild-fowl by the gun became attainable.

The sport, after being long given up, was revived in England a few years ago by Colonel Thornton, the Duke of St. Albans, and a few other gentlemen, chiefly through the influence of a taste for whatever is elegant and romantic in the usages of our forefathers. It is said to be a gallant and goodly sight, when a train of well-mounted English ladies and gentlemen rides forth in a clear sunshiny day, to pursue this sport, attended by their falconers, each with his hawk on his wrist. In the present day, as of yore, various kinds of feathered game are flown at. Heron-hawking is, we believe, in greatest esteem. The heron, as must be generally known, is a large bird in appearance, with a long neck, long legs, and a long sharp bill, being designed to haunt marshes and pools, and feed upon whatever fish it can find therein. It is, however, a light unsubstantial bird, with nothing to protect it from enemies but its sharp bill. Herons are gregarious, and the lonely places where they live are called heronries. These explanations will introduce the following account of heron-hawking, from Blaine's "Encyclopædia of Rural Sports:"—

"The daily visitations of the heron to its feeding-places are watched by the falconers, who station themselves to the leeward or down wind of the heronry, so that the heron on his return must fly against the breeze, which gives a great advantage to its enemy. As soon as one is discovered on the return, a cast of falcons is let loose, who, catching sight of the quarry, rise in pursuit. The heron, instinctively aware that its life is at stake, prepares for the fray by disgorging the contents of its stomach to lighten the weight of the body. The coursing falcons ascend the airy vault in spiral gyration, by which the atmospheric resistance to their flight is lessened. These circlings, it has been observed, have frequently the curious effect of presenting the three birds as flying in different directions; whereas the real intentions of the two hawks are steadily directed to one point, which is that of contact with the heron, whose entire efforts are as steadily engaged in avoiding it. To effect this, the affrighted heron strenuously endeavours to rise above the hawks, who, however, by the superior power of wing, commonly succeed in getting the upper station, from which one presently makes its stoop; and happy it is for the poor heron if he can evade the blow, which he occasionally does, either by shifting his station, or by receiving the falcon on his sharp bill, which instantly transfixes it. This danger is, however, denied on authority, but we feel assured that it does occur. The second hawk, if the first fails, stoops in his turn; but the meditated blow of this also is frequently evaded like the former. The trio then still rising higher and higher, the sight becomes interesting in the extreme, and the spectators are scarcely less agitated than the feathered warriors above. At length another stoop takes place, and the fatal seizure is made by one hawk, while the other *binds* to his fellow, and all three quickly descend together, but not with a dangerous rapidity, as their powers of inflation and the action of their wings break the fall. It is now that the mounted horsemen make the best of their way to the assistance of their falcons, and their first efforts must be directed to secure the head of the heron, that the sharp beak may not take effect on one or both of them."

Pheasants are objects of this sport, but not to a great extent, on account of the inconvenience presented by the sylvan ground in which the sport must be practised. Partridge-hawking is found to be a more convenient sport. To quote the same authority—"The scene of practice is commonly on large fields or open tracts of country, where the horsemen and company generally can beat in line, and the attendant falconer or master, being well mounted, can ride forward and be ready to receive the quarry. Either pointers or spaniels are necessary, or both.

"The partridge being flushed, the hawk will stoop with astonishing rapidity, and seize on it; at which time neither horses, dogs, nor company, should press forward; on the contrary, they should permit the falconer only to advance, who, approaching the hawk with caution, must walk quietly round her, when, gently kneeling down with his arm extended, as though in the act of feeding the hawk, he should lay hold of the partridge, and at the same time place the hawk on his fist. This done, put on the hood, and reward the hawk with the head of the quarry, and if she be not intended to fly again, let her be fed immediately.

"A somewhat different method of partridge-hawking is practised in the latter part of the season, when the country is very bare, and when the partridges are often very wild, and lie indifferently even to the dog. In such cases it is recommended that the company 'draw up in line at fifty or sixty yards' distance from each other, and gallop across the plain with a hawk upon wing,' the falconer being in the centre of the line, that he may regulate the pace by the situation of the hawk. Sir John Sebright informs us that this method of partridge-hawking has afforded him more sport than any other, and that when the face of the country was so bare, and the birds so wild as to make it impossible to approach them in the usual way.

"Brook-hawking, as it is often termed, was much in vogue formerly. The practice was not, however, confined to brooks, but extended to rivers, sea-shores, moors, and ponds. It engaged, according to Blome, 'the jer-falcon, the haggard falcon, the jerkin, and the tassel gentle.' Waterfowl of every description were made prey of; but some particular objects, according with the training of the falcons, were particularly sought for. Dogs were employed to rouse the fowl, being led on by men who traversed the water's edge; while horsemen, with the hawks on their fists, were at hand to *cast off* one or more, according to the nature of the game. A heron or mallard would require two, while a widgeon or teal would probably engage only one."

Deer-hunting was another principal amusement of past times, but has now been abandoned in the form in which it used to be conducted. The species of animals chiefly hunted in England was the fallow-deer, a beautiful creature with stately horns or antlers, and of great speed in running. Fallow-deer are now closed up in parks, at least in Britain. The stag, red deer, or hart, whose female is called the hind, differs in size and in horns from the fallow-deer. He is much larger, and his horns are round, whereas in the fallow species they are broad and palmated. Red deer are now, we believe, the only objects of field sport in this country, and principally in the Highlands of Scotland, where they still exist in considerable numbers. No hounds, however, as in the chase in former ages, are employed, the hunter depending on his gun and his skill in approaching the animal noiselessly. This, which is called *deer-stalking*, is a sport requiring a vast deal of tact, knowledge of the animal's habits, and patience, as whole days are occasionally taken up in stealthily watching an opportunity for a shot. Such is the power of sight, scent, and hearing, that to approach unperceived on a plain is impossible. They must be approached down the wind, and from behind thickets or hillocks. A telescope is required in these difficult manœuvres. When it is impracticable to reach them in this artful manner, attendants drive them into gorges among the mountains, and the sportsman singles out an object for his gun as it passes his concealed station. A lively work on deer-stalking has lately been written by Mr. Scrope, to which we beg to refer those who are interested in the subject.

FOX-HUNTING.

The variety of fox most common in Britain is called the *cur fox*, which is of a brown colour, with generally some white on the breast and belly, and a light tip to the long bushy tail. Foxes go to *clicket* in winter, and cubs are produced in the latter end of March; they breed but once a year, and have from three to six young ones at a time. In his nature the fox is playful, but rapacious in his appetite, and his predominating characteristic is great craftiness. He usually fixes his abode on the border of a wood, at no great distance from a farm-house or village; he listens to the crowing of the cocks and the cries of the poultry; he scents them, and chooses the time of his attack with judgment; he conceals his road as well as his design; he slips forward with caution, sometimes even trailing his body, and seldom makes a fruitless expedition. He plans similar encroachments on the nests of birds, rabbit warrens, &c.; and, in a word, is so destructive to live-stock that it is absolutely necessary to take and kill him.

Fox-hunting on a proper scale requires to be conducted with the class of active horses termed hunters, a pack of fox-hounds to scent and run down the prey, and terriers to turn the animal from his hole, should he take to earth. A pack of hounds varies from twenty to thirty couples; but besides these, some hounds are always left undrafted into the field. The cost of a good pack is reckoned at from £1000 to £1200, and the annual expense of its keep and management as much. The huntsman, as the grand leader of the chase, is a functionary of no small importance; he is assisted by two whippers-in, who bring up and take charge of the hounds.

The fox being an early riser, and his scent lying best on the damp grass, he is hunted in early morning; and the first business on taking the field is to ride to and draw cover—that is, bring out the fox from his retreat. At the first sight, the view halloo is given by the huntsman, and all follow the sweeping track of the hounds. It is a rule in hunting never to get before the dogs, or to throw them out any way by a false signal; on the contrary, the great art is to keep them to the scent, and to aid their search. The run is considered the exhilarating part of the sport, and consists of a rapid chase through a broken or rough country, with the hounds in full cry. Then is the ardour of the chase shown; and it continues till the fox, by some clever manœuvre—such as tracking up a brook—throws the hounds off the scent, and the party is brought to check. The scent and track of the animal being again found, off all go once more in pursuit, but with generally frequent doubts of the result. "See," says Beckford, in his enthusiastic style, "where the hounds bend towards yonder furze brake; I wish he may have stopped there. Mind that old hound; how he dashes over the furze! I think he winds him! Hark! they halloo! Ay, there he goes! It is nearly over with him! Had the hounds caught view he must have died! He will hardly reach the cover. See how they gain upon him at every stroke! It is an admirable race; yet the cover saves him. Now be quiet, and he cannot escape us; we have the wind of the hounds, and cannot be better placed. How short he runs! He is now in the strongest part of the cover! What a crash! Every hound is in, and every hound is running for him! That was a quick turn! Again, another! He's put to his last shifts! Now mischief is at his heels, and death is not far off! Ha! they stop all at once; all silent, and yet no earth is open. Listen! Now they are at him again! Did you hear that hound catch him?—they overran the scent, and the fox had laid down behind him. Now reynard, look to yourself! How quick they all give their tongues! The terriers, too, are now yelping at him. How close *Vengeance* pursues!—how terribly she presses!—it is just up with him! What a crash they make; the whole wood resounds! That turn was very short!—There!—now!—ay, now they have him! Who-hoop!" The chase is over: Reynard is no more; and his *brush* or tail being cut off as a trophy by the huntsman, his unfortunate carcass is thrown to the hounds, and in a few moments destroyed, leaving scarcely a wreck behind.

HARE-HUNTING—COURSING.

Hares are hunted in much the same manner as foxes, the chief difference being that harriers are employed instead of hounds; both hunt by the scent. Of this branch of field sports, the writer of the excellent article on *Hunting*, in the "Encyclopædia Britannica," makes the following mention:—

"Hare hunting claims precedence of fox-hunting in the sporting chronology of Great Britain, and we believe of all other countries, inasmuch as a hare has always been esteemed excellent eating, and a fox the rankest of carrion. We gather from Xenophon that it was practised before his day, and he wrote fully three centuries before the Christian era, both hounds and nets being then used in the pursuit. Neither can we marvel at hare-hunting being the favourite diversion in all nations given to sporting, where the use of the horse in the field had not become common. But we will go a point farther than this, and assert, that how inferior soever may be the estimation in which hunting the hare is held in comparison with hunting the fox, no animal of the chase affords so much true hunting as she does, which was the opinion of the renowned Mr. Beckford

"The difficulty of finding a hare by the eye is well known. It is an art greatly facilitated by experience, although not one person in ten who attempts it succeeds. But here we recognise the hand that furnished her with such means for her security; as, from the delicacy of her flesh, she is the prey of every carnivorous animal, and her means of defence are confined only to flight. In going to her form, she consults the weather, especially the wind, lying always, when she can, with her head to face it. After harvest, hares are found in all situations; in stubble fields, hedge-rows, woods and brakes; but when the leaves fall, they prefer lying upon open ground, and particularly on a stale fallow, that is, one which has been some time ploughed; as likewise after frost, and towards the spring of the year. In furze or gorse, they lie so close as to allow themselves nearly to be trodden upon, rather than quit their form. The down or upland-breed hare shows best sport; that bred in a wet marshy district the worst, although the scent from the latter may be the strongest. If a hare, when not viewed away, runs slowly at first, it is generally a sign that she is an old one, and likely to afford sport; but hares never run so well as when they do not know where they are. Thus trapped hares turned out before hounds, almost invariably run straight on end, and generally till they can run no longer; and they generally go straight in a fog. The chase of the hare has been altered, and rendered less difficult in some degree, by the improvement of the hound used in it.

"The difference in the terms used in hare-hunting and fox-hunting is comprised in a few words:—Harriers are cast off in the morning; fox-hounds throw off. The hare is found by the quest or trail; the fox by the drag. The hare is on her form or seat; the fox in his kennel. The young hare is a leveret; a fox a year old is a cub. The view hollo of the hare is 'Gone away;' of a fox 'Tallyho.' The hare doubles in chase; the fox heads back, or is headed. The harrier is at fault; the fox-hound at check. The hare is pricked by the foot; the fox is balled or padded. The hare squats; the fox lies down, stops, or hangs in cover; the 'who hoop' signifies the death of each."

Hares are hunted with packs of generally twenty couples of harriers; but whatever number is employed, it is the established rule never to run in upon the hares as soon as discovered in their forms, but to allow them a little space before the dogs are set on. The hares, also, must not be pressed upon in the chase by the company, neither are the dogs, on losing scent, to be called on the right path; for this leads them to depend on the sight of the huntsman instead of their own nose. Leave the harriers pretty much to themselves.

Coursing is the chasing and taking of the hare by means of greyhounds, which hunt by the sight only. Among fox-hunters it is considered an inferior kind of sport, but many country gentlemen find in it an exhilarating recreation, and it is patronised by numerous coursing clubs. "There is," says Blaine, "even a philanthropic character about coursing almost unknown to other huntings. It may be said to offer a kind of refuge for the sporting destitute, for it holds out innocent recreation to those whose means or whose prudence will not allow them to risk either their neck after a fox or their wealth after a racer. Here the octogenarian, at once labouring under his increased years and his decreased energies, may solace himself with an epitome of former huntings; and farther, that the joys of this chase are within the reach of every state or stage of life."

The greyhound, whose form so eminently adapts him for competing with the hare in a race, requires to be well trained in the art of turning suddenly, and determinedly pursuing his game on a new line of pursuit. His eye should be clear and quick, and his wind good, to enable him to hold out to the last. Greyhounds are delicate in their nature, and require very careful treatment; their lodging must be dry and comfortable, and when taken out in a cold morning they must be held in leash with jackets on, ready to let slip. In any case, they are not uncoupled or let go till the hare has been seen and started. A single pair of dogs is generally sufficient for the sport; and betting often ensues as to the points in the course. There are numerous rules of ancient and modern date on the subject of coursing. The following, established by the Duke of Norfolk in Queen Elizabeth's reign, are yet held applicable:—

"The Feuterer, or person who lets loose the greyhounds, was to receive those that were matched to run together into his leash, as soon as he came into the field, and to follow next to the hare finder, or him that was to start the hare, until he came to the form, and no horse or footmen were to go before or on either side, but directly behind for the space of about forty yards.

"A hare was not to be coursed with more than a brace of greyhounds.

"The hare finder was to give the hare three 'sohos' before he put her from her form, to give notice to the dogs that they may attend her starting.

"The hare was to have twelve score yards law before the dogs were loosed, unless the small distance from the cover would not admit it without danger of immediately losing her.

"The dog that gave the first turn, and during the course, if there was neither cote, slip, nor wrench, won.

"A cote is when the greyhound goes endways by his fellow, and gives the hare a turn.

"A cote served for two turns, and two trippings or jerkins for a cote; if the hare did not turn quite about, she only wrenched, and two wrenches stand for a turn.

"If there were no cotes given between a brace of greyhounds, but that one of them served the other at turning, then he that gave the hare most turns won; and if one gave as many turns as the other, then he that bore the hare won. A 'go-by,' or bearing the hare, was equivalent to two turns.

"If neither dog turns the hare, he that led last to the cover won. If one dog turned the hare, served himself and turned her again, it was as much as a cote, for a cote was esteemed two turns.

"If all the course were equal, the dog that bore the hare won; if the hare was not borne, the cause was adjudged dead. If a dog fell in the course and yet performed his part, he might challenge the advantage of a turn more than he gave.

"If a dog turned the hare, served himself, and gave divers cotes, and yet in the end stood still in the field, the other dog, if he ran home to the cover, although he gave no turn, was adjudged the winner.

"If by accident a dog was rode over in his course, the course was void, and he that did the mischief was to make reparation for the damage. If a dog gave the first and last turn, and there was no other advantage between them, he that gave the odd turn won.

"He that came in first at the death, took up the hare, saved her from being torn, cherished the dogs, and cleansed their mouths from the wool, was adjudged to have the hare for his trouble.

"Those that were judges of the course were to give their decision before they departed out of the field."

SHOOTING—GROUSE—PARTRIDGES, &c.

The leading sports with dog and gun are the shooting of grouse, partridges, and pheasants, which differ in some respects from each other. The first thing to be attended to in either case is having a good fowling-piece or gun; and the second is to know how to use and clean it. Next, the sportsman must be provided with a dog trained to point the kind of game for which he is taken to the field; to take a dog accustomed to point partridges on a grouse-shooting excursion would be improper. The gunpowder employed should be kept very dry in a metal flask, and of proper strength and purity. Patent shot is now commonly used; it is of eight sorts, each numbered, and rises from 83 pellets to 620 pellets in the ounce. The more tender the birds, the smaller may be the pellets or drops. For grouse, shooters begin with No. 7, or 480 to the ounce; ducks require shot No. 4, or 105 to the ounce.

The following hints to a beginner in shooting are by Hawker and others:—"In raising the gun, let him remember that the moment it is brought up to the centre of the object, the trigger should be pulled, as the first sight is always unquestionably the best. Then send him out to practice at a card with powder, till he has got steady, and afterwards load his gun occasionally with shot, but never let the time of your making this addition be known to him; and the idea of it being perhaps impossible to strike his object will remove all anxiety, and he will soon become perfectly collected.

"The intermediate lesson of a few shots at small birds may be given; but this plan throughout must be adopted at game, and continued, in the first instance, till the pupil has quite divested himself of all tremor at the springing of a covey, and observed in the last, till most of his charges of shot have proved fatal to the birds. If he begins with both eyes open, he will save himself the trouble of learning to shoot so afterwards. An aim thus, from the right shoulder, comes to the same point as one taken with the left eye shut, and it is the most ready method of shooting quick. Be careful to remind him (as a beginner) to keep his gun moving, as follows:—before an object, crossing; full high for a bird rising up or flying away, very low; and between the ears of hares and rabbits running straight away. All this, of course, in proportion to the distance; and if we consider the velocity with which a bird flies, we shall rarely err by firing, when at forty yards, at least five or six inches before it. Till the pupil is *au fait* in all this, he will find great assistance from the sight, which he should have precisely on the intended point, when he fires. He will thus, by degrees, attain the art of killing his game in good style, which is to fix his eyes on the object, and fire the moment he has brought up the gun. He may then ultimately acquire the knack of killing snap shots, and bring down a November bird the moment it tops the stubble, or a rabbit popping into a furze-brake, with more certainty than he once used to shoot a young grouse in August or a partridge in September.

"Many begin with very quick shooting, and kill admirably well, but are often apt not to let their birds fly before they put up their gun, and therefore dreadfully mangle them, and, I have already observed, are not such every-day shots as those who attain their rapid execution on a slow and good principle.

"If a rival shooter (some stranger) races to get before you, push him hard for a long time, always letting him have rather the advantage, and then give him the double without his seeing you. Having done this, go quietly round (supposing you have been beating up wind); and on reaching the place where you began, work closely and steadily the whole of the ground or covert that you have both been racing over, and you will be sure to kill more game than he will, who is beating and shooting in haste, through fear of your getting up to him, and (if the wind should rise) driving the dispersed and consequently closest lying birds, to your beat as fast as he finds them.

"Beware of the muzzle of the gun being kept hanging downwards; when so carried, the shot is apt to force its way from the powder, especially in clean barrels. If it happens that a space of sixteen or eighteen inches is thus obtained, and the gun fired with its point below the horizon, it is ten to one but the barrel bursts. There are other perilous consequences besides those that generally accompany the disruption of a barrel, for the men, horses, and dogs are in perpetual danger of being shot when a gun is carried in the before-mentioned pendant manner.

"When a gun begins to exhibit symptoms of having done its work, the sooner a man discards it the better. An injured barrel or enfeebled lock may prove fatal to the owner or his associates. Accidents occur every day, and very lamentable consequences proceed, from a culpable neglect in retaining arms which should be declared unserviceable and disused."

Grouse Shooting.—This favourite field sport, as is well known, commences annually on the 12th of August, when thousands of persons adjourn to remote parts of the country to follow it, with all its toils and privations. Among the varieties of the game are numbered the cock of the wood or capercailze; the black cock, black game, or black grouse; the red grouse or moor-fowl; and the white grouse or ptarmigan. The moor-fowl are the most common, at least on the northern moors and hills. The birds being hatched in April, if the summer is dry, they will be pretty strong on the wing in August. The best weather for shooting is that which is dry and warm; wet makes them lie still on the ground. No one need attempt grouse shooting who is of delicate health, or not well trained by previous feeding or exercise. The labour of walking over heather is most toilsome, and the danger of colds from rain or wet feet considerable. The dress ought to be very strong, without any regard to fineness; stout shoes or quarter boots are indispensable.

The times of day best suited for grouse shooting are the morning and evening, when the birds are in quest of food; but few are able to reach their haunts till eight o'clock, when the sport commences. "To find the birds," says the author of "Wild Sports of the West," "when, satisfied with food, they leave the moor to bask in some favourite haunt, requires both patience and experience, and here the mountain-bred sportsman proves his superiority over the less practised shooter. The packs then lie closely, and occupy a small surface on some sunny brow or sheltered hollow. The best nosed dogs will pass within a few yards and not acknowledge them: and patient hunting, with every advantage of the wind, must be employed to enable the sportsman to find grouse at this dull hour. But if close and judicious hunting be necessary, the places to be beaten are comparatively few, and the sportman's eye readily detects the spot where the pack is sure to be discovered. He leaves the open feeding grounds for heathery knowes and sheltered valleys; and while the uninitiated wearies his dogs in vain over the hill-side, where the birds, hours before, might have been expected, the older sportsman profits by his experience, and seldom fails in discovering the dell or hillock where, in fancied security, the indolent pack is reposing."

Our most practical authority on this exciting topic is the "Oakleigh Shooting Guide:"*—"Grouse shooters should separate and range singly; they should have no noisy attendants. In wet weather one dog is sufficient; we advise rest from eleven till two. The flight of grouse is generally about half a mile. Their favourite haunts, when undisturbed, are those patches of ground where the young heather is most luxuriant. They avoid rocks, and bare places where the heather has been recently burnt; at any rate, they are not to be approached in such places. It is in young heather that grouse most frequently feed. They are seldom found in the very long thick heather that clothes some part of the hills, until driven there for shelter by shooters or others. It is early in the morning and towards evening that grouse are to be found in young heather. During the middle of the day the shooter should range the sunny side of the hill, and avoid plains.

"No species of shooting requires the aid of good dogs more than grouse shooting, and in no sport does so much annoyance result from the use of bad ones. The best dog, perhaps, for the moors, is a well-bred pointer, not more than five years old, which has been well tutored—young in years, but a veteran in experience. The setter is occasionally used with success, but we prefer the pointer. The latter has unquestionably the advantage when the moors are dry, as it not unfrequently happens that they are in August. If a setter cannot find water wherein to wet his feet every half hour, he will not be able to undergo much fatigue. Some sportsmen will hunt a couple of mute spaniels for grouse shooting in preference to any other team of dogs. Of course, when this method is pursued, the birds are never pointed, and the shooter must ever be on the look-out, for the game is generally sprung very near the gun."

Partridge Shooting.—Of partridges there are two kinds, the red and gray, the latter being that which is common in this country; the plumage is of a brown and ash colour, elegantly mixed with black; the tail is short, and the figure more plump than handsome. Partridges pair about the third week of February, and sometimes, after being paired, if the weather be severe, they all gather together and form a covey, and are then said to pack. They begin to lay in six weeks after pairing. The female lays her eggs on the ground, scraping together a few bents and decayed leaves into any small hollow. The young birds begin to appear about the first ten days in June, and the earliest will take the wing towards the latter end of that month. In dry seasons they are most numerous. So many are the enemies of the partridge, that it is believed never more than half of those produced come to perfection. The affection of both parents for their young is very remarkable; they lead them out in quest of food, shelter them with their wings, and resort to many tricks to lead supposed enemies away from their broods.

Partridge shooting commences, by law, on the 1st of September, when the birds are strong. In the course of this month, the short flights of the coveys, in tolerably well-preserved grounds, afford abundance of sport. In more open districts of country, where there is a wider range, partridge shooting requires more skill, and a steady pointer or setter. In shooting either at a flight of grouse or covey of partridges, select a bird on the outside, and fire at it alone; it is only over-hasty or ill-taught sportsmen who let fly indiscriminately at the centre of a group of birds.

Pheasant Shooting.—Pheasants are a species of birds allied to domestic fowls, and partake of some of their habits; no birds of the game kind possess such elegant plumage, and few are so large. They breed on the ground, and like partridges are fond of nestling in clover, but their chief resort is shrubberies or secluded spots in plantations. The pheasant and its brood, if undisturbed, remain in the stubbles and hedgerows some time after corn harvest; if molested they seek the woods and only issue thence to feed in the stubbles at morning and evening. Besides corn, the birds will live on wild berries, or any seeds they can pick up. As the cold weather comes on, they begin to fly up at sunset into trees, where they roost during the night.

"For shooting pheasants, it often becomes necessary

* This manual has been republished in an improved and handsome form in the volume entitled "The Rod and the Gun." A. and C. Black, Edinburgh.

to start very early in the morning, as they are apt to lie during the day in high covert, where it is almost impossible to shoot them till the leaf has fallen from the trees. We can never be at a loss in knowing where to go for pheasants, as we have only to send some one the previous evening, for the last hour before sunset, to watch the different barley or oat stubbles of a woodland country, and on these will be regularly displayed the whole contents of the neighbouring coverts. It then remains to be chosen which woods are the best calculated to shoot in; and when we begin beating them, it must be remembered to draw the springs, so as to intercept the birds from the old wood. If the coverts are wet, the hedgerows will be an excellent beginning, provided we here also attend well to getting between the birds and their places of security. If pheasants, when feeding, are approached by a man, they generally run into covert; but if they see a dog, they are apt to fly up.

"There are very few old sportsmen but are aware that this is by far the most sure method of killing pheasants, or any other game, when they are tolerably plentiful in covert; and although, to explore and beat several hundred acres of coppice, it becomes necessary to have a party with spaniels, yet on such expeditions we rarely hear of any one getting much game to his own share, except some sly old fellow, who has shirked from his companions to the end of the wood, where the pheasants, and particularly the cock birds, on hearing the approach of a rabble, are all running like a retreating army, and perhaps flying in his face faster than he can load and fire."

It is necessary, in pheasant-shooting, to use a short double-barrelled gun of wide bore, and large shot. Fire at not a greater distance than thirty yards, and only when the bird has risen clear of the bushes: aim is to be taken at the head; but if the pheasant is crossing your path, fire a little before the head, the rapid flight of the animal bringing it in contact with the shot. Towards November, this field sport may be united with woodcock shooting

GAME.

According to law, wild animals are no one's property but of these animals only certain kinds may be killed without a license. Those protected from indiscriminate slaughter are called *game*, and are deer of every species, foxes, hares, partridges, grouse, pheasants, woodcocks, snipes, &c. The wild animals not reckoned game are rabbits, rats, mice, crows, rooks, pigeons, sparrows, all kinds of sea-birds, &c.; any one may kill and appropriate these, provided it be in a highway, the sea-shore, or any other public ground. Game cannot be legally taken or killed in any form without a license procured from the competent officer of the crown, and a permission from the proprietor of the ground on which the game happens to be. To shoot or hunt without a license is called *poaching*: to shoot or hunt with a license, but without a permission, renders the person liable to an action for trespass. These game laws are relics of ancient laws instituted by the Anglo-Saxon and Norman sovereigns for protection of the royal forests; and though some of these provisions are useful, they are, generally speaking, a disgrace to the statute book, and ought to be simplified and amended.

ANGLING.

ANGLING is the art of alluring and capturing fish by means of a rod and line, to which a hooked bait of some kind is attached—an *angle*, as it were, being formed by the apparatus as held over the surface of the water. Either for profit or amusement, the practice of taking fish in this excusably crafty manner is of great antiquity, as we may learn from the mention made of it by the prophet Isaiah: "The fishers also shall mourn, and all they that cast angle in the brooks" (chap. xix., ver. 8). As well as fishing with nets, the practice has continued through all ages to the present time, and in almost all countries. In the British islands, it has long formed a favourite pastime among every class of society, lay and clerical, and to all presents many features of attraction. "It is," to use the words of Mr. Blaine, "far from dangerous or expensive, but on the contrary is productive of interest and amusement without any extraordinary sacrifice. Its *apparent* simplicity lures many into the practice; and as a trifling success elates the tyro and leads him on by its fascinations, so he pursues it, although he soon discovers that extreme nicety and precision, great patience, caution, and perseverance, are essential requisites to the attainment of proficiency in the art. Nevertheless, he still continues the pursuit; difficulty after difficulty is overcome; each succeeding year adds interest to the practice, which he continues with undiminished ardour to the latest period of his life. It is asserted, and we believe with truth, that there is not one among the field sports that takes so permanent a hold on the passions as this. It is no less remarkable for the variety it offers, for it presents itself under many forms, some of which are suited to the taste of every age, of every rank, and every variety of character and habit. The sedentary, the thoughtful, and the advanced in life, may watch the float as it slowly moves with the stream, without disturbance to the train of thought, or without any fatiguing exercise to their person. The active and volatile may throw afar the leaded bait for the pike, or may engage in the graceful evolutions of the fly-rod. Its seductions, therefore, prove universal, and it owns votaries of every age and station." As the sport is pursued on the banks of rivers or lakes, in the midst of purely natural scenery, and in weather which invites to out-of-door recreation, all conspires to render it in a peculiar manner delightful and healthful, when indulged in with judicious moderation.

No kind of amusement has been the object of such frequent description as angling. Hundreds of treatises have been written descriptive of the sport in all its departments, and with reference to all varieties of fish and the waters to which they resort. The first writer of note on the subject, and who has been acknowledged the great father of the angle, was Isaac Walton (born in Stafford, 1593, died 1683), who in the year 1653 gave to the world his "Complete Angler," a work afterwards enriched with additions by his friend Charles Cotton, and which till this day is esteemed not more for the correctness of its details than the singularly happy humour of its apologues, poetical pieces, and disquisitions. According to old Isaac, all recreations sink into insignificance in comparison with angling, which in almost every page he lauds for its moral qualities, and the happiness it is calculated to yield. "Will you hear," says he on one occasion, "the wish of an angler, and the commendation of his happy life, which he sings in verse:—

'Let me live harmlessly, and near the brink
  Of Trent or Avon have a dwelling-place,
Where I may see my quill or cork down sink
  With eager bite of perch, or bleak, or dace;
And on the world and my Creator think,
  Whilst some men strive ill-gotten goods to embrace,
And others spend their time in base excess
Of wine—or worse, in war and wantonness.

'Let them that list these pastimes still pursue,
  And on such pleasing fancies feed their fill,
So I the fields and meadows green may view,
  And daily by fresh rivers walk at will,
Among the daisies and the violets blue,
  Red hyacinth and yellow daffodil.
Purple narcissus, like the morning rays,
Pale gander-grass, and azure culver-keys.

'I count it higher pleasure to behold
  The stately compass of the lofty sky,
And in the midst thereof, like burning gold
  The flaming chariot of the world's great eye;
The watery clouds that in the air up-roll'd.
  With sundry kinds of painted colours fly;
And fair Aurora, lifting up her head,
Still blushing, rise from old Tithonus' bed

'The hills and mountains raised from the plains,
  The plains extended level with the ground;
The grounds divided into sundry veins.
  The veins enclosed with rivers running round;
These rivers, making way through nature's chains,
  With headlong course into the sea profound;
The raging sea, beneath the valleys low,
Where lakes, and rills, and rivulets do flow

'The lofty woods, the forests wide and long,
  Adorn'd with leaves and branches fresh and green,
In whose cool bowers the birds, with many a song,
  Do welcome with their choir the summer's queen;
The meadows fair, where Flora's gifts among
  Are intermix'd with verdant grass between;
The silver scaled fish, that softly swim
Within the sweet brook's crystal watery stream:

'All these, and many more of His creation
  That made the heavens, the angler oft doth see;
Taking therein no little delectation.
  To think how strange, how wonderful they be,
Framing thereof an inward contemplation
  To set his heart from other fancies free;
And whilst he looks on these with joyful eye,
His mind is rapt above the starry sky.'"

So much for the *poetry* of angling; we shall now speak of the practice of the art, beginning with a few observations on the

GENERAL CHARACTER OF FISH.

The fish which are the object of attention to the angler are all confined to fresh water, and are chiefly found in rivers or small brooks; some are found in lakes and ponds. All, except eels, have a pretty uniform character though differing in appearance and size. Their form is suitable, in a remarkable way, to give celerity and ease of motion—a small head swelling into a thick body, and tapering off towards the tail. Those designed for slower motion are more thick and lumpy in figure. The power of moving quickly, and of buoying themselves in the water, is very nicely provided for by their specific gravity which is nearly the same as the water in which they move; in other words, they are about the same heaviness as the water which they displace, and consequently they are almost destitute of any feeling of weight. On this account they are not in the slightest degree encumbered in their movements, and difficult to tire in their exertions.

The tail is the grand instrument of motion; it is a thin delicate membrane, whose smallest bending to and fro impels the body forward in any required course. The fins are principally required for balancing and regulating the movements of the fish; if any be cut off, the animal loses the power of keeping itself with the back fairly upwards; should it be deprived of the tail, the ability of moving forward is gone, and it lies a hulk at the mercy of its enemies. Not the least remarkable peculiarity in the economy of the fish is the existence of an air-bladder, by the dilatation or contraction of which it possesses the power of rising or sinking in the water, according as it feels inclined. It may be observed that fish, while in water, are constantly moving the gills, which is analogous to the art of breathing. The water sucked in by the mouth, and vented by the gills, contributes a minute portion of air, but enough to keep up the circulation of the blood and sustain life; if we were to tie up the gills, the fish would be immediately suffocated. The blood of fish is cold, being only about two degrees warmer than the water in which they live.

The senses of fish have engaged much attention from naturalists. Their quickest sense is that of sight; but they are destitute of the power of contracting the iris of the eye, so as to accommodate themselves to different degrees of light. In ordinary circumstances this is of no consequence, as the water diminishes the intensity of light, and the animal has the means of retiring to the bottom, or into holes, to escape the glare of the mid-day sun. It has been doubted if fish have any organs of hearing; but it is certain they do possess them, and hear to a limited extent. They are affected by any loud noise, though this may be partly ascribable to feeling the vibrations of the water. The taste of fish is allowed to be very blunt, if it exist at all; and so, likewise, is their smell. Whatever may be their deficiencies in these respects, they are provided with an appetite of boundless voracity.

"Every aquatic animal that has life," observes Daniel, "falls a victim to the indiscriminate voracity of one or other of the fishes. Insects, worms, or the spawn of other tenants of the waters, sustain the smaller tribes; which in their turn are pursued by millions larger and more rapacious. A few feed upon mud, aquatic plants, or grains of corn; but the far greater numbers subsist upon animal food alone; and of this they are so ravenous as not to spare those of their own kind. That there are vegetables in both fresh and salt waters admits of no doubt, and these may furnish food to particular fishes; but those sorts are few, perhaps no one kind can be pointed out that subsists entirely upon them; and although most fishes eat flies and terrestrial worms when they come in their way, yet in the immeasurable waste of waters surrounding this globe, the swarms of fishes are so immense that the subsistence to be derived from the above sources appears to be altogether disproportioned to their wants, and those of a smaller size seem to constitute the principal food of nearly all the fishes known to us. Charr kept in a pond, if scantily supplied, frequently devour their own young; other fish, that are arger, go in quest of more bulky prey, it matters not of what sort, whether of their own or of another species. If we turn our attention, in this argument, to sea-fish, those with the most capacious mouths pursue almost every thing that exists, and often meet each other in fierce opposition, when the fish which has the widest throat comes off with victory, and devours his antagonist.

"The voracious fishes differ widely from the predatory kinds of terrestrial animals; they are neither limited in their number nor solitary in their habits. Their rapacity is not confined to a few species, one region of the sea, or individual efforts. Almost the whole order is continually irritated by the cravings of an appetite which excites them to encounter every danger, and which, by its excess, often destroys that existence which it was intended to prolong. Innumerable shoals of one species pursue those of another through vast tracts of the ocean, from the vicinity of the pole to the equator. The cod pursues the whiting, which flies before it from the banks of Newfoundland to the southern coasts of Spain. The cachalot drives whole armies of herrings from the regions of the north, devouring at every instant thousands in the rear. Hence the life of every fish, from the smallest to the greatest, is but a continued scene of rapine; and every quarter of the immense deep presents one uniform picture of hostility, violence, and invasion.

"In these conflicts, occasioned by the voracity of the different kinds of fishes, the smaller classes must have long since fallen victims to the avidity of the larger, had not nature skilfully proportioned the means of their escape, their numbers, and their productive powers, to the extent and variety of the dangers to which they are unceasingly exposed. To supply the constant waste occasioned by their destruction in the unequal combat, they are not only more numerous and prolific than the larger species, but, by a happy instinct, are directed to seek for food and protection near the shore, where, from the shallowness of the water, their foes are unable to pursue them. These, however, yielding to the strong impulse of hunger, become plunderers in their turn, and revenge the injuries committed on their kind by destroying the spawn of the greater fishes, which they find floating upon the surface of the water.

"In what manner digestion, to such an amazing extent and rapidity, is carried on in the stomach of fishes, the inquiries of naturalists have at present been unable to ascertain. It so far exceeds every thing that can be effected either by trituration, the operation of heat, or of a dissolving fluid, that a celebrated physician (Dr. Hunter), after various experiments, was of opinion that none of these causes were equal to the effect, and that the digestive force in the cold maw of fishes is so great as to overturn the systems that have attempted to account for it on those principles; that by some power in the stomach yet unknown, which from all kinds of artificial maceration acts differently, the meat taken into the maw is often seen, although nearly digested, still to retain its original form; and whilst ready for a total dissolution, appears to the eye as yet untouched by the force of the stomach." It may be added, that although generally voracious, fish have a remarkably accommodating appetite, and will endure hunger a much longer period than most terrestrial animals.

Fishes are for the greater part oviparous, that is, produced by eggs or spawn, in the deposition of which a male and female fish are concerned. It is usual to call the male a *milt* or *milter*, and the female a *roe* or *rowaner*. The process of spawning, which takes place in secluded parts in the beds of rivers, is involved in considerable obscurity. The salmon, of which most is known, seeks the higher parts of rivers for spawning, and there the deposit is made. Mr. Halliday, in his communications to the House of Commons on this subject, describes the process as follows:—"When they proceed to the shallow waters, which is generally in the morning, or at twilight in the evening, they play round the ground, two of them together. When they begin to make the furrow, they work up the gravel rather against the stream, as a salmon cannot work with his head down the stream, for the water entering his gills in this manner would drown him. When they have made a furrow, they go to a little distance, the one to one side and the other to the other side of the furrow, and throw themselves on their sides when they come together, and rubbing against each other, they shed their spawn both into the furrow at once. They do not lay it all at once; on the contrary, it requires from about eight to twelve days for them to lay their stock of spawn, which being deposited, the bed is made and covered as they go along, both assisting in the operation."

Immediately after spawning, all fish are thin and poor, and not worth the trouble of catching. In about twenty days, if the circumstances be favourable, the eggs are hatched, and emit the young fry of fish. The number of young is in some cases enormous. Carp, perch, or roach, produce from 30,000 to 200,000 young; a herring from 20,000 to 36,000; a mackerel 400,000 to 500,000; and a cod between three and four millions. Of the young of any fish, however, comparatively few reach maturity, the greater proportion being devoured by enemies shortly after hatching. As if for the sake of mutual protection, most fish of a kind, as may be observed in the case of minnows and pars, associate together and swim in flocks.

That fishes are liable to diseases arising from variations of temperature and other causes, there is no reason to doubt; but few are ever seen dead in the water, there being too many scavengers of the deep to allow of this waste of food. In general the weak fall a prey to the strong before the period of natural death. It is understood that fishes possess a blunted nervous energy, which renders them almost insensible to any ordinary infliction; and so mean are their reflective faculties, that after escaping from a hook which has lacerated their palate, they will in the next minute catch at a similar bait, and be hooked a second time and drawn from the water. A number of years ago, two young gentlemen, while fishing in a lake in Dumfriesshire, having expended their stock of worms, had recourse to the expedient of picking out the eyes of the dead perch they had taken, and attaching them to their hooks—a bait which this fish is known to take as readily as any other; one of the perch caught in this manner struggled so much when taken out of the water, that the hook had no sooner been loosened from its mouth than it came in contact with one of its eyes, and actually tore it out. In the struggle, the fish slipped through the holder's fingers, and again escaped to its native element. The disappointed fisher still retaining the eye of the aquatic fugitive, adjusted it on the hook, and again committed his line to the waters. After a short interval, on pulling up the line he was astonished to find the identical perch that eluded his grasp a few minutes before, and which literally perished in swallowing its own eye.

Fishes are exposed not only to external foes, which it requires all their dexterity to elude, but to the torment of parasitical marauders in their own person. Besides creatures which make a lodgment in the intestines, various parasites fix themselves beneath the scales, in the mouth, and upon the gills. Salmon, perch, trout, and other fresh-water fish, are preyed upon in this manner by different species of lice; and as some of these parasites cannot live in salt water, it has been supposed that one of the reasons for the salmon migrating to the sea is to relieve itself from the lice (*lernea salmonea*) which have adhered to its gills. The trout louse, or *lernea truttæ*, is not unknown to trout fishers.

FISHING TACKLE.

The Rod.

This is the chief implement of the angler. It ought to be strong, but perfectly elastic, and bend, on being waved, through its upper half, but particularly at the small tapering point. The wood most suitable is hickory or ash, with yew for the upper part, to which a point of whalebone is attached. The size and strength must depend on the nature of the duty to which the rod is put. One for trout, perch, &c., ought to be from twelve to fifteen feet in length, and a salmon one from sixteen to twenty feet, besides being considerably stronger. Whatever be the length, it must be quite straight, and on all occasions bend back to its original straightness. If there be a single knot in the timber reject it, for it will certainly snap at the first severe pull or jerk. It should be varnished, to protect it from the action of the water. The rod is not all of one piece. For the sake of convenience, it is divided into four, or perhaps six pieces in the length. These pieces are usually joined by means of screws and verules; but if this be the plan of the rod offered to your choice, take care to see that these metal junctions do not impair the bending properties of the instrument, or render it too heavy. Rods of a plain kind made in the country are spliced with waxed threads, and these are generally more serviceable than the fine looking rods manufactured in cities. Listen to what John Young, of St. Boswells, (a village on the Tweed) says on this subject:—"To those who reside near the water, I would recommend a rod all of glued and tied joints as best in point of real use, and not so liable to break in the moment of action. Or, indeed, even for travelling, I would prefer tied joints, as wherever a person has time to stop to fish, though only for a day or two, he has at least five minutes to spare for tying his rod in a sufficient manner. Rods are often breaking at brass joints, and those who use them, instead of bringing in a back-load of fish, are constantly arriving home from the water, telling you, 'I've broke my rod!' Such sickening news may generally be prevented by tied joints."*

At the bottom of the rod where it is grasped by the hand, a brass reel or *pirn* is attached, and on this the line is wound. It should be simple in its mechanism, so as to allow of expeditious winding or unwinding. The line is conducted from the reel to the upper termination through small wire loops, in Scotland called *mylies*, which are fixed to the rod; these must be in an even line when the pieces of the rod are joined together, and be about a foot asunder. In *fashionable* rods, the mylies are small rings held by wires to the rod, and they conveniently fall flat when the rod is not in use. Good serviceable rods require no such elegance of design. The angler who is skilled in his art cares nothing for finery of apparatus, and will pull out dozens of fish in a day with an instrument which many would think not worth the carrying.

Lines.

These should be long, smooth, light, and flexible, and of a material which will not be easily injured by wet. These qualities are found in lines made of horse hair and gut, which we recommend in preference to any other. The part of the line which is wound on the reel, and goes along the rod, is called the *reel line*: and being designed to be let out only on occasions when a fish darts off with a hook in its mouth, it need not be so thin and light as the bulk of the portion termed the *casting line*. The reel line, which may be about thirty yards in length for ordinary trout fishing, is formed by spinning together horse hairs, so as to make a fine even cord. As it is troublesome to make, it should be purchased from a respectable dealer in fishing tackle. It should be from twelve to fifteen hairs in thickness, the hairs being white, fresh, and well cleaned. The line for salmon should contain from eighteen to twenty-four hairs, and extend to at least sixty yards in length.

The casting line, which is united by a loop to the reel line, may be also of horse hair, but of a smaller texture, and lighter in weight. It should be five lengths of hairs in extent, the uppermost length being eight hairs in thickness, and gradually diminishing the number to three or four in the lowest length. To the lower end of this casting line is added the *gut line*, which is the part that actually falls upon the water, and therefore requires to be very fine. It consists of a series of strong gut, and to it is attached the short lengths or casts of gut on which are the hooks. In some instances, the casting line is altogether made of gut, on which usually more dependence can be placed than on hair lines; if of gut, three threads are sufficient for the thickness.

On the article gut, Mr. Stoddart has the following observations:—"This article, originally imported from the east, and now brought in considerable quantities from Spain and Italy, is, as far as we have been able to learn, fabricated from the male silk-worm in a state of decomposition. The operation is principally conducted by children, and consists in removing the external slough of the worm with the fingers, elongating at the same time the gluey substance which composes its entrails. To do this properly requires some care and attention. Should the worm be kept too long, a hard crust forms itself over it, in destroying which the application of the nail is necessary; hence the gut becomes flattened, and loses much of its value. The sinews of herons and other birds are also manufactured in Spain into a sort of gut, and are much used, although unwittingly, by our salmon fishers. Worm-gut varies in length from nearly two feet and downwards. We have seen, however, an article very closely resembling it from the Archipelago, which measures at least a yard and a half. This is not to be confounded with sea-weed, although a vegetable fibre, and drawn out of a plant. It is much stronger and better suited for angling. The inhabitants of the Greek islands use it for catching mullet, and will often toss a fish some pounds' weight over their heads by a thread or two. We ourselves have found it excellent for the larger sorts of tackle. Animal gut is, however, more generally used, and better adapted for trouting. It ought to be small, round, and transparent, without any flaw or roughness. When worn or disordered, the application of a piece of Indian rubber will at once renovate it. In joining threads together for the purpose of making casts, the single knot properly drawn is quite sufficient. One should avoid clipping the useless extremities too closely in this operation, as in that case the knot is somewhat liable to give way. Gut, to keep well, should be moistened with fine oil, and stored in oiled paper."*

To these recommendations we may add, that lines of all kinds should be kept dry. On returning from a fishing excursion, draw out the line, and let it be thoroughly dried by waving in the air before being wound up or laid aside. When to be again used, look it over, giving it a gentle tug here and there to try its strength, and repair damaged parts. On coming to the water side, and just before throwing, allow the casting line to be wetted in the water, and this will at once give it smoothness and elasticity.

Hooks.

These are small instruments made of tempered steel, and of whatever size, they require to possess the qualities of lightness and great strength. They have been always

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* "On River Angling for Salmon and Trout," by John Young, St. Boswells. Edinburgh: Blackwood and Sons. 1840.

* "The Art of Angling as practised in Scotland," by Thomas Tod Stoddart, Esq., author of the "Death Wake," and other poems. Edinburgh: W. and R. Chambers. 1835.

principally manufactured at two places—Kendal, in Westmoreland, and Limerick, in Ireland. The Kendal circular bends, as they are called, are reckoned the best hooks of a small size, while the Limerick hook is preferable for salmon. Many of the fish-hooks of ordinary English makers are worthless. Hooks range in size from about an inch and a half in length down to a quarter of an inch, with a proportional diminution of thickness. Some makers number them from No. 10, the smallest, to No. 20, the largest, while others number from 1, the largest, to 14, the smallest. The Limerick hooks are denoted by letters, commencing with A, and so on. In purchasing hooks, try their power of resistance by forcing the bend with the fingers, and urging the point against the thumb-nail. Hooks for fly-fishing should be thinner in the shank than those designed for bait. An angler should keep a small stock of hooks of various sorts, to be ready on all emergencies; with the tackle to which they are attached, they require to be kept very dry.

Landing Net—Gaff—Drag-Hook.

The *landing net* is considered in England a necessary implement for an angler, but in our opinion they must be poor hands at fishing who cannot drag a trout or any similar small fish from the water after hooking it without resorting to such a cumbrous apparatus. Perhaps it is found to be essential, in consequence of the feebleness of the rods and tackle usually employed. It consists of a small bag net stretched on a hoop at the extremity of a pole four or five feet in length. Mr. Blaine seems to think a landing net of first importance; and for the use of tyros in the art he gives the following directions:—"In fly-fishing, when the line is long, and there is not much space to step backward, or the reel clogged, it is necessary sometimes to lay hold of the line with one hand; but this should be done with great caution, and then only after the fish is well nigh spent, or one struggle may carry away line, hook, and fish. In all other cases avoid touching the line if possible; but having sufficiently played the fish, whether taken by bottom or by fly-fishing, bring him within reach of the landing net, and then carefully conduct or slide the net obliquely under the foreparts of his body, which, if the fish be completely exhausted, will fall into it; but if he has still sufficient vigour, it will be prudent rather to slide him over the net than the net under him. It must have occurred to every angler to have supposed a trout or salmon to be completely spent, who, the moment he has been touched by the net, or has even caught sight of the fisher, has sprung off with most annoying violence. Against such an accident it is prudent to be ever prepared by keeping the rod in an upright position, acting on a tightened line, but yet so disposed that it can run at liberty if required. When the head and shoulders of the fish are once fairly within the net, a slight turn of it will take in the whole body, and the net being then kept horizontally, will insure his safety; for with the head downwards, no efforts he can make will disengage him from the net; but if he be received tail foremost, as is sometimes done in deep waters, from overhanging banks, &c., beware of his plunges."*

The *gaff* is another aid to landing fish, and is employed in cases in which the landing net would be too small. It is used chiefly for landing salmon, and consists of a peculiarly-shaped hook at the end of a staff. When the salmon flounders about and incommodes the fisher, he is expected to secure the animal, and prevent it from breaking his line and rod by hooking it with the gaff at the gills, the tail, or any part he can conveniently reach.

The *drag-hook* is an implement with three bent prongs, or hooks, with a long cord line attached. It is used for casting into rivers to clear away any object at the bottom upon which the hook is caught. We pity the angler who attempts fishing in weedy puddles requiring such a clearer of hindrances.

Angler's Pocket-book, &c.

The angler's equipment is completed by the addition of a basket for holding his fish, which is slung on the back by a shoulder-belt; also pocket-book for holding hooks and other trifles; and a round flat tin box for his fly-casts. Many carry their supply of fly-casts wound round their hat, and some keep them within the leaves of their pocket-book. This pocket-book, which is the storehouse of all kinds of odds and ends—we have seen a good one made out of an old pocket almanac—should have two or three pockets for holding an assortment of hooks, silk thread, stuff for making flies, gut, wax, small cord, fly-nippers, scissors, &c.—all to be used in case of breakage of tackle or rod, or any other accident.

In fishing for perch, gudgeons, bream, &c., a small float is often used. Floats are made of cork, quill, and other materials; and a choice, according to circumstances, can be added to the contents of the pocket-book.

Dress.—All finery is worse than useless. Fish are easily scared with the appearance of any light or showy object on the banks. Let the angler, therefore, dress himself in a plain dull-coloured suit, with a hat equally sober in its aspect, and let him use only strong shoes or boots, which will not be injured by water.

Baits.

A bait is any substance put upon a hook to act as a lure to the fish; and when used, the baited hook is dropped into and allowed to sink in the water, instead of being kept near or upon the surface, as in the case of fishing with fly. The materials, living and dead, used for bait are very numerous; but the leading kinds are worms, maggots, minnows, insects, and salmon roe. The hook employed in either case is tied by the shank to the gut with waxed silk, and the preparation is therefore not at all difficult. When dressed to the gut, it is called bait or worm-tackle.

Worms used for bait are of various sorts; but that which is most commonly employed is the lob or garden worm, a long reddish-coloured reptile found in abundance in many gardens, grass-plots, and in any rich old soil. They may be dug up with a spade, or caught crawling from their holes at twilight, and particularly after heavy showers. "He who seeks them," says Daniel, "must move cautiously without noise, or they will quickly retreat into the earth; draw them gently out of their holes without nipping; those that sever in taking must be thrown away, as they will soon become putrid, and infect the others; when as many are collected as are wanted, having plenty of good moss freed from dirt, dip it into clean water, and wring it nearly dry; put it into an earthen pot proportioned to the quantity of worms, laying it regular, and forcing it down with the hands; strew the worms on the surface, after dipping them in clear cold water to rid them of the soil that may adhere to them; such as are not injured will soon bury themselves in the moss, and those that do not must the next morning be picked off as useless; they must be inspected every three or four days, the dead ones removed and have fresh moss, or that wherein they have been kept well washed and picked, and the water squeezed out at least once a week; they must be so placed summer and winter as to be safe from the extremity of the weather at both seasons. In a week's time they will be fit for use; and upon the angler coming home from fishing, he will return from his worm-bag into the pot those which he has not used. By observing the above care fully, they may be kept a month in summer, particularly by now and then giving them, drop by drop upon the moss, a small quantity of new milk and the yolk of an egg well beaten together, and warmed so as to thicken

* Encyclopædia of Rural Sports.

it; but when a stock of lob worms is meant to be retained for a considerable length of time, a large vessel must be filled half or three-quarters full of good mould, in the middle of which is to be placed some moss or old coarse linen cloths, hopsack, or rags wetted; in hot, dry weather, clean water must be sprinkled upon the earth with a watering-pot, so as to keep them moist but not wet; they may thus be preserved as long as is requisite; and a week before angling, what are wanted may be drawn from the store, and put into moss to scour themselves." Another worm, which is found in dunghills, called the *brandling*, from its striped appearance, forms a good bait, but it is seldom used.

Maggots.—These larvæ of insects, as is well known, are found on fly-blown meat or any putrid animal substances; very fine ones are procured from game in a *high* condition. Daniel calls these creatures *gentles*, and describes them as of great virtue in certain kinds of fishing:—"Gentles," he observes, "may be procured almost at any time at the tallow-chandlers, and should be kept in oatmeal and bran, as bran by itself is too dry. Those who live in or near London may buy them in proper condition for the day on which they wish to use them; but for the accommodation of those who reside in the country, remote from such convenience, the best modes of breeding them will be here mentioned, in order to prevent disappointments. Coarse fish, such as *chub* and *roach*, may be laid in an earthen pot in the shade, and will soon be fly-blown; when the gentles are of the proper size (but not before), put some oatmeal and bran to them, and in two days they will be well scoured and fit to fish with; in about four more they become hard, assume a pale red colour, and soon after change to flies; the red ones should not be thrown away, as frequently roach and dace take these with a white one, in preference to all other baits. Some have recommended a piece of liver suspended by a stick over a barrel of clay, into which the gentles fall and cleanse themselves; but clay will not scour them, and, besides, they fall from the liver before they have attained their full size. The before-mentioned is a less disgusting plan; for a short time after oatmeal and bran are put to the gentles, the fish in which they are bred will be found perfect skeletons, and may be thrown away; however, if they are to be bred from liver, it should be scarified deeply in many parts, and then hung up and nearly covered over, as in that way the flies will blow it better than when wholly exposed; in two or three days the gentles will be seen alive; the liver is then to be put into an earthen pan, and there remain until the first brood are of full growth; a sufficient quantity of fine sand and bran, (letting the liver remain) is then to be put into the pan, and in a few days they will come from the flesh, and scour themselves in it: the liver should then be hung across the pan, and the latter brood will soon drop out and be fit for use; and by thus breeding them in October, and keeping them a little warmer than those bred in the summer, until they arrive at their full growth, and afterwards putting them in the same pan into a dampish vault, they may be preserved for winter fishing. Those bred in summer, but for the bran and sand, would soon sink into a dormant state; the skins take on a blackish-red, full of white matter, and shortly after become flies; those produced in autumn, from whatever substance, will continue in this state all the winter, provided they can shelter themselves under the surface of the earth in fields, gardens, &c., and in the warm weather of the ensuing spring they change into flies, thus preserving their kind from year to year. Gentles are so universal and so alluring a bait, that the angler should never be unprovided with them. Trouts have been taken with them in clear water, when they have refused all kinds of worms and artificial flies."

Caddis, or *cad-bait*, is another kind of larvæ, inhabiting pieces of straw, or adhering to bits of stick or sand at the sides of rivers. Daniel has some interesting observations on this species of bait:—"The several kinds of cadews in their nympha or maggot state, thus house themselves: one sort in straw, thence called straw-worms; others in two or more parallel sticks, creeping at the bottom of brooks; a third in a small bundle of pieces of rushes, duck-weed, &c., glued together, therewith they float on the surface, and can row themselves about the water with the help of their feet; both these are called cad-bait. It is a curious faculty that these creatures possess of gathering such bodies as are fittest for their purpose, and then so glueing them together, some to be heavier than water, that the animal may remain at bottom where its food is, and others to be so buoyant as to float, and there collect its sustenance; these houses are coarse, and show no outward art, but are within well tunnelled, and have a tough hard paste, into which the hinder part of the maggot is so fixed that its cell can be drawn after it without danger of leaving it behind, and it can also thrust out its body to reach the needful supplies, or withdraw into its covering for protection and safety.

"These insects inhabit pits, ponds, low running rivers, or ditches, in cases of different forms, and composed of various materials; some of them enclosed in a very rough shell, found among weeds in standing waters, are generally tinged green; others are bigger than a gentle, and of a yellowish hue, with a black head; they are an excellent bait, and are found in most plenty in gravelly and stony rivulets, and by the sides of streams, in large rivers among stones.

"To collect them, turn up the stones, and the best will adhere to them; when the quantity wanted is obtained put them into a linen bag for five or six days, dip them, together with the bag, into water once a day, and hang them up; they will then turn yellow, become tough, and fitter for angling than when first got from the brook. If meant to be kept long, they must be put into a thick woollen bag, with some of the moist gravel or sand from the same rivulet whence they are taken; they must be wetted twice a day, but oftener in very hot weather; when you carry them abroad, fill the bag with water, and holding the mouth of it close, let the water run from them; in this way they may be kept three weeks. Another way of preserving them is by placing them in an earthen pot full of river water, with some of the gravel they were bred in at the bottom; but the preceding method is preferable. Some use bait pans of different sizes for insects, the tops punched full of holes, not so large as to admit of their escaping when placed in the river, which not only keeps them cool, but supplies them with aliment in the fresh water; some keep them in moss in a woollen bag on a damp floor, taking care that the bag retains a proper moisture. Another mode of preserving caddis, and also grasshoppers, caterpillars, oak-worms, or natural flies, is to take the green withy bark from a bough six or seven inches round, and about a foot in length; turn both ends into the form of a hoop, and fasten them with a large needle and thread; stop up the bottom with cork, and bore it with a [illegible] full of holes with a red-hot wire; tie over it a colewort leaf, and lay it in the grass every night. In this manner caddis may be preserved until they turn to flies. When grasshoppers are to be preserved in the case, some grass must be put into it.

"In angling with caddis, the line, when all out, should be as long as the rod, for three lengths next the hook, of single hairs, with the smallest float, and the least weight of lead that the swiftness of the stream will allow to sink; and that may be aided by avoiding the violence of the current, and angling in the returns of a stream, or in the eddies between two; which are also the most likely places wherein to kill fish, either at the top or bottom. The caddis may be at times, with very good effect, joined to a worm, and sometimes to an artificial fly, to cover the point of a hook, and also two or three together may be put in upon the hook; but it is always to be angled with at the bottom, especially when by itself, with the finest tackle, and at all seasons is a most holding bait for trout and grayling."

Minnow bait.—Minnows are a small fish, from an inch to two inches in length; they swim in flocks, and may be captured by a hoop-net on the end of a staff, or more simply by a crooked pin baited with a small worm. Anglers generally hire a boy to catch a quantity of them. The tackles used for minnow bait are various in their formation; some are single hooks; others a pair of hooks dressed back to back; and a third kind are a series of pairs, one above another. We cannot do better than give Mr. Stoddart's description of these deadly instruments, and the mode of baiting them. He alludes to Kendal hooks:—

"The most simple, and in some places the most deadly, is a common single bait hook. This we insert through the back of the minnow, and drawing it out, run below the gill, allowing the barb to protrude from the mouth; we then tie up the tail along the gut, either with a piece of silk thread, or more expeditiously with the gut itself, hitched over the part. This is angled with in the same manner as the worm, allowing plenty of time for the fish to gorge. A tackle similar to it may be used in standing pools or lochs. Here, however, the shank of the hook (a long one) is loaded, and the bait allowed to descend rapidly towards the bottom. Large cautious fish are sometimes taken by this method of angling. Of all minnow tackles, that with swivels is the commonest and most agreeable to employ. There are many ways of constructing it. Two of these we shall mention as preferable to all others. One is simply a large hook, No. 11, fastened to good round gut with two smaller ones, No. 7, tied back to back above, and looped in the dressing, so as to slide along, and shorten or lengthen the tackle to the dimensions of the bait. In using it, enter the lowermost hook through the mouth, and bring it out near the tail of the minnow; insert one of the hooks on the slider through its lips, noticing that the fish be slightly curved so as to spin properly. The other tackle is composed of six hooks, No. 7, dressed in pairs, and is angled with only when the trout are in a taking mood. Two or more swivels are required for both of these contrivances—the lowermost fastened about two feet or so above the bait. Leaden pellets may also be used, but many think them unnecessary. Some anglers attach behind the whole apparatus an extra hook, No. 12 or 13, dressed upon a hog's bristle, which, should the trout miss the minnow, is apt to catch him, when retiring, by the middle or other part of the body. This is a superfluity, and, like many superfluities, does more harm than good, alarming the fish without securing them. Tackle for trolling with par or small trout ought to be constructed on the same principles as the minnow tackle; only the hooks should be larger and dressed upon gimp instead of gut. Snap-hooks, also, are in use for this kind of angling. Small silk cord oiled will be found the best trolling-line."

Insects.—The insects used for baits are grasshoppers, crickets, day-flies, spring-flies, May-flies, humble bees, and various others. The ephemeræ, or those fragile creatures that live but for a day or even a few hours, and therefore called day-flies, are found sporting by the low banks of rivers in warm weather, and form a taking bait for trout and some other fish.

Salmon Roe.—The efficient use of this as a bait is a modern discovery, and has added largely to the angler's means of capturing the fishy tribes. The roe is taken from a salmon a fortnight before spawning, at which time it is best for the purpose. Some prepare it for use by salting it a little, and drying it to a state in which it will keep; others cure it with sugar instead of salt. Blaine recommends the following as a method by which it may be kept good for two years in a cool situation:—"A pound of spawn is immersed in water as hot as the hands can bear it, and is then picked from membranous films, &c. It is now to be rinsed with cold water, and hung up to drain for twenty-four hours, after which put to it two ounces of rock or bay salt, and a quarter of an ounce of saltpetre, and again hang it up for twenty-four hours more. Now spread it on a dish, and gently dry it before the fire or in the sun, and when it becomes stiff pot it down. We should, however, recommend that the potting be not in one mass, but, like the shrimp paste sold at the fish-sauce shops, that it be divided into small pots, pouring over each some melted suet, by which method a pot can be opened when wanted, instead of disturbing the general store. It forms an additional security to cover each over with a moistened skin or bladder. Trout roe is also said to make a good bait, but we have no personal experience of its efficacy; in fact, we never tried it; but it has been so strongly recommended, that it would be but fair to give credence to its value until numerous trials have proclaimed it as totally inert.

"To bait with salmon roe, first put on the hook (which should be sized according to the fish intended to be tried for) a mass which shall fill up the hollow of the bend and hide the steel. On the point put two or more firm large grains of it, both to conceal the snare and tempt the fish. In this way it is said to be principally a winter and a spring bait, but we know no reason why it may not be advantageously used at other times, for spawn of some kind is almost always to be found."

Pastes made of shrimps, of cheese, of bread crumbs mixed with honey, and of other materials, are also employed, according to the fancy of the angler, and the nature of waters and sport he intends to pursue; our limited space, however, obliges us to refer those who are curious in the subject of baits to the Encyclopædia of Blaine, where there is a vast body of highly interesting matter on angling. Those who are disinclined to prepare roe and pastes, or have not the means of doing so, may be supplied by the principal dealers in fishing-tackle.

Artificial Flies.

Hooks dressed up so as to bear something like a resemblance to actual live flies, are by far the most important lures employed by the angler. The principal materials employed in dressing are light portions of cock's hackle or other feathers, to form wings, the fur of a hare's ear or some other substance to make the body and waxed silk thread by which the whole is tied in an artful manner on the shank of the hook. A whole sheet might easily be filled with descriptions of artificial flies suitable to different fish, waters, and seasons; but the bulk of what has been written by Walton, Daniel, and many others, is now considered superfluous, experienced fishers having arrived at the conclusion that fishes in general are such eager and heedless fools as to be satisfied with a very limited choice of deceptions. The author of the article *Angling*, in the "Encyclopædia Britannica,"* has some clever remarks on this branch of the art:—

"As simulation," says he, "consists in the adoption or affectation of what is not, while dissimulation consists in the careful concealment of what really is—the one being a positive, the other a negative act—so the great object of the fly-fisher is to dissimulate in such a manner as to prevent his expected prey from detecting the artificial nature of his lure, without troubling himself by a vain effort to simulate or assume with his fly the appearance of any individual or specific form of insect life.

* Republished in the handsome volume, "The Rod and the Gun." A. and C. Black, Edinburgh.

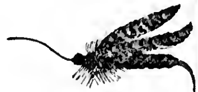
There is, in truth, little or no connection between the art of angling and the science of entomology; and therefore the success of the angler, in by far the greater proportion of cases, does not depend on the resemblance which subsists between his artificial fly and the natural insect. This statement is no doubt greatly at variance with the expressed principles of all who have deemed fishing worthy of consideration, from the days of Isaiah and Theocritus, to those of Carrol and Bainbridge. But we are not the less decidedly of opinion, that in nine instances out of ten a fish seizes upon an artificial fly as upon an insect or moving creature *sui generis*, and not on account of its exact and successful resemblance to any accustomed and familiar object.

"If it is not so, let us request to be informed upon what principle of imitative art the different varieties of salmon-fly can be supposed to bear the most distant resemblance to any species of dragon-fly, to imitate which we are frequently told they are intended? Certainly no perceptible similarity in form or aspect exists between them, all the species of dragon-fly, with the exception of one or two of the sub-genus Calepterix, being characterized by clear lace-like pellucid wings, entirely unadorned by those fantastic gaudy colours, borrowed from the peacock and other 'birds of gayest plume,' which are made to distinguish the supposed resemblance. Besides, the finest salmon-fishing is frequently in mild weather during the cooler seasons of the year, in autumn and early spring, several months either before or after any dragon-fly has become visible on the face of the waters, as it is a summer insect, and rarely makes its appearance in the perfect state until the month of June. If they bear no resemblance to each other in form or colour, how much more unlike must they seem when, instead of being swept like lightning down the current, as a real one would be, the artificial fly is seen crossing and recrossing every stream and torrent with the agility of an otter and the strength of an alligator! Or darting with regular jerks, and often many inches under water, up smooth continuous flows, where all the dragon-flies on earth, with St. George to boot, could not maintain their place a single second! Now, as it is demonstrable that the artificial fly generally used for salmon bears no resemblance except in size to any living one—that the only tribe which, from their respective dimensions, it may be supposed to represent does not exist in the winged state during the period when the imitation is most generally and most successfully practised—and if they did, that their habits and natural powers totally disenable them from being at any time seen under such circumstances as would give a colour to the supposition of the one being ever mistaken for the other—may we not fairly conclude that, in this instance at least, the fish proceed upon other grounds, and are deceived by an appearance of life and motion, rather than by a specific resemblance to any thing which they had previously been in the habit of capturing? What natural insect do the large flies, at which sea-trout rise so readily, resemble? These, as well as gilse and salmon, frequently take the lure far within the bounds of the salt-water market; and yet naturalists know that no such thing as a salt-water fly exists, or at least has ever been discovered by their researches. Indeed, no true insect inhabits the sea. What species are imitated by the palmer, or by three-fourths of the dressed flies in common use? An artificial fly can, at the best, be considered only as the representative of a natural one which has been drowned, as it is impossible to imitate the dancing or hovering flight of the real insect over the surface of the stream; and even with that restricted idea of its resemblance to nature, the likeness must be scarcely perceptible, owing to the difference of motion and the great variety of directions in which the angler drags his flies, according to the nature and special localities of the current, and the prevailing direction of the wind.

"We are therefore of opinion that all or a great proportion of what has been so ofte, and sometimes so well said about the great variety of flies necessary to an angler—about the necessity of changing his tackle according to each particular month throughout the season—about one fly being adapted solely to the morning another to noonday, and a third to the evening—and about every river having its own particular flies, &c., is, if not altogether erroneous, at least greatly exaggerated and misconceived. That determinate relations exist between flies of a certain colour and particular conditions of a river, is, we doubt not, true; but these are rather connected with angling as an artificial science, and have but little to do with any analogous relations in nature. The great object, by whatever means to be accomplished, is to render the fly deceptive; and this, from the very nature of things, is continually effected by fishing with flies which differ in colour and appearance from those which prevail upon the water; because, in truth, as we shall afterwards have occasion to show, none else can be purchased or procured. Even admitting for a moment the theory of representation, when a particular fly prevails upon a river, an artificial one in imitation of it will never resemble it so closely as to appear the same to those below (that is, the fish); on the contrary, a certain degree of resemblance, without any thing like an exact similitude, will only render the finny tribe the more cautious through suspicion, while a different shape and colour, by exciting no minute or invidious comparisons, might probably be swallowed without examination. Indeed, it seems sufficiently plain that where means of comparison are allowed, and where exact imitation is at the same time impossible, it is much better to have recourse to a general idea than to an awkward and bungling individual representation."

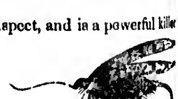
Mr. Stoddard, one of our most experienced anglers, entertains a similar opinion:—"The colours of water and sky," he observes, "are the only indicators which can lead us to select the most killing hook, and even these are often deceptive. We have fished in one stream where dark, and, in the next, where red flies took the lead. There is no trusting to the fancy in certain places. On Tweed, we have seen it veer about, like the wind, in one moment, without a note of preparation. Most rivers, however, are more steady; and when the water is of a moderate size, may be relied on with at most two sorts of flies all the year round. For ourselves, our maximum in every Scottish stream is reduced to only four descriptions of artificial flies, with one or other of which we engage to catch trout over all the kingdom. Knowledge and practice have convinced us of the needlessness of storing up endless and perplexing varieties, which some do, to look knowing and scientific."

The following, according to these and other trustworthy authorities, form a very serviceable set of lures for fly-fishing;—First, there is a fly which has been called *the professor*, after Professor Wilson of Edinburgh. The wings are formed of a mottled brown feather, taken from the mallard or wild drake, the body being composed of yellow flos silk, rather long, and wound about close to the head with a fine red or black hackle. This simulated fly has a tight clever aspect, and is a powerful killer.



The Professor.

Second, a fly which differs from the above only by being a little shorter, more thick, and with a body made of pale green instead of yellow silk. Green worsted may be used.



Fly with Green body.

Rough Hackle.

Third, a rough powerful hackle, with wings of white and black marked feather, a bristling body of dark-green wound about with gray or mottled hackle, to which is given a pointed tail.

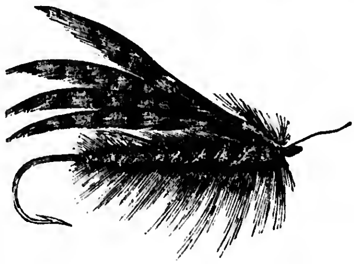
Fourth, a fly of a sombre cast, the wings formed of woodcock, snipe, or lark feather, and the body of hare's ear, darker or lighter, according to fancy.

Fifth, a fly with wings of the starling or fieldfare, and having a body made of mouse or water-rat fur.

Sixth, a plain hackle, black or red, without wings, and commonly called *palmer*.

Seventh, a red hackle, with wings of the starling, and a body formed of light-red mohair, and a red cock's hackle.

To these may be added any other variety of fly that the fancy suggests as being suitable to the time or place of fishing. Flies for salmon-fishing must be of a much more large and powerful kind, as representing insects



Salmon Fly.

of larger proportions. In the adjoining figure, a specimen is given of a powerful spring lure, with wings of variegated turkey feather, a body of orange camlet, mixed with mohair, and a brown cock's hackle. A thread of gold may be wound round the body for summer fishing. We refer to the work, the "Rod and the Gun," for further information on salmon-flies, which in all cases require to be dressed on double gut.

From dealers in fishing-tackle all sorts of artificial flies may be obtained at a reasonable advance upon the raw material; persons, however, who intend to make themselves masters of the art of angling, should not be dependent on tradesmen for their supplies, but learn to dress hooks for themselves. Mr. Stoddart offers the following explicit directions on fly-dressing:—

"Our materials for the making up of flies are as follow:—Hooks, and small round gut; a pair of brass nippers for twisting hackles; a point for dividing the wings; a pair of fine scissors; orange, yellow, and green silk thread of all sizes; good cobblers' wax enclosed in a piece of soft leather; a hare's ear; some brown wild-drake teal, and pheasant feathers; the fur of a mouse, squirrel, and water-rat; a few wings of lark, snipe, landrail, and starling; and lastly, red and black hackles, taken from the neck and head of an old cock at Christmas; these should be fully formed and free from softness. Plovers' herls, and those of the peacock, are used by some, yet, we deem them superfluous, as also tinsel, except for large flies.

Commencing your operations, the first step is to lay out the intended wings and body before you; wax your silk, and applying one end of it to the gut and hook together, wrap them both round four or five times, commencing a little below the end of the shank, and proceeding downwards; you then fasten, by drawing the disengaged end of the thread through under the last turn of the wrapping. Work the silk upwards to where you commenced, then take your wings, which are still unseparated, and lay them along your hook, so that their extremity or tips shall reach its curve; twirl the thread twice round the upper part, which lies along the shank top; then, taking it under, press firm, and clip off the unnecessary portion of the feather; divide with your point or penknife, so as to form the two wings; take up the silk betwixt them, and wrapping again around at the head, bring it back crosswise; then lift your hackle, and lay the root of it down along your hook; whip the thread over, as far as your first fastening; seize the top of the hackle with your nippers, and whirl it round in the same manner; fasten and lengthen the body to your liking with fresh floss silk; fasten once more, and your fly is made. This last fastening ought, in our opinion, to be the same as that used in arming bait-hooks, for which we quote Hawkin's directions:—'When you are in about four turns of the bend of the hook, take the shank between the fore-finger and thumb of the left hand, and place the silk close by it, holding them both tight, and leaving the end to hang down; then draw the other part of the silk into a large loop, and with your right hand turning backwards, continue the whipping for four turns, and draw the end of the silk (which has all this while hung down under the root of your left thumb) close, and twitch it off.' When the body of your fly is required to be of hare's ear or mouse skin, pull out a small quantity of the fur, and lay it along the silk, after the wings are formed; twist together, and then wrap as if the thread were bare, and fasten as above. In making flies, keep all tight, guard against heavy wings and much dubbing; the fibres of your hackle ought to be short and lie near the head of the fly; they are intended to resemble legs, which in the real insect are always so placed. Such is our method of fly-dressing, commendable both for its simplicity and expedition. It differs, we find, somewhat from that generally practised, being in a manner self-taught, and not encumbered with any unnecessary display."

Having now described the various parts of the angler's apparatus, and the lures which he generally employs, we proceed to show how he is to practise his craft when fully equipped for the purpose

PRACTICE OF ANGLING.

There are two distinct kinds of angling—bait-fishing and fly-fishing, and these are variously practised according to the depth or nature of the water, or the fish that are to be caught.

Bait-Fishing.

This kind of angling is practised to great extent in the Thames, the Lea, and other deep and somewhat dull rivers of England. The fish usually sought for in these waters are gudgeon, dace, roach, bream, chub, barbel, tench, carp, perch, and pike; all are sometimes taken by fly, but a bait of worms, gentles, roe, or some other material, is commonly employed. The angler, in these rivers, usually stands on the shore while fishing, but in some instances he fishes from a punt, or small flat-bottomed boat, in which his chief occupation is to sit watching his float, and pulling in his line when a fish appears to be hooked. Among the apparatus of this order of deep-water fishers, a plummet and line is carried, in order to sound the depth of the river, which having ascertained, the angler puts his float upon the line, at that point which will allow the bait to trail on the bottom, while the float swims on the surface.

The first thing the bait-fisher has to learn is the art a baiting his hooks. Taking the hook in his right hand and the bait between his fingers in the left, let him enter the hook at the head of the worm, and carry it through the animal to near the tail, covering the entire hook and its tying. The worm should be broken or mangled as little as possible; and the more life-like it appears, the greater the probability of its proving an effectual lure. There must not, however, be too much spare worm left dangling from the hook, otherwise the fish will keep nibbling it away without biting at the bait bodily, and taking it into its mouth, the thing which the angler desires.

In throwing the line with bait, take care not to splash the water, but let the bait fall gently on the surface, and sink slowly in the water, to the required depth. After sinking, the rod and line should be very slowly moved in a direction against the stream, or in some other way to give motion to the bait, which the fish perceiving to glide through the water will hasten to seize upon.

Occasionally the angler will *feel* a nibble, but he must not be in a hurry to *strike*, that is, to draw the fish from the water. Perhaps it is no more than a nibble, and it is well to allow the fish time to get the hook in his mouth. If drawn too quickly, you may actually pull away the hook after it is half gulped. Experience and dexterity are required in this ticklish part of the craft. As a general rule, do not strike till the line has been distinctly tugged; then strike by a slow side motion at first, then a more quick jerk, so as to cause the hook to catch in the jaws of the animal. Supposing the fish to be hooked, do not draw it violently out of the water as if in a transport of delight, but wind up part of your loose line if necessary, and holding up your rod, retire gradually backward, by which the fish may be landed on the shore. A good fisher does not lay aside his rod to take a fish from the hook, unless it be of great size, requiring two hands; if small, hold the rod in the right hand while you catch the fish with the left; unhook it carefully, place it in the basket, put on a new bait, and once more proceed to your sport.

The *gudgeon*, a fine large fish of the trout shape, affords a favourite amusement to anglers in the Lea, a river near London, and also in the Thames. Blaine thus speaks of this branch of angling:—"Fishing for gudgeons in the Thames is usually practised by means of a punt, which is fixed across the stream part of the river just above a tolerably sharp scower, running over a fine gravelly bottom, free from weeds, at depths varying from five to eight or ten feet. As the eddy is greater generally, and the water deeper in these scowers than in those of the Lea, so the tackle used is commonly somewhat stronger, and a fine gut line is more frequently met with there than one of single hair. Fine tackle, however, in a good hand, is to be always preferred; and we have seen many hundred dozens of gudgeons taken in the sharpest currents of this river also with a single hair only for the two bottom links. Punt fishing for gudgeon in the Thames is a delightful amusement, particularly to the luxurious angler who is not inclined to take much trouble. The scenery, the quietude and safety from interruption, the cleanliness of the practice, where the bait is put on the hook by the attendant fisherman, and where even the prize it gains is removed by the same hand, all tend to make it epicurean in the extreme. But the thorough-bred fisher is soon tired with it after this method, for the very reason that there is actually too much luxury in it to constitute true sporting, which must of necessity present some labour to keep up the attention, and some difficulty to enhance the value of the prey. In the Thames, so many as fifty dozen of gudgeons have been taken in a day; but in the Lea seldom half that number are caught. Yet the Lea angler has the best scope for his sport, for he can commence it in March, whereas in all that part of the Thames within the liberties of the city of London, it must not be attempted until the beginning of June, at which time the gudgeons have spawned, and continue for some time afterwards inferior in point of their gastronomic worth. Gudgeon fishing seems to have varied little from the ancient practice, and the angler who has aught of the antiquarian about him, will be amused probably at the close parallel between the present method and the gudgeon-fishing of early times, as it is described by John Davors or John Dennys, Esq., for it is a disputed point to which of these worthies the 'Secrets of Angling,' in which it is contained, owes its birth. Walton ascribes it to Davers, and gives the name at full length in the fifth edition of 'The Complete Angler:'—

> "Loe, in a little boat where one doth stand,
> That to a willow bough the while is tied,
> And with a pole doth stir, and raise the sand,
> Whereat the gentle streame doth softly slide;
> And then with slender line and rod in hand,
> The eager bite not long he doth abide.
> Well loaded is his line, his hooke but small,
> A good big cork to bear the stream with all.
>
> "His bait the least red worme that may be found,
> And at the bottome it doth alwayes lie;
> Whereat the greedy gudgion bites so sound,
> That hooke and all he swalloweth by and by.
> See how he strikes, and pulls them up as round,
> As if new store the place did still supply;
> And when the bit doth die, or bad doth prove,
> Then to another place he doth remove."

The *roach* is a thick fish deep from the back to the belly; it inhabits the bottom of deep rivers or lakes, and is usually reckoned so incautious and silly as to be called the water sheep: nevertheless, it is not taken without some degree of skill. It is angled for by means of bait sunk to within a few inches of the bottom. The fish may be attracted by throwing in some crumbs of bread. It is caught in the Thames some time after the end of August. The baits used are gentles, red paste, and boiled malt or wheat; one grain of the latter is sufficient. Great attention is required to strike quick when the bait is taken. Dace and tench are angled for much in the same manner. Carp is angled for in stagnant waters from February to September, and the baits are worms, larvæ, grain, and pastes. The perch also inhabits dull waters, and is a short unshapely fish, soft in the flesh, and seldom worth cooking. It is so eager to bite that little skill is required in pulling out a whole fry; the baits employed for it are worms, insects, and minnows.

Pike-Fishing.

The pike is a voracious fish, and may very appropriately be termed the fresh-water shark; it does not confine itself to feed on worms, insects, fish, and frogs, but will devour water-rats and young ducks, and attack much larger animals. All small fish are terrified at the approach of this marauder, which, if permitted, would soon clear a pond of all its finny tribes. "Pike," says Daniel, "love a still, shady, and unfrequented water, with a sandy, clayey, or chalky bottom (arriving at a larger size in pools than rivers); and from May to the beginning of October, they usually place themselves among or near flags, bulrushes, and water-docks, and particularly under the *ranunculus aquaticus* when in flower, and which floats on the surface; they will sometimes be found in the termination of sharp currents; from March to the end of May they resort to back waters that have direct communication with the main stream; as winter approaches they retire into the deeps, under clay-banks, bushes impending over the water, stumps and roots of trees, piles of bridges, and flood-gates. They spawn in March or April, according to the coldness or warmth of the weather, quitting the rivers for the creeks and ditches communicating with them, and there dropping their ova in the grass and reeds; in ponds they choose the weeds upon the shallows for depositing it; ducks and other wild fowl eagerly devour the spawn, and by them it is transported to other waters. The appearance of the pike in ponds where none were ever put, has been deemed as extraordinary as its asserted longevity; it is, however, easily accounted for upon the well-known principles of the generation of fishes. If a heron has devoured their ova, and afterwards ejected them while feeding in one of these ponds, it is highly probable that they may be produced from this original, in the same way as the seeds of plants are known to be disseminated.

"Pike are in season from May to February (the female fish are to be preferred), are bold biters, afford the angler good sport, and may be fished for all the year; but the best months (especially for trolling) are February, before the weeds shoot, and October when they are rotted; the latter is to be preferred, as the pike are fattened by their feed during the summer; and from the lowness of the waters, their harbours are easily discovered."

The same author thus describes the method of trolling for pike:—"For trolling, the rod should be twelve or fourteen feet long; but a strong top for this fishing, with a ring at the end for the line to run through, may be fitted to a fly or general rod; there should be one ring upon each joint to conduct the line, which is better than a greater number (and these rings must be set on straight, that it may run freely, so that no sudden check after the bait is taken prevent the pike from gorging it): the line should be of silk, with a swivel at the end to receive the armed wire or gimp, and at least thirty yards long, wound upon a winch or reel fixed to the butt end of the rod. Hooks for trolling, called dead gorges, and other sorts for trolling, snap, and trimmer, and fishing-needles, are to be bought at every shop where fishing-tackle is sold. In the choice of the first let them not be too large, nor their temper injured by the lead on the shanks, nor the points stand too proud; and although usually sold on wire, it is recommended to cut off the wire about an inch from the lead, and with double silk well waxed, fasten about a foot of good gimp to the wire, with a noose at the other end of the gimp large enough to admit the bait to pass through, to hang it upon the line. The best baits are gudgeons or dace of a middling size; put the baiting needle in at the mouth, and out at the middle of the tail, drawing the gimp and hook after it, fixing the point of the hook near the eye of the fish tie the tail to the gimp, which will not only keep it in a proper position, but prevent the tail from catching against weeds and roots in the water; thus baited, the hook is to be fastened to the line, and dropt gently in the water near the sides of the river, across the water, or where it is likely pike resort; keep the bait in constant motion, sometimes letting it sink near the bottom, and gradually raising it. The angler need not make more than two or three trials in a place, for if a pike be there, he will within that time bite if he means to do so. When the bait is taken, if at a depth too great to see, it will easily be ascertained by the line being drawn tight, and by some resistance; let the pike have what line he chooses, it will be soon known when he has reached his harbour by his not drawing more; allow from five to ten minutes for his gorging the bait; wind up the line gently until the pike is seen (which he will permit though he has not gorged); should the bait be across his mouth, give more time; but if he has swallowed, manage him with a gentle hand, keeping him, however, from roots and stumps, which he will try to fasten the line upon; in clear water veer out line until he is sufficiently tired, and a landing-net can be used; but by no means, however apparently exhausted, attempt to lift him out with the rod and line only; for the moment he quits the water he will open his mouth, and from his own weight, tear the hook from his stomach and the fish will be lost to the angler, although it must inevitably perish. In trolling, the bait should never be thrown too far; in small rivers the opposite bank may be fished with ease; and the violence of its fall upon the water, in extensive throws, soon spoils the bait, by rubbing off its scales, and alarms the pike instead of enticing him. Pike are to be allured by a large bait, but a small one is more certain to take them; never suffer weeds to hang upon the hook or bait when recast into the water, and which cannot touch the surface too softly. Always prefer a rough wind, and when the stream is clear, for trolling; pike never bite in white water after rain, &c. If a pike goes slowly up the stream after taking the bait, it is said to be a signal of a good fish."

Mr. Stoddart's methods of angling for pike here deserve notice:—"In rod angling for pike, we adopt three methods, employing the gorge tackle, the swivel tackle, and the fly. Our gorge-hook is double brazed, and armed upon brass wire. A par or small trout inverted is the usual bait. We insert the wire of our tackle through the fish, bringing the upper end of it out at the tail, and allowing the two barbs of the hook to protrude from its mouth. In angling, we both throw and drop the bait, as the nature of the water demends, moving it slowly towards the surface. When a pike seizes it, there is at first no perceptible tug; one feels as if he heard the shutting of a pair of jaws on the bait; and if you can manage to see your fish, you will observe him holding your trout by the middle, as if crushing the life out of it. Keep a tight line, but do not pull or strike. Too much resistance places your intended victim on his guard; a little, however, sharpens his appetite. After a few seconds, the pike will begin to move towards his den, still grasping your bait between his teeth, and intending to bolt it immediately. Let out line with your hand from the reel; and now he is fixed, and darts off like a tiger, shaking his chain, and with open mouth tossing himself out of the water at thirty yards' distance—the worst is over, and he turns revengefully towards the shore; wind up—ha! he is out again, and again he makes for the shallows; but the monster is exhausted and moves heavily; lead him with caution to the edge, lay down your rod, and lift him upon the bank. In order to disengage your hook from the entrails of this formidable fish, the gills should be forced open, and a knife introduced for the purpose, taking care previously to thrust it through the spine-bone of your victim, and so prevent the possibility of your catching a Tartar. Unfasten your hook from the wire before drawing the latter through the mouth of the pike, as otherwise it is again apt to catch among the teeth, from which it may be somewhat difficult to extricate it, without incurring a few scratches.

"Should a fish, after having bitten, abandon your gorge-hook, try him with a running bait upon swivels, and let this be a fresh trout of a smaller size than your other, and fixed upon a gimp tackle with the tail downwards, as in minnow fishing. See that it spins judiciously; and when the pike rises, let him turn with the bait before you strike. River pike, it may be remarked, seldom play so well as those in lochs. They push generally below the banks, instead of striking across, and look out for old stumps upon which to entangle and break your line. One ought, therefore to make quick sport with such rascals—running them down upon level banks in a twinkling, and before they are able to get under weigh.

"The third method of angling for pike is with a fly—a kind of fishing not much in use, but still on some waters very deadly. The pike-fly should be large and gaudy, fabricated of divers feathers and tinsels to resemble the king-fisher or a huge dragon-fly. Use it in a strong warm wind, upon water from six to two feet deep, and near weeds. You will kill with it fish of various sizes, from ten inches in length and upwards: very heavy ones, however, refuse to take it, on account, probably, of the exertion necessary in order to come to the surface. We have always noticed that the biggest pike are caught during close sultry weather with a ground bait, and at those times when trout refuse food altogether. Also at night, with set lines, in the summer months, when they leave the weeds and bulrushes in quest of food.

"Although the pike is often nice and suspicious in places where trout abound, still, when provoked, he becomes bold and unwary, treating your presence as no constraint upon his temper and appetites. He will follow the bait to your very feet, and should it escape him, will retire a yard or two, waiting eagerly for its reappearance. When angry he erects his fins in a remarkable manner, as the lion doth his mane or the porcupine his quills; moreover, the pike appears careless of pain, if, indeed, fishes in general feel it to any great degree. We have actually landed one of these fish, cooped him alive in our creel, and when by some negligence of ours, he made his escape into the water, have succeeded a second time in securing him. On another occasion, we remember having a part of our tackle, consisting of a large double gorge-hook, dressed upon brass wire, carried off by a pike; and yet, upon renewing it, the aggressor returned to the charge and was taken. The former hook we discovered gorged by him in such a manner as must, we thought, not only have suffocated any other animal, but done so by the medium of the most exquisite internal agony.

"Great injury has of late years been done by the transference of the pike to many of our best trouting lochs, where a single individual has been known to consume nearly its own weight of fish daily. This was the case on Loch Turit, near Creiff, where the trout, formerly abundant, are now greatly reduced by the hostile and merciless depredations of their natural enemy. The pike at table is reckoned by some a coarse dry fish, and so in general they are; yet to our knowledge, in certain lochs, for instance that of the Lowes, in Selkirkshire, they almost rival the turbot, and should be cooked somewhat in a similar manner. They are none the worse for being kept a few days, especially if of any size. A good eating pike ought to weigh at least from five to twelve pounds—the smaller ones being without exception bad."

Trout-Fishing.

The trout is of different species and varieties, as the common trout, the gillaroo or gizzard trout of Ireland, the bull-trout, and the salmon-trout. The shape is handsome; the flesh firm and sweet, and coloured pink or white, according to species and feeding-ground; and the weight varies from half a pound to four or five pounds. In one or other of its varieties, the trout is a universally-known fish in temperate climates; its favourite haunts are clear running rivers; and there, both in England and Scotland, it affords a favourite object of sport to the skilful angler. Sometimes bait is employed, but the fly is more common. In some cases the bait and fly must be tried alternately in one day, as the fish is capricious, and requires to be tempted in all kinds of ways. The season most favourable for trout-fishing is spring and early summer.

Trout-fishing with bait.—"Trout," says Blaine, "begin to take a bait on or near the ground early in the year, and before March will readily take most bottom baits all day long in favourable weather; but as the summer advances, it is only very early or very late in the day that they will take a bait near the ground, they being at the intermediate hours more disposed to rise to the surface for winged insects. In March and April use the worm in the forenoon, and a fly or minnow, according to the state of the water, the rest of the day, in the swiftest and sharpest currents, provided the day be warm and bright, and in the deeps early and late; but if the water be discoloured or very thick, try the gravelly shallows near the sides and tails of streams, with a worm only, to run on the bottom with one large shot a foot at least from it. When there is a small *fresh*, or the water is clearing off, and is of a dark brownish colour, first use the worm, which should be a well-scoured brandling, cast in as a fly at the head of the stream, and move it gently towards you, still letting it go down with the current so as to keep it a little under water; the line should be rather short, with no lead upon it, and the hook fine; then try the minnow, and as the water clears, the artificial flies should be tried. In fishing for trout with the worm, use running-tackle, and employ a strong line, but let its strength consist in the excellence of its material rather than its bulk, to which end the hook should be small, the gut fine, the shotting fine also, and let the whippings be well concealed, for in bright water trout are singularly wary and suspicious. In some few instances a float is indispensable, and when such is the case, let that likewise be as light and fine as the water will allow."

A short line and quick striking are recommended by Mr. Stoddart, who says the line "ought always to be kept at its full stretch, and moved in a half circle with the angler. It requires some degree of perception to know the exact instant when the fish first seizes your bait; it does so with such softness, and with no likeness of a tug, as one is apt to imagine; nay, it merely closes its jaws upon the hook, as a gaping oyster would do upon one's finger, then is your opportunity for striking; if you neglect it, you allow the trout its more leisurely process of nibbling, and its chances of escape. In striking with the short line, do it sharply, and never against the current, but rather with it, in a diagonal direction, and not too high. The reason of this advice is obvious, for all fish feed with their heads pointing up the stream—kindly giving you the choice of pulling the hook into or out of their mouths; the latter of which purposes you accomplish, to a dead certainty, by striking against the current. This whip-jack manner of bait-fishing is very deadly with an experienced hand. The long-line anglers make nothing of their method comparatively: and yet, among clear waters, and where fish are few, or bite shyly, patience and a long line will carry the day. Remarkably fine gut ought to be used by all ground anglers, whatever be the practice. Trout are a suspicious, distrustful set, and three in general slink off for one that nibbles, terrified, no doubt, by those singular accompaniments of your worm, a line and hook.

"To all bait-fishers Scotland affords excellent sport; her rivers run so strongly, and are maintained by so many sources in the shape of mountain burns. These romantic streamlets abound in trout; every stone shelters its inhabitant, and the meanest pool is peopled with numbers. Burn fish, however, are generally of a small size; they seldom exceed a pound in weight, except in the spawning season, when larger ones ascend from broader streams, or lochs at a distance. Still, the taking of them is a pleasant pastime, especially when they bite eagerly at your worm, as they do during rain and in discoloured water. At such times, you have only to drop your bait without art, and the fish will manage its own ruin. Worms are taken greedily at night and early in the morning; also, when the sun is very powerful, at mid-day. Akin to this sort of angling is roe-fishing, concerning which we remark, that in autumn it is the most fatal method of capturing trout, and is growing much into practice in the south of Scotland."

The same enthusiastic brother of the angle next proceeds to treat of minnow fishing, which he says is by far the pleasantest mode of capturing trout, next to angling with the fly:—"If you wish to engage in this pleasant sport, provide your minnows by means of a small drag-net or hook. Select those of a moderate size, and which shine whitest. They may be salted, but are best perfectly fresh. The tail of a small trout or par is no bad substitute, if minnows cannot be had. Our only reason for preferring the fresh to the salted minnow is, that by its silvery appearance and more rational form it better attracts the fish; at the same time, it is well known that a trout loves a salt bait, and will repeat its attack upon a minnow of that description, while it refuses to do so upon one newly taken. Fish in rapid streams, also in deep discoloured pools, and during a smart curl. Manage the minnow as you would your fly, throwing it down and across as far as you are able; bring it towards you about six inches or more below the surface, spinning rapidly by the aid of several swivels. When a fish rises, give him time before you strike; let him turn and gorge the bait, then strike sharply, and he is yours; all fly-fishers are apt to strike too soon, and miss the fish.

"Trout seize a minnow by the middle, or near the head, and you generally hook them on the upper hooks. In rivers where numbers of minnows are found, you must angle with the very smallest, not above an inch in length, and use a proportionate tackle. The trout in such waters love delicate tid-bits, and are absurdly nice in their feeding. Artificial minnows are sometimes employed by anglers, but generally fail, except in muddy waters and lochs. Mother-of-pearl makes the best imitation—there is a virtue in it which few fish can resist."

"Trolling with par for large trout," he continues, "is a glorious pastime, especially on a Highland loch circled with mountain scenery—the craft of nature by incantation wrought, when the morning stars sang together. It needs intellect to enjoy it well, and a poet's heart to know its luxury. Take with you some choice and idle spirit, a rower he must be, that can manage your airy shallop as the winds do a weathercock—can chant a ballad of yore, of ladye and chieftain, and pranksome elf and kelpie wild—can speak to the echoes and to yourself, cheering you with wit and wisdom, and admiring your science and skill; and the gorgeous fish you are playing, twenty fathom off, with a strong and steady hand, your heart 'high fluttering the while, like woman's when she loves.'

"Tackle for trolling should be dressed upon tried gimp. Bait as you do with a minnow: use a strong rod, heavy lead, and a long line of oiled cord wound upon an easy reel. Choose a sunny day, with a stiffish breeze, and troll near but not among the weediest parts of the loch. Plant yourself at the boat stern, and get rowed gently at the rate of three miles an hour, letting out from twenty to thirty yards of line between you and your bait. Trout from six to nine pounds' weight cause the best sport when hooked; a larger one seldom leaps or makes any violent exertion to escape; he swims sullenly, and at ease, regarding the angler with a sort of sovereign contempt. You must row after him, and turn him if you can before he gets among weeds; never slack your line for an instant, and look well about you. Land as soon as you are able, and play him from the shore. Your companion will assist you at the death.

"So much for the different kinds of bait-fishing practised in Scotland. We esteem it folly to talk of the less popular baits used by the *virtuosi*—of frogs, grubs, and leeches, water-rats, and mice—all of which animals trout will devour. It might be asked, may fish not be taken with any thing? They have been known to swallow money, rings, and many other marvels; nevertheless they seem to have no pleasure in snapping at the bait of the unskilful angler, and refuse to die under his hands."

Trout fly-fishing.

This, after all, is the true angling, all other efforts at taking fish being either somewhat childish or murderous. A long flexible rod, fine lines, and appropriate flies are the necessary equipment; and the best time for making the attempt is on a dark lowering day, at any rate not in bright sunshine. If the moon has shone brightly the previous night, it will have prevented the trouts from feeding freely, and they will accordingly bite more readily when tempted with the artificial fly. Great skill and nicety are required in throwing the fly line. Mr. Stoddart gives the following directions how to proceed:—

"Your rod and tackle being ready, the wind in your favour down the river, draw out with your left hand a few yards of line from your reel, dip the top of your rod in the water, and with a rapid jerk you will lengthen as you wish that part you intend for throwing. A thirteen foot wand will cast from six to seven fathoms of line. With a large double-handed rod you may manage a much greater length. Always, if you can, angle from a distance. Trout see you when you least imagine, and skulk off without your notice. Noise they care little about; you may talk and stamp like a madman without frightening them, but give them a glimpse of your person, and they won't stay to take another. Some icthyologists attribute to them an acute sense of hearing; this we are disposed to question; for how happens it that the most obstreperous rattling of stones, when wading, causes no alarm, although conveyed to them through the medium of water, a good conductor of sounds? We remember angling one still night by St. Mary's Loch, when our movements were heard distinctly by some shepherds from the distance of a mile, and yet the fish rose eagerly at our very feet, following our fly to the shallowest parts of the margin—a fact which, if it does not prove the obtusity of hearing, at any rate renders it a matter of little consequence to the angler.

"It requires some art to throw a long line. The beginner should commence with a short one, and without flies, lengthening it gradually as he improves. The best method of casting is to bring the rod slowly over the right or left shoulder, and with a turn of the wrist make the line circle behind you, then, after a pause, fetch it forward again in the same manner, and your flies will descend softly upon the water. All jerks are apt to whip off your hooks or crack your gut. A fly-fisher may use two, three, or four flies on his casts, according to pleasure. When angling with small hooks, we adopt the medium number. Large ones ought to be fished with in pairs, and well separated. In throwing the cast, the lowermost or trail-fly should be made to alight foremost; its fall ought to be almost imperceptible; it should come down on the water like a gossamer, followed by the droppers. The moment a fly touches the surface, it is ten times more apt to raise a fish than during the act of drawing it along. At no time are we stanch advocates for the system of leading our hooks either against or across a stream; our method is rather to shake them over it for a moment and then repeat the throw. A trout will discover your fly at the distance of several yards, if feeding, and will dart at it like lightning. Always, if you can, fish with the wind, and do not concern yourself, as some do, from what quarter it comes. In spring, no doubt, a south-west breeze is preferable to all others; yet we have seen even easterly winds not the worst on many waters, especially during summer months, when the natural fly is apt to become over plenty.

"Trout will sometimes take in the most unlikely weathers, so that the angler should not despair at any time

Hunger causes them to feed at least once in the twenty-four hours, and generally much oftener. If the wind blows down the river, commence at the pool head, and fish every inch of good water; you may pass over the very rough and very shallow parts, also those which are absolutely dead calm, and clear, unless you see fish rising in them, when, should your tackle be light, there is no harm in taking a throw or two. Dead water, however, when rippled or discoloured, may be angled in with great success. When you raise a good trout, strike slowly, or hardly at all; only continue the motion of your hand without slacking it; the fish, if large, will hook itself. Small trout and par may be whipped in with rapidity: it is folly to play or use ceremony with such trifles. Should the fish miss your fly altogether, give him another chance, and a third if that will not do; a touch of your barb, however, will sharpen his wits, so as to prevent him from again rising. He prefers flies without stings. When you hook a trout, if you can, turn his head with the stream, and take him rapidly down. Thus you will exhaust him in the shortest time, whereas, by hauling against the current, you allow him to swim freely in his natural direction, and also exert three times more strength upon your tackle than is really needful. A good-sized fish, handled in this foolish manner, can never be taken; it is impossible to tire him out, and the strongest line will give way to his resistance. When your victim is exhausted, draw him gently ashore upon the nearest channel, or most level part of the margin. He will come in sideways, and generally lie motionless for a few seconds, during which time you will be able to run forward and seize him. Beware of catching hold of your line until he is properly banked. Many a famous trout have we seen lost by this inadvertence on the part of anglers, who think so to save time and labour. One should remember how the spring of the rod is thus removed, and how there remains no proper curb to the strength of the fish, which easily breaks a single gut, or tears itself from a sharp hook, and wishes the astonished angler better sport further on."

The practice of double-rod fly-fishing for trout or for salmon is a murderous kind of sport, and should be prohibited by law. A line stretched between two rods, and hung with flies, is taken down the stream by two individuals on its opposite sides, so that every part of the water is gone over, and every feeding trout raised. By this plan large numbers are caught, but many also are wounded, and escape to pine away for months at the bottom, unable either to feed or spawn.

Salmon-Fishing.

This may be described as a gigantic trout-fishing, the principle of alluring and capturing being the same, but all the tackle requiring to be stronger, and a greater degree of physical power being necessarily called into operation. The salmon has a peculiar habit very likely to upset the calculations of beginners; it consists of the ugly practice of running off at a violent speed as soon as he feels himself hooked, darting up the stream, throwing himself several times out of the water, and generally in the end hastening into some sheltered haunt where he expects to be safe. Great tact is necessary on these occasions, first to give line, and then to keep him from burying himself in some unapproachable nook.

With respect to the minutiæ of the art, both in throwing and striking, the recommendations of Mr. Younger of St. Boswells are well worthy of attention:- "I recommend a beginner," says he, "to practise throwing the line on a broad smooth pool, where he can see that it is delivered out properly, and falls lightly, without splashing. In such a case the practitioner will perceive something which he cannot easily account for: and that is, that after he has even attained a great degree of perfection in the art, he will not be able to distinguish how it happens that in one throw his long line will proceed direct out, his fly alighting first on the water; in another throw the middle of his line will fall first, while the farther part, still obedient to the general impulse, will proceed out the full length, the fly falling the last on the surface. This last throw is not so good as the former, for this reason, that the main current having caught the middle of his line first, carries it too quickly down, leaving the fly lagging, to form an awkward curve, as, before it comes over above the fish, the fly should lie on the water, so as to have the appearance of flying at an angle against the current. And the angler should so manage his rod that, while he lets his line float round at its full length, yet to cause his fly to come as slowly as possible over the main spot. In this case the salmon will sometimes rise at once, rather before you expect him, but more generally will follow the fly to the eddy, or edge of the deep, where, if on examination he feel disposed to seize the hook, he has it before you perceive a head, fin, or tail above the surface. Indeed, before you perceive the web of his tail he generally has the hook in his jaw a foot below water, as in descending he goes, like other divers, head foremost."

Having managed to place the fly over the desired spot, our authority continues—"He will make no perceptible motion to keep his fly on the surface (except on a sluggish pool), but let it sink a little, depending on feeling rather than on sight; and though apparently keeping no pull on his line, yet all the while able to detect the touch of a minnow. On a *boil*, or rather appearance of a fish, he pulls up his line, not twitchingly but actively, steps a yard or two back, rests a minute to let the fish resume his lair and attention, and perhaps feels inclined to alter his fly, before he annoy and disgust or alarm his fish, to a shade darker or a size smaller, when he will most probably come up and seize it in earnest. Should he not rise again, or rise and pass it thrice, leave him quietly alone for the present, and return to try him some time afterwards. On taking the fly, the fish means to return with it to his precise select *spot* of lair, on rock, stone, or gravel, at the bottom; and the fine angler, holding him gently, often, in the first instance, allows him to do so, but soon, too surely feeling his awkward predicament, he bolts off 'indignant of the guile.' Then is the time when the fisher is attentive; with the butt end of his rod resting on his thigh or groin, he keeps the top nearly erect, never allowing it to fall below the proper angle of forty-five degrees, as relative to the situation of the fish, as in this position the elasticity of the rod never allows the line to slacken in the least degree for a single instant, however the fish may shake, flounce, jerk, or plunge. With two or three fingers and the thumb of his left hand the angler holds his rod while the wheel-line runs out, regulated by the first or first and second fingers, relieved or assisted, as occasion may suggest, by the right hand, when it can be spared from its necessary occupation of rolling up the wheel-line, as the fish settles a little or returns inwards. In this manner the fish is allowed to run right out, up, down, or across, as he may choose. But if in an outright dash of thirty or fifty yards aslant, ending in an outward bound fling above water, the inexperienced angler should feel flustered, which he is very likely to do, and by some involuntary twitch of the running line let the top of his rod be pulled down to a level with his own head, then the tug of the last plunge will assuredly break his hook or line, or tear the hook from the mouth of the fish. Or, what is as bad, a sudden jerk or turn of the fish will give the line a momentary slackening, when the hook's hold, already so strained as to have widened its incision, will fall out, and your fish is gone for ever."

Now is the critical moment for the salmon-fisher, who must keep up his rod and give line. "The fish will then," continues John, "allow himself to be led at ease to the angler's side of the river, like a bridegroom to the altar, when, on finding the water shallowing, he will again make another desperate effort, probably a new dash into the middle current; but too much exhausted to resist the still continued pull upon him, he will soon again fall into the shallow, where, on a sight of his enemy, he is again alarmed into a new effort, and again exhausted by turning his outward-bound head down with the water, again and again, and again, as if the parties were in the amusement of forming circles, until his own last efforts to keep swimming are made subservient to the cautious angler in moving him by degrees into the shallow, where, half dry, he must, like all the strong, at last yield to his fate, and fall panting on his side, while the line rolled up to within rod length, which is to be held with its top landwards, without slackening, and the fisher seizing him with the fore finger and thumb of his right hand across by the root of the tail (which is by far the surest method of seizure), lifts or rather slides him out head foremost over gravel and grass, and in mercy fells him with a blow on the back of the neck.

"After going through this process with a twenty-two pounder (and the process would be the same with a forty-four), the writer can aver, that he does not conceive that from the moment he has hooked such until he was laid on the grass, he ever for an instant had three ounces of more or less pull on the fish; for in all circumstances of run, regularity of pull is the sure test of true skill and final success. Indeed, I have seen many a fine fish laid on the dry gravel when the hold of the hook in the lip of his mouth was so slight as to be smaller than the steel of the hook—so much for equal pull and cautious management in the run. And, in short, a man is never a master angler so long as a desire to have his hooked fish to land excites in his feelings the least agitation, as the matter should be managed with that cool philosophical ease of mind which is alike above the paltry calculations of loss and gain and the common ridicule, which often tends to stir up a degree of childish fretfulness. This perfect ease is absolutely necessary to first-rate excellence and ultimate success."

Leistering is the name usually given to a murderous kind of sport pursued by salmon fishers in Scotland. Armed with *leisters*, or spears with three-barbed prongs, a set of fishers proceed to the river's bank, and there attract the fish by the glare of torches held over the water by members of the party. When a salmon is discovered, one selects it as his prey, and by a cool but rapid blow transfixes it with his spear. In many cases, the fish cannot be secured or landed without plunging into the water, but this usually forms no obstacle, and several men may be seen floundering in the depths of the stream while shouts and confusion prevail among the spectators on the banks. Sir Walter Scott, in his novel of *Guy Mannering*, has presented a vivid picture of this species of sport, which is still pursued on the Tweed and its tributaries, but mostly by parties of rude marauders who are regardless of law, and kill vast numbers of fish during "close time," or when the rivers are legally shut—from about the middle of October till February.

THE PAR.

The par is a small fish, which is found in great abundance in almost all rivers which are clear, and have a free communication with the sea. It varies in size, of course, according to its age, but seldom reaches a greater length than six inches, and is usually found below that magnitude. It is silvery in appearance, and marked by peculiar blueish bars or marks along the body; while a more nicely-forked tail, and one regular row of scarlet spots along the sides in place of two or three, aid further in distinguishing the par from the trout, the fish which it most resembles.

Of the actual character of the par, whether it is an independent species, or the fry of salmon, there has been a long-continued controversy. Many naturalists were inclined to hold it as a kind of mule, or creature betwixt the trout and salmon breeds. The dispute, however, may be said to have been terminated recently by Mr. Shaw of Drumlanrig, whose lengthened and ably conducted experiments establish the par to be the natural produce or fry of the salmon. In a memoir communicated to the Royal Society of Edinburgh, Mr. Shaw mentions that his first experiment on the subject consisted in the removal of a number of pars from their native stream to a pond, when he found that all of them assumed the perfect appearance of *salmon fry* or *smolts*, at the end of periods of time proportioned to their bulk when placed in the pond. He also satisfied himself that the change from the state of par to that of smolt, which is marked by the appearance of a covering of silvery scales over the blue bars, always takes place at the age of *two years*; and that then, for the first time, the metamorphosed fry take their departure for the sea.

But it was objected to these experiments, that Mr. Shaw might have mistaken young salmon for pars in the first instance, so rendering his conclusions of no weight. To settle all disputes, he began his experiments with the *ova* or *eggs* of the salmon, first constructing ponds for their reception. These ponds, three in number, he protected by falls, pipes, and gratings, in such a manner as to seclude them in a perfect manner from all interference on the part of any other fishes whatsoever. Having provided a proper net, Mr. Shaw was successful in capturing a pair of adult salmon, male and female, while engaged in depositing their spawn. By expressing a portion of the ova from the female, and of the milt from her companion, he had it in his power to transfer fertilized ova to his ponds on the 2[illegible]th of January, 1837. "On the 21st of March, fifty-four days afterwards, the embryo fish were visible to the naked eye. On the 7th of May they had burst the envelop, and were to be found among the shingle of the stream. It is this brood which I have now had an opportunity of watching continuously for a length of time."

Mr. Shaw's descriptions of the brood, read to the Royal Society, and accompanied with specimens, will best show the general scope of the results. At the age of forty days after the exclusion from the egg, the symmetry of the young fish's form was but imperfectly developed. "After the lapse of two months (7th July) the shape was found to be materially improved, and to exhibit in miniature much of the form and proportions of a mature fish. At the age of four months (7th September) the characteristic marks of the *par* were clearly developed. Two months later (six months old, 7th November) an accession both of size and strength was apparent, and on comparing the pond specimens with the par of the river, no marked difference was perceptible. The average length at this time was three inches.

"During the winter months, the general temperature of the rivers is so low, and the consequent deficiency of insect food so great, that the whole of the Scottish salmonidæ which inhabit the fresh waters during that season are well known to lose rather than gain in point of condition. The same rule holds in regard to the young salmon in the experimental ponds, although not to the same degree, they having maintained comparatively a superior condition throughout the winter to those found in the river of a corresponding age and size. The temperature of the ponds, averaging about 40 degrees during the winter, not only keeps the young fishes which occupy them in a more active condition, but the insects themselves are also more abroad, and thus afford a convenient supply of food not to be obtained by those at that time in the river, the average temperature of which, in ordinary winters, barely exceeds 34 degrees. I shall now refer more specially to the specimens before the Society

"Number six is a specimen from pond number one, of the age of nine months, taken in the middle of February, 1838. It exhibits little or no particular accession of size or condition to that of number five, but may serve to show the general appearance of the several broods of the young salmon in my possession at the age of nine months.

"Number seven is a specimen twelve months old, taken from pond number one, on the 10th May, 1838. It is much improved in condition, as well as in external appearance, in comparison to that taken in February, and has exchanged its dusky autumnal and winter coating for that which may be called its summer dress. It measures about three and three quarter inches in length, and is denominated, along with those of a corresponding age and size in the river, the *May Par*. Immediately after the migration of the two-year-old par (which the latter always effect about the beginning of May, under the name of salmon-fry), there is no other par, besides such as have been recently hatched, to be found in the river, save those which correspond with this specimen, which is the *Pink* of the river Hodder, alluded to by Mr. Yarrell. As the summer advances, they increase in size, and are actually the little fish which afford the angler in salmon rivers so much light amusement with the rod, during the months of August, September, and October. They remain over the second winter in the river, during which period the males shed their milt, and are found continuing their kind along with the female adult salmon, although still bearing all the external markings of the par, as I shall afterwards more particularly mention. Number eight is a specimen eighteen months old, taken from pond number one, on the 14th November, 1838. It measures six inches in length, and has now attained that stage when all the external characteristic markings of the par are strikingly developed, and, in point of health and condition, cannot be exceeded by any taken from the river. All the males, at the age of eighteen months, of the several broods in my possession, last autumn (1838) attained a most important corroborative stage, namely, that of showing a breeding state, by having matured the milt, which could be made to flow freely from their bodies by the slightest pressure of the hand. The females of the same broods, however, although in equal health and condition, did not exhibit a corresponding appearance in regard to the maturing of roe. The male and female pars in the river, of a similar age, are found respectively in precisely a corresponding state, which may surely be admitted as most important evidence in support of the fact that all these individuals are, in truth, specifically the same.

"Number nine is a specimen two years old, taken from pond number one, on the 20th May, 1839, *after having assumed the migratory dress*. The commencement of the change, which was perfected by the whole of the broods about the same time, was first observable about the middle of the previous April, by the caudal, pectoral, and dorsal fins assuming a dusky margin, while, at the same time, the whole of the fish exhibited symptoms of a silvery exterior, as well as an increased elegance of form. The specimen in question, so recently par, exhibits a very perfect example of the salmon fry or smolt."*

These experiments, conducted in an unexceptionable way, were confirmed by other observations. Being satisfied that the par never migrated to the sea until the age of two years had been attained, and the change from par to smolt had taken place, Mr. Shaw watched to discover the descending shoals. He was successful on three occasions. "The first of these was in the first week of May, 1831. I was able deliberately to inspect them as the several shoals arrived behind the sluices of a salmon cruive; and while they yet remained in the water, and were swimming in a particular direction, indistinct transverse lateral bars might still be seen; but as they changed their position, these became as it were lost in the silvery lustre. I also examined many of them in the hand, and could there also, by holding them at a certain angle in relation to the eye, produce the barred appearance; but when the fish were held with their broad side directly opposed to view, the character alluded to could not be seen. Its actual existence, however, could be easily proved by removing the deciduous silvery scales, when the barred markings became apparent, and, of course, continued so to whatever light exposed. The third opportunity to which I shall here refer occurred in May, 1836, at which time, as I have stated, I compared a few of the descending smolts with those which (having been two years in my possession as par) had, in the confinement of the pond, assumed the corresponding silvery aspect of the salmon fry. The river during this month being remarkably low, I was thus enabled to ascertain more accurately the time during which they continued to migrate, which I found to be nearly throughout the whole of the month, but more especially in the course of the second week, in which the shoals were both larger and more frequent in their successive arrivals. Their external aspect was the same as that of the former shoals, and the average length, as usual, from six to seven inches."

To conclude this subject, it may be added that pars are never found where salmon do not exist; and that large pars are always found to disappear when smolts disappear; being, indeed, as Mr. Shaw shows, the same animals slightly changed. Other points in the history of the par are fully elucidated by Mr. Shaw, whose memoir the disciple of Walton would do well to consult.

Pars are caught by the rod and fly, or with worm-bait, in the same manner as trouts; and fishing for them forms a common and amusing sport to the juvenile anglers in our Scottish rivers.

FISH PONDS

Artificial ponds for the rearing of fish and supplying them when wanted for the table, were common in ancient times. The luxurious Romans possessed such preserves, and we learn that one belonging to Lucullus sold after his decease for upwards of £24,000. Comparatively little has been done in modern times in the way of establishing artificial ponds, and those which exist are chiefly to be found in noblemen's preserves. Yet artificial fish ponds may, with little or no trouble, be made to yield a large and regular supply of fish, and may be constructed at a most insignificant expense in any piece of low-lying waste ground intersected by a rivulet of pure water.

The fish most suitable for ponds are trout, carp, tench, perch, and minnows. Eels also thrive in ponds, and, what has frequently been a matter of surprise, these animals sometimes find their way to ponds of their own accord, without actual transfer. It is extremely probable that the spawn or young of eels and other fish is gobbled up and vented by birds in appropriate localities; there is at least no other rational means of accounting for the spontaneous stocking of remote fish ponds and lakes.

The size of a pond may be from one to twenty acres; but a piece of water of from two to three acres is considered the most convenient dimensions. Of whatever size, the pond must not be overstocked, and it must not be left too long unfished. Fish ponds, to be on the most effective scale, should be in a series of two or three, the water running from the one to the other. This will allow means for periodical cleaning, if required, and for having a choice of fish. Some remarks of Daniel may here be introduced:—"In ponds so situated as to have communication with each other, never put into the upper of them either a pike, a bream, or a roach; the spawn

* One or two of each of the three broods assumed the migratory or smolt dress at the age of twelve months.

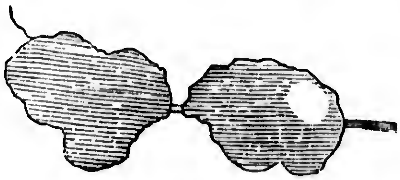
will get through the gratings, and by that means all the lower ponds will unexpectedly swarm with them. The pike will destroy the fry of the carp and tench, and the two latter will consume all the food which should be the subsistence of both parents and progeny. Pike, bream, and roach should, therefore, on no account be ever put into the first or highest of a succession of ponds." He continues—"Some have recommended, in raising carp, to have three ponds. One wherein the fish are to spawn (which is mostly from May to July), and in which they should continue during the summer and ensuing winter. A second for the convenience of nursing up the young fry, into which they should be put at the end of March, or early in April following, choosing a calm but not sunny day for their removal, and being careful to prevent their being destroyed when coming to the sides of their new habitation. In this pond they may remain two years, and become four, five, or six inches long. The third or main pond is for the reception of those that are so grown as to measure a foot or more in length, including their heads and tails.

"The proportions advised for the stocking these different ponds are—for the first sort, per acre, 'three or four male, and six or eight female carps, those of five, six, or seven years old, in good health, with full scale, and fine full eyes and a long body, without any blemish or wound,' are to be preferred. The pond must be previously cleaned of all sorts of voracious fishes and other animals, as 'perch, pike, eels, and trout; the water beetle, and also the frogs; the newts or lizards;' have a warm and open exposure with soft water, and all kinds of water-fowl kept from it. For the nursing pond a thousand or twelve hundred carp may be not more than sufficient for an acre; and for the main pond one to every square of fifteen feet is the allowed space, as their growth depends greatly on the room and quantity of food."

Our friend Mr. Stoddart likewise treats of fish ponds, but mainly in reference to Scotland, where the fish must be of the hardier kinds—perch, pike, and trout. In either case, the transfer of the fish to the ponds may be made with little difficulty. On being caught with a hoop-net, place them in large jars of water, and cart them to their new habitation; if this be inconvenient, they may be carried in wet moss or straw. All fish bear carriage best in winter, and better during the night than during the day.

"Ponds intended solely for perch do not require to be made large; they should slope gradually down towards the middle, from a depth of six inches to one of five or six feet. Water weeds ought not to be greatly encouraged. A series or chain of small basins, at different elevations, is preferable to a single large reservoir for this fish. These basins should be connected by a sluice and flood-gate, so that one may be readily emptied into another for the mutual convenience of cleaning and repairing. Also, the uppermost ought to be shallower than those below, and more exposed to the sun, so as to serve for a nursery and breeding-pond. Bream live well with perch in a warm situation; they are not, however, obtained readily in Scotland. Perch ponds should be let off and paved with channel stones every four or five years; many allow them to remain fallow for some months, and others sow them with grass and oats, a conceit laboriously encouraged by whimsy and theoretical writers of bygone days."

The following engraving represents a pair of perch ponds; *a* is the upper or breeding pond; *b*, the lower



pond; *c*, a covered sluice with movable gratings; *d*, the sluice with outlet; and *e*, the small feeder.

"The pike-pond," proceeds our authority, "if for breeding and fattening to some extent, ought to be large, covering from eight to twenty acres; its mean depth six or seven feet. One end, however, should be much shallower, and sown with bulrushes or other water-plants. Previous to stocking it with this fish, a sub-stock of perch or trout should by all means be introduced; otherwise, without a great supply of such sustenance, pike will not only become thin and ill-tasted, but quarrel and devour each other. To facilitate a steady supply of perch, small tanks should be constructed alongside of the leading preserve, with connecting sluices and flood-gates, so as to expel, when necessary, a shoal of live food."

Our author next treats of trout ponds:—"Choose from six to twenty acres, less or more, of an oval shape, but indented with small bays. Cast a long trench through the middle, from head to foot, noticing that you can readily divert along it the stream just mentioned, which stream is intended as a spawning place, seeing that trout never shed their roe in dead water. Let this trench deepen gradually as the ground descends; so that at the intended foot of the pond it should sink nearly three yards, while the upper part thereof is kept shallow. Dig from either side of your trench, keeping its slope and level until within four fathoms of the intended margin of the fish pond. When this is done, turn your attention to what is called the dam-head, at the outlet or lowest part of the pond. From it continue your trench for a short distance in the form of a paved sluice. Build stones, grass-sods, and clay, along the bank on each side, if needful, and drive in a few piles to strengthen it. Then set a flood-gate at the out-let, and another to serve as a check in case of accident, three yards farther down, where your paved sluice terminates. A few cart-loads of coarse channel, not from the sea, ought to be emptied over the earthy parts of your pond, which otherwise are apt to get covered with weeds, or else to encourage eels, the marked enemies of trout in all stages. After this is done, let loose your stream and form your preserve, introducing trout of about six inches in length, eight or ten to every acre. Raise also at the head a small nursery of minnows, connecting it by distinct sluices both with the pond and its feeder. These are favourite food of trout, and fatten them at a quick rate."

To these remarks it may be added that little care need be taken to fetch apparently fine breeds of any species of fish from a great distance, as what seem poor fish at the period of transfer will greatly improve by good pond feeding, and the easy unharassed life which they enjoy.

GYMNASTIC EXERCISES—OUT-OF-DOOR RECREATIONS.

Cricket.

A DESIRE for indulging in active sports and exercises has evidently been given to youth for the admirable purpose of promoting bodily health and strength, at a period of life when mental occupation or sedentary employment would not only have been unfitting, but positively injurious. Instead, therefore, of railing at the boisterous pastimes of boyhood, ridiculous as they may sometimes appear, we ought to view them, so long as kept within the bounds of moderation, as consistent with a great providential design in creation, and worthy of our warmest approval and encouragement. Impressed with these considerations of the value of youthful recreations, particularly those carried on in the open air, we should by all means afford reasonable scope for all the usual and harmless sports in which young persons are pleased to indulge; we should say to parents, let the boy have his marbles, ball, nine-pins, and bat; and the girl her doll, skipping-rope, and hoop, besides any other toys which would call their respective faculties into harmonious exercise. But an indulgence in physical recreations and general amusements is not to terminate with the period of youth. In advanced and middle life, it is of the greatest importance to health to relieve the tasked brain, to soothe and compensate the drudgery of our current labours, and to bring into exercise those parts of our muscular frame and intellect which professional duty has left unoccupied. To young men, especially, whose frame requires regular and bracing exercise, those out-of-door recreations which afford a certain degree of amusement are indispensable; and to them the contents of the present sheet are more particularly submitted. Our object will be to point out what sports may with propriety be indulged in, suitable to the different seasons of the year, and how they may be pursued with advantage to health and other circumstances.

GYMNASTIC EXERCISES.

Gymnastics are those exercises of the body and limbs which tend to invigorate and develop their powers.* In an ordinary course of living, without due regard to rules for promoting bodily strength, the frame becomes relaxed, the muscles are soft, the circulation of the blood languid, the bones and joints debilitated, and the stomach weakened and dainty. To avert as far as possible these imperfections, gymnastics ought to form a part of education in youth, when the joints and muscles are flexible, and time is permitted for the various kinds of exercises.

Precaution.—It has not been unusual of late years to conduct the gymnastics of schools on an improper scale, by impelling young persons of comparatively feeble frames to undertake feats and exercises which have been at variance with the bodily organization, or at least highly dangerous and of no practical value. A caution is necessary on this subject. "The best guide we can have," observes Dr. Andrew Combe, in a work on physiology, "is to follow the footsteps of nature, whether it is in harmony with the mode of action assigned by the Creator to the parts which are to perform it. If it be so, we may proceed with perfect confidence that it will not only improve the health, but add to the freedom, elegance, precision, and strength of our movements; whereas, if it be opposed to the obvious intention of the Creator, we may rest assured that no good can accrue from it. If, for example, we examine the various attitudes and motions of the body which occur in fencing, dancing, swimming, shuttlecock playing, and some of the better class of gymnastic exercises, we find that they are not less graceful and beneficial to the young who engage in them, than pleasing to those by whom they are witnessed—just because they are in perfect harmony with nature, or, in other words, with the structure and mode of action of the joints, ligaments, and muscles by which they are executed. But it is far otherwise with some of the anomalous exercises which were at one time so fashionable, and which are not yet extinct in schools and gymnasia, and which seem to have for their chief object the conversion of future men and women into foresters, firemen, or savages, rather than into beings who are to continue to have the use of stairs, ladders, carriages, steam-boats, and the other conveniences of civilized life. It is no doubt a good thing for a boy to be able to climb up a perpendicular pole or a slippery rope, when no other means present themselves of attaining an important object at its upper end; and it is an equally good thing for a young lady to be able to sustain her own weight hanging by one or both hands, when there is no possibility of resting her feet on terra firma; and where boys and girls are strong enough to take pleasure in such amusements, there is no great reason to hinder them, provided they are impelled to them, not by emulation or any secondary motive which may lead to over-exertion, but by the pure love of the exercise itself. In all ordinary circumstances, those only who are vigorously constituted will attempt them, and, if left to themselves, will be sure to desist before any harm can be done. But the case is entirely altered when such extraordinary evolutions are not only encouraged but taught to all indiscriminately, whether they are strong or weak, resolute or timid. We have only to reflect for a moment on the structure of the shoulder joint, and on the sphere of action of the muscles surrounding it, to perceive at once that the position of the one and the strain upon the other caused by the exercises alluded to, are so forced and unnatural as to exclude the possibility of the Creator having intended either to be practised, except upon occasions of urgent necessity, and to discover how preposterous it is therefore to make them a subject of general instruction. Nay, the very violence of the effort required to sustain the body when hanging by the hands, is far beyond that moderate exertion which adds to nutrition and to strength, and in delicate subjects it may even induce relaxation and stretching of the ligaments and blood-vessels, and thus, as in the case of the young men at Cambridge, lay the foundation for future and fatal disease. The same

* The term *gymnastic* is from a Greek word signifying *naked*—the athletæ or young persons who practised bodily exercises in the public arena or gymnasium of ancient Greece, being nearly in a state of nudity. The more gentle kind of gymnastics for females are termed *calisthenics* from words signifying elegant or graceful exercises.

remarks apply to a common practice of making the pupils slide down an inclined plane, resting on the hands alone, by which unnatural effort the shoulders are pushed half way up the neck, and the wrists, arms, and chest severely tried. But in these and other similar evolutions, it requires only to look at the dragging and distortion which they produce, and which form such a painful contrast to the ease and grace of all natural motions and attitudes, to perceive that they are out of the order of nature, and that neither health nor elegance can result from them. In the selection of exercises for the young, then, we should not be misled by a vain desire of surmounting difficulties and performing feats at the serious risk of inducing aneurism or rupture, but rather endeavour to strengthen the body by active amusements, which shall call the social and moral feelings and intellect into play at the same time, and by the practice of such gymnastic evolutions only as tend to improve and give tone to the natural action of the moving powers. And in endeavouring to attain this object, we should be always careful to avoid great fatigue, and to modify the kind, degree, and duration of the exercise, so as to produce the desired results of increased nutrition and strength; and to remember that the point of which these results are to be obtained, is not the same in any two individuals, and can be discovered only by experience and careful observation."

With the precaution suggested by these observations, the following gymnastic exercises may be pursued:—

General Directions.

The exercises are best performed in an open court or piece of ground, firm below, but without any stones to injure the feet or person; a grass plot is the most suitable. The fittings are a climbing stand, vaulting bar, leaping poles, &c. The dress of the gymnast is to consist of easy-fitting trousers, and encircled with a belt or girth. The belt should pass round the loins, and not be too tight. The performances should be in the forenoon, or at least before any heavy meal.

Positions and Motions.

The body must be drilled in the art of standing and throwing out the limbs. In standing properly, the person should be erect, the head held up, and the face looking straight forward; the shoulders are to be square, with the chest fully exposed, so as slightly to curve the back; the legs closed; the heels in a line, and closed; the toes turned out; the arms hanging straight down; the elbows held in to the body; the hands open to the front; the little finger touching the legs; and the thumb flat to the forefinger. When perfected in the art of standing in this position, which is called *attention*, as shown in fig. 1, the next thing is to be taught to march or walk, as in the case of a soldier on drill, the feet being alternately thrown out, and both brought together into position, at the order to halt.

Fig. 1.

The pupil next learns to bend the body and extend the arms. The first exercise of this kind is to carry the hands to the front, the fingers lightly touching at the points; now raise the arms, the hands still together, till they are held over the head, as in fig. 2.

Fig. 2.

The second motion is to learn to hold the arms out in front, the tips of the fingers touching, and returning to the position of fig. 1: this is to be done repeatedly. The third is to extend the hands separately, and raise them over the respective shoulders, the fingers pointing upwards. The fourth motion is to keep the arms and legs straight, and to bend the body forward, with the head down and the tips of the fingers towards the ground. This somewhat difficult motion is represented in fig. 3.

Fig. 3.

A fifth motion is to resume the position of attention, allowing the arms to fall freely to their place, but still without bending the legs. These motions are trying to the pupil, and should be done gradually; the great object is to exercise the muscles bit by bit, and perfection is not desirable at first. Then follow other motions, as throwing the arms out in opposite directions, swinging the arms, &c. In these, it is of importance to exercise the left hand and arm fully more than the right, in order to make them as active and strong.

Indian Club Exercises.

The pupil having advanced in simple personal exercises, is supposed to be somewhat strengthened; and to further the operation, he proceeds to the Indian club exercises. The main object is to expand the chest, and increase the power of the arms. For this end, some sedentary persons regularly exercise themselves with dumb-bells; that is, heavy pieces of metal, one being held in each hand. The club exercise is an improvement on that of the dumb-bells. The club bears a resemblance to the bat for cricket, and varies in weight from two to twelve pounds. One is used in each hand. The following, according to Torrens, are the regulation-exercises now adopted in the army:—

"The recruit being placed in the position of attention, with a club in each hand pointing downwards, as in fig. 4, must be exercised as follows:—

Fig. 4.

"*First Part.*—1. At the word *one*, the club in the right hand is slowly carried round the head, until the hand arrives in a perpendicular line above the shoulder, with the large end of the club pointing in a diagonal direction to the rear; 2. The club in the left hand is raised in a similar manner, and carried over that in the right hand till it reaches a corresponding position; 3. The hands are carried slowly to the right and left, until they become in a true horizontal line with the shoulders, the large ends of the clubs still remaining to the rear; 4. The hands are brought slowly to the first position. Care must be taken that the recruit does not stand with a hollow back during this and the succeeding practice.

"*Second Part.*—1. Raise both hands to the front, approaching them close together, in horizontal line with the shoulders, the clubs being held perpendicular, with the large ends upwards; 2. With the body well poised forward, separate the hands, and carry them to the right and left line with the shoulders, the large ends of the clubs remaining upwards; 3. With the head well kept up, let the clubs turn over till they point in a diagonal direction to the rear, the hands still remaining out in a line with the shoulders; 4. With the arms extended, drop them slowly to the first position.

Fig. 5

"*Third Part.*—1. The club in the right hand is circled round upon the *right* of the body for a few revolutions of the circle, or until the word *halt* is given; 2. The one in the left hand is used in the same manner on the *left* of the body, until the word *halt* is given, when the recruit will remain perfectly steady in the first position; 3. With the body rather leaning forward, circle both clubs at the same time, on the right and left of the body, until ordered to halt."

Leaping.—Vaulting.

The simplest kind of leaping is that of jumping on level ground from one point to another, with or without a run. The run accumulates power in the person, or momentum, and enables a person to leap considerably farther than without such an aid. "In all kinds of leaping," observes Walker, in his "Manly Exercises," "it is of great importance to draw in and retain the breath at the moment of the greatest effort, as it gives the chest more solidity to support the rest of the members, impels the blood into the muscular parts, and increases their strength. The hands, also, should be shut, and the arms pendant. The extent of the leap in height, or horizontally, is proportioned to the power employed and the practice acquired. As it is performed with facility only in proportion to the strength exerted, and the elasticity and suppleness of the articulations and muscles of the lower extremities, much exercise is necessary to attain that degree of perfection which lessens all obstacles, and supplies the means of clearing them without danger. Lightness and firmness are the qualities necessary for leaping; every thing should be done to acquire these two qualifications, for without them leaping is neither graceful nor safe." Pupils begin by leaping short distances and no great height, and as they become expert, the feat is increased. To regulate the exercise, a leaping stand is employed; it consists of two movable posts, about six feet high, having, above eighteen inches from the ground, holes bored through them, at the distance of an inch from each other; a rope stretched across from pins, and held tight by sand-bags, is the bar to be leaped over.

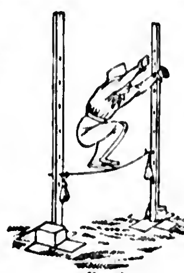


Fig. 6.

In leaping *without* a run, hold the legs and feet closed, bend the knees well up, hold forward the head, and throw out the hands, as in fig. 6. Skill in throwing forward the body with a jerk, thus doubled up, is only acquired by experience. Let great care be taken to descend with an inclination forward, and to fall on the fore part of the feet, so as to touch the ground lightly, and by the spring of the feet and limbs, to deaden the shock.

In leaping *with* a run, the run preceding the leap should never exceed ten paces; the rise into the air to take place at a distance from the cord equal to half the height of the chord from the ground. Skill should be attained in leaping from either foot, or from the spring of both feet. It is considered a good leap when five feet are cleared; a first-rate one is five and a half; and an extraordinary one six feet; few, however, ever reach more than four feet.

What is gained in height is lost in distance. To make a long leap, therefore, it is not necessary to go high. The measurement of long leaps is by marks on level and soft ground, and he who clears the greatest number of marks is the most proficient. As in high leaping, the body must be inclined forward, and the spring made from the balls to the toes. To clear twelve feet without a run is considered a good leap. With a run of ten to fifteen paces, increased in velocity as the runner approaches the springing point, a leap may be performed of fourteen or fifteen feet. In this running leap, it is best to spring from the foot in which there is most proficiency, and to rise to a moderate height from the ground; too low a spring defeats the desired end.

Leaping from a high to a low situation is another useful exercise. To acquire proficiency in it, begin with moderate heights, and learn to fall softly on the balls of the toes, or fore-part of the feet. If the fall be upon the heels, the whole body may be jarred, and the legs stove. Keep the body compact in the descent, with the hands well forward, so that, when alighting, the person will spring lightly up from a crooked posture.

Vaulting is that kind of leaping in which the body is helped forward by a momentary leaning on an object by the hands. The art of vaulting may prove useful in many circumstances in life, as, for instance, in getting quickly over a paling, fence, or gate to elude danger. Exercises are performed with vaulting bars, of which an illustration is given in fig. 7; they are of various heights, and some are shaped like a horse with a saddle.

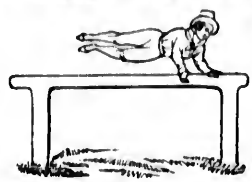


Fig. 7.

Vaulting is performed with or without a run. The spring, as usual is from the toes; and resting the hands on the bar, the legs are raised, and by a jerk pitched over to the other side. The pupil is to learn to vault in this manner, either towards the left or right. When perfect in the exercise, he learns to vault straight forward over the bar, between his hands, in which feat very great skill is necessary in doubling up the body during the spring. The methods of vaulting on and off horse-blocks are innumerable.

Leaping with a pole is a combination of simple leaping and vaulting, and is also a most useful and an elegant accomplishment. The pole should be smooth, light, and from seven to ten feet long. Held in the hands, as represented in fig. 8, the left hand below and the right above, the pole is planted with its lower point on the ground, and by a spring from the left foot, the body is impelled through the air to the desired distance.


Fig. 8.

In performing this exercise, the pupil must learn not to lean too much on the pole, and not to keep too close to it. The knack of pole-leaping is, like all other kinds, dependent on the spring of the feet, and the presence of mind in throwing the body forward lightly and gracefully. The best plan is to begin with short leaps across ditches, and to increase the distance afterwards. When the method of springing from a fixed situation is acquired, proceed to advanced practice by making a run, a quick plant of the pole, and a spring to a considerable distance, as across a brook of twelve or fifteen feet in width.

The next step is to learn to vault over a high object by means of the pole. Two posts and a cross cord, as in fig. 9, are usually employed in this exercise. The leap is taken by a run, and "upon this run," observes Walker, "principally depend the facility and success of the leap. As the spring can take place only with one foot, and as this must arrive correctly at the springing place, it is necessary that the order of the steps should be arranged so as to effect this object. The fixing of the pole in the ground and the spring must take place at the same instant,

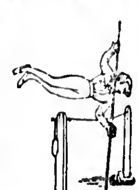


Fig. 9.

because by that means the upper and lower members operate together; no power is lost, and the swing is performed with the greatest facility. The leaper must carefully observe that the spring of the foot, and the plant of the pole, are in the direction of the preparatory run."

Carrying Weights.

A regular course of gymnastics embraces the art of lifting and carrying weights; but lessons in these exercises must be conducted with much caution, and only when the body has been otherwise well disciplined.

In lifting a weight, power is best exercised by doubling the body, as if about to sit down; the hands then grasp the ring of the weight placed between the feet, and the body gradually straightening, the arms rise with it and lift what is in the hands. By this means the whole force of the body is exerted, and no part more than another.

Loads of any kind are most advantageously borne on the back and shoulders, with the body erect. The arrangement of knapsacks on the backs of soldiers is on this plan, the weight depending from each shoulder, and not hanging too low. The more close the load is to the shoulder, the shorter is the lever, and the less the pull on the point of resistance.

A man exercises his power of draught with the greatest advantage by pulling a rope over his shoulder, for in this case he throws forward the weight of his person, and he acts both by muscular energy and weight. The least advantageous exercise of his power is to carry a load up a ladder; for he has to carry up his own weight as well as the load which is on his shoulders.

Running—Walking.

The art of walking with ease, firmness, and grace, forms a necessary part of gymnastic or drill exercises. Few persons walk well naturally; the constraint of dress, distortion from labour, or bad habits of some kind generally contributing to give a slounge to the figure, and an awkwardness to all the motions.

To walk gracefully, the body must be erect, but not stiff, and the head held up in such a posture that the eyes are directed forward. The tendency of untaught walkers is to look towards the ground near the feet; and some persons appear always as if admiring their shoe-ties. The eyes should not thus be cast downward, neither should the chest bend forward to throw out the back, making what are termed "round shoulders;" on the contrary, the whole person must hold itself up, as if not afraid to look the world in the face, and the chest by all means be allowed to expand. At the same time, every thing like strutting or pomposity must be carefully avoided. An easy, firm, and erect posture, are alone desirable. In walking, it is necessary to bear in mind that the locomotion is to be performed entirely by the legs. Awkward persons rock from side to side, helping forward each leg alternately by advancing the haunches. This is not only ungraceful but fatiguing. Let the legs alone advance, bearing up the body. In setting down the feet, let the outer edge of the heel first touch the ground, and the sole of the foot bear and project the weight of the body. The length of step is of course to be determined by the length of limb. Efforts at taking long steps, out of proportion to the power of motion, are always ungraceful. Reckoning from heel to heel, or toe to toe, the length of a military step at drill march is thirty inches, which is considerably more than the length of ordinary steps in walking. The length of step at a moderate pace, of a man five feet nine inches high, is usually twenty-four inches; and this will be found a convenient length to acquire the habit of using.

The motion of the arms to and fro, in cadence with the movements of the legs, greatly helps the locomotion, and is advantageous in exercising the muscles of the shoulders and expanding the chest. The motions of the arms, however, should be on a moderate scale, the hands not swinging through a greater space than eight or nine inches before and behind the leg. The practice of working forward the shoulders and swinging the arms at a great rate is most odious. It may be added, that the art of comporting the hands, keeping them down, or from middling with the person, is one very necessary in polite behaviour, and should be acquired by all young persons, before bad habits are confirmed.

Running is a rapid leaping kind of walk, the leap being from each foot alternately, and the motion being promoted by throwing forward the weight of the person. The following are Walker's definitions of running, which we illustrate by fig. 10:—"The upper part of the body is slightly inclined forward; the head slightly thrown backward, to counteract the gravity forward; the breast is freely projected; the shoulders are steady, to give a fixed point to the auxiliary muscles of respiration; the upper parts of the arms are kept near the sides; the elbows are bent, and each forms an acute angle; the hands are shut, with the nails turned inwards; and the whole arms move but slightly, in order that the muscles of respiration on the chest may be as little as possible disturbed, and follow only the impulse communicated by other parts. There exists, in fact, during the whole time of running, a strong and permanent contraction of the muscles of the shoulder and arm, which, though very violent, is less serviceable to the extended movements than to keep the chest immovable, toward which the arms are brought close, the flexors and adductors of which are especially contracted.

Fig. 10.

"At every step the knees are stretched out, the legs kept as straight as possible, the feet almost graze the ground, the tread is neither with the mere balls of the toes nor with the whole sole of the foot, and the spring is made rapidly from one foot to the other, so that they pass each other with great velocity.

"Speed, and still more duration in running, are in proportion to the development of the lungs, and consequently the volume of oxygen and blood which they can combine in their parenchyma at each respiratory movement. Thus, of two men, one having the abdominal members developed, and the other possessing good lungs, the former will run with the greatest speed for a short distance; but if the distance be considerable, he will soon be gained upon by the latter. A runner, after performing a certain space, is seized with a difficulty of breathing, long before the repetition of the contractions has produced fatigue in the abdominal members. To excel, therefore, in running, requires, like walking and dancing, a peculiar exercise. As the muscular contractions depend, for the principle of excitement, on the respiration, the chest should be firmly fixed, so as both to facilitate this and to serve as a point of support for the efforts of the lower members. The best runners are those who have the *best wind*, and keep the breast dilated for the longest time.

"During the whole time of running, long inspirations and slow expirations are of the greatest importance; and young persons cannot be too early accustomed to them. To facilitate respiration towards the end of the race, the upper part of the body may be leant a little forward. Running should cease as soon as the breath becomes very short, and a strong perspiration takes place."

Exercises in running should commence with very moderate distances, and for short periods of time; and great or fatiguing feats are only to be attempted after the body and lungs are strengthened by training.

TRAINING.

The method of training in modern times for pedestrian feats and other laborious undertakings, does not differ materially from that pursued by the ancient Greeks. The great object is to increase the muscular strength, and to improve the free action of the lungs or wind of the person subjected to the process. The means adopted to accomplish the end in view is evacuation, to cleanse the stomach and intestines; sweating, to take off the superfluous fat and humours; daily exercise, to strengthen the muscles and system generally; and a peculiar regimen to invigorate the body. And to this we add the use of the tepid bath, to remove impurities and promote a healthy action to the skin. We present the following graphic account of the process of training, from "Walker's Manly Exercises:"—

"The most effectual process for training appears to be that practised by Captain Barclay, which has not only been sanctioned by professional men, but has met with the unqualified approbation of amateurs. We are here, therefore, almost entirely indebted to it for details. According to this method, the pedestrian, who may be supposed in tolerable condition, enters upon his training with a regular course of physic, which consists of three doses. Glauber's salts are generally preferred; and from one ounce and a half to two ounces are taken each time, with an interval of four days between each dose. After having gone through the course of physic, he commences his regular exercise, which is gradually increased as he proceeds in the training.

"When the object in view is the accomplishment of a pedestrian match, his regular exercise may be from twenty to twenty-four miles a day. He must rise at five in the morning, run half a mile at the top of his speed up hill, and then walk six miles at a moderate pace, coming in about seven to breakfast, which should consist of beef-steaks or mutton-chops under-done, with stale bread and old beer. After breakfast, he must again walk six miles at a moderate pace, and at twelve lie down in bed, without his clothes, for half an hour. On getting up, he must walk four miles, and return by four to dinner, which should also be beef-steaks or mutton chops, with bread and beer, as at breakfast. Immediately after dinner, he must resume his exercise, by running half a mile at the top of his speed, and walking six miles at a moderate pace. He takes no more exercise for that day, but retires to bed about eight; and next morning he proceeds in the same manner.

"Animal diet, it will be observed, is, according to this system, alone prescribed, and beef and mutton are preferred. All fat and greasy substances are prohibited, as they induce bile, and consequently injure the stomach. The lean of meat contains more nourishment than the fat; and in every case the most substantial food is preferable to any other kind. Fresh meat is the most wholesome and nourishing. Salt, spiceries, and all kinds of seasonings, with the exception of vinegar, are prohibited. The lean, then, of fat beef cooked in steaks, with very little salt, is the best; and it should be rather under-done than otherwise. Mutton, being reckoned easy of digestion, may be occasionally given, to vary the diet and gratify the taste. The legs of fowls are also esteemed.

"It is preferable to have the meat broiled, as much of its nutritive quality is lost by roasting or boiling. It ought to be dressed so as to remain tender and juicy; for it is by these means that it will be easily digested, and afford most nourishment. Biscuit and stale bread are the only preparations of vegetable matter which are permitted to be given; and every thing inducing flatulency must be carefully avoided. In general, the quantity of aliment is not limited by the trainer, but left entirely to the discretion of the pedestrian, whose appetite should regulate him in this respect.

"With respect to liquors, they must be always taken cold; and home-brewed beer, old but not bottled, is the best. A little red wine, however, may be given to those who are not fond of malt liquor; but never more than half a pint after dinner. It is an established rule to avoid liquids as much as possible; and no more liquor of any kind is allowed to be taken than is requisite to quench the thirst.

"After having gone on in this regular course for three or four weeks, the pedestrian must take a four mile sweat, which is produced by running four miles in flannel at the top of his speed. Immediately on returning, a hot liquor is prescribed, in order to promote the perspiration; and of this he must drink one English pint. It is termed the sweating liquor, and is composed of one ounce of carraway seed, half an ounce of coriander seed, one ounce of root-liquorice, and half an ounce of sugar-candy, mixed with two bottles of cider, and boiled down to one-half. He is then put to bed in his flannels, and being covered with six or eight pair of blankets and a feather-bed, must remain in this state from twenty-five to thirty minutes, when he is taken out, and rubbed perfectly dry. Being then well wrapt in his greatcoat, he walks out gently for two miles, and returns to breakfast, which, on such occasions, should consist of a roasted fowl. He afterwards proceeds with his usual exercise.

"These sweats are continued weekly till within a few days of the performance of the match; or, in other words he must undergo three or four of these operations. If the stomach of the pedestrian be foul, an emetic or two must be given about a week before the conclusion of the training. He is now supposed to be in the highest condition.

"Besides his usual or regular exercise, a person under training ought to employ himself in the intervals in every kind of exertion which tends to activity, such as golf, cricket, bowls, throwing quoits, &c., so that, during the whole day, both body and mind may be constantly occupied. Although the chief parts of the system depend upon sweating, exercise, and feeding, yet the object to be attained by the pedestrian would be defeated, if these were not adjusted each to the other, and to his constitution. The trainer, before he proceeds to apply his theory, should make himself acquainted with the constitution and habits of his patient, that he may be able to judge how far he can with safety carry on the different parts of the process. The nature of the patient's disposition should also be known, that every cause of irritation may be avoided; for, as it requires great patience and perseverance to undergo training, every expedient to soothe and encourage the mind should be adopted.

"The skilful trainer will, moreover, constantly study the progress of his art, by observing the effect of its processes, separately and in combination. If a man retain his health and spirits during the process, improve in wind and increase in strength, it is certain that the object aimed at will be obtained; but if otherwise, it is to be apprehended that some defect exists, through the unskilfulness or mismanagement of the trainer, which ought instantly to be remedied by such alterations as the circumstances of the case may demand. It is evident, therefore, that in many instances the trainer must be guided by his judgment, and that no fixed rules of management can, with absolute certainty, be depended upon for producing an invariable and determinate result. In general, however, it may be calculated that the known rules are adequate to the purpose, if the pedestrian strictly adhere to them, and the trainer bestow a moderate degree of attention to his state and condition during the progress of training.

"It is impossible to fix any precise period for the completion of the training process, as it depends upon the previous condition of the pedestrian; but from two to three months, in most cases, will be sufficient, especially if he is in tolerable condition at the commencement, and possessed of sufficient perseverance and courage to submit cheerfully to the privations and hardships to which he must unavoidably be subjected. The criterion by which it may be known whether a man is in good condition—or, what is the same thing, whether he has been properly trained—is the state of the skin, which becomes smooth, elastic, and well coloured, or transparent. The flesh is also firm, and the person trained feels himself light and full of spirits. In the progress of the training, his condition may also be ascertained by the effect of the sweats, which cease to reduce his weight, and by the manner in which he performs one mile at the top of his speed. It is as difficult to run a mile at the top of one's speed as to walk a hundred; and therefore, if he performs this short distance well, it may be concluded that his condition is perfect, or that he has derived all the advantages which can possibly result from the training process."

PEDESTRIAN FEATS.

Prepared by training, and acting under certain precautions as to food and rest, a person may perform very surprising feats of pedestrianism. He may, for instance, completely out-travel a horse, by walking for days continuously from thirty to forty miles, and yet be as fresh at the end of his journey as at the beginning. Without preparatory training, however, the most fatal injuries may be committed in attempting pedestrian feats. We must offer some precautionary advices on this subject.

Advices to Young Men on Walking Excursions.

Young men who break away from regular, and perhaps sedentary, employment, to take a walking excursion of a few days in the country, often commit such grievous errors as mar their enjoyments, and deprive themselves of all the benefit they had calculated upon as the proper result of an exemption from ordinary duty. With soft and relaxed frames, they, in many instances, address themselves to walk such a distance each day as only could be conveniently walked by a person accustomed to such tasks. Accordingly, by the end of the second day at farthest, their feet are all over blisters, their strength is completely exhausted, and their whole system is in a fever of nervous agitation, the consequence of enormous voluntarily incurred suffering. The next morning, perhaps, sees them a little recovered, and, with their small stock of renewed strength, soaped stockings, and a vigorous resolution, they set out upon the third day's travel, which probably concludes by leaving them in a worse state than before. There is no time, however, to wait for a perfect recovery; so they travel on, and probably complete their excursion in a miserable dragging fashion, glad to get over the country without enjoying it, so that they only have the prospect of being again speedily at home and at rest.

This is the unavoidable consequence of ignorance and want of reflection. The excursion might have been a source of pleasure instead of pain, and might have added considerably to the youth's stock of ideas, instead of leaving him disgusted with the country and with nature, if he had only proceeded upon right principles. He ought to know that the body, after being long under the influence of a sedentary profession, or of ordinary city life, is not in a state fit for undertaking great fatigue. When soldiers, after being a considerable time in garrison, are about to undertake a long march, they usually are led out to take short walks each day for about a week beforehand, every day's walk lengthening a little, until they become fitted for the serious task. This they call being *beat into a march*. It is a practice founded on right physiological principles, and worthy of being followed by every individual in like circumstances. In the walks of the first two or three days, young pedestrians should not set themselves to any certain number of miles, but only walk as far as they feel their strength will agreeably carry them. Thus they will gradually acquire power, instead of losing it, and in the long run become good walkers, enjoying the country, moreover, as they go along, and leaving off with an increased love of nature, and a disposition to have another such walk at the first opportunity.

Young travellers, and old ones too, often make a great mistake with regard to eating. They suppose that, having much fatigue to undergo, they ought to eat a great deal; and the excitement of novelty, and the tempting and unusual food presented at inns, enable them to carry out this idea into practice. In a few days, however, they find themselves unaccountably unwell. This is the consequence of simple over-eating, for in travelling there is no need for more food than usual. Food is also taken at wrong times, and of wrong kinds. It is not uncommon for young pedestrians to walk ten or twelve miles before breakfast, not so much for any economy of time or money, as under the impression that they will have a capital appetite at the end of their walk. As they go along, they delight themselves with reflections as to how they will astonish the waiters, how fresh relays of eggs will be called for, and rolls vanish like morning dreams. Alas! when they have walked their dozen miles, their frames are in a state the most unsuited for the receipt of a full meal; and if they are *able* to eat largely, it will be the worse for them after. The whole aim here is the very reverse of what it ought to be. A very full meal should never be taken on a pedestrian excursion, and that simply for the reason that there is no time to digest a very full meal. A breakfast or dinner during a walking excursion, when only a little time can be allowed for rest afterwards, should be light. Whether light or heavy, the longer the rest afterwards the better—that is, of course, within a reasonable limit. Certainly the rest should not be less than three quarters of an hour; and if a heavy meal have been taken, half an hour longer will be required at the very least.

Many young travellers have the prudence to fare slightly during their day's walk, but, on getting to their inn in the evening, they make all up, as they think, by taking a great composite meal—dinner, tea, and supper, rolled into one. If, as often happens, this be taken pretty late, the tea keeps them awake half the night, by virtue of its exciting power. But it may act injuriously in another way. When much of it is taken in proportion to the solids, it prevents digestion. The gastric juice, it must be understood, requires that what is submitted to it should possess a certain solidity. It is for this reason that nature has so arranged, in the case of sucking infants, that the milk curdles immediately after being taken, the gastric juice being thereby enabled to catch hold of it. When a young man, after exhausting his energies by a long walk, fills his stomach with a great *blashy* meal, he commits one of the greatest of imprudences. The gastric juice gets mixed and confounded with the mass, and several hours will elapse before any progress whatever be made in digestion. Many is the sleepless night endured on this account on summer excursions. It is obviously necessary that, if tea is to be taken at all at a late hour, it should be weak, and in quantity strictly proportioned to the solids taken at the same time. Weak coffee, however, ought always to be preferred to tea, if to be taken near bedtime, as its exciting power is much less.

The rules here laid down are all of them grounded on natural principles, which will be found more particularly explained in physiological works—Those, for instance, of Dr. Combe, which are by far the most intelligibly written, at the same time that they are even more philo sophical than most others. By attending to such rules, a rural excursion may be made very delightful, and may have the best effects on both body and mind, while neglect of them as certainly must entail pain and disappointment.

Captain Barclay's Feats of Walking.

Captain R. Barclay Allardice, of Ury, an enthusiastic cultivator of manly sports, is well known as having some years ago performed various remarkable feats of pedestrianism, and his mode of walking is well worthy of notice. Pierce Egan thus writes of his performances:—"His style of walking is to bend forward the body and throw its weight on the knees. His step is short, and his feet are raised only a few inches from the ground. Any person trying this plan will find his pace quickened, and he will walk with more ease to himself, and be better able to endure the fatigue of a long journey, than by walking perfectly erect, which throws too much of the weight of the body on the ankle-joints. He always uses thick-soled shoes and lambs'-wool stockings, which preserve the feet from injury."

We have not space to conclude an account of the various extraordinary feats performed by this able pedestrian, and shall only notice his famous match with Mr. Webster, in October, 1808. "The captain engaged himself to go on foot a thousand miles in a thousand successive hours, at the rate of a mile in each and every hour, for a bet of one thousand guineas, to be performed at Newmarket heath, and to start on the following first of June. In the intermediate time, the captain was in training by Mr. Smith, of Owston, in Yorkshire. He started on his match at twelve o'clock at night on Thursday, the 1st of June, in good health and high spirits. His dress, from the commencement, varied with the weather. Sometimes he wore a flannel jacket, sometimes a loose gray coat, with strong shoes, and two pair of coarse stockings, the outer pair boot-stockings, without feet, to keep his legs dry. He walked in a sort of lounging gait, without any apparent extraordinary exertion, scarcely raising his feet two inches above the ground. During a great part of the time the weather was very rainy, but he felt no inconvenience from it; indeed, wet weather was favourable to his exertions; as, during dry weather, he found it necessary to have a water-cart to go over the ground to keep it cool, and prevent it becoming too hard. Towards the conclusion of the performance, it was said, the captain suffered much from spasmodic affection of his legs, so that he could not walk a mile in less than twenty minutes; he, however ate and drank well, and bets were two to one and five to two on his completing his journey within the time prescribed. About eight days before he finished, the sinews of his right leg became much better, and he continued to pursue his task in high spirits, and consequently bets were ten to one in his favour in London, at Tattersall's, and other sporting circles.

"On Wednesday, July the 12th, Captain Barclay completed his arduous undertaking. He had till four P. M. to finish his task, but he performed the last mile by a quarter of an hour after three in perfect ease and great spirit, amidst an immense crowd of spectators. The influx of company had so much increased on Sunday, that it was recommended that the ground should be roped in. To this, however, Captain Barclay objected, saying, that he did not like such parade. The crowd, however, became so great on Monday, and he had experienced so much interruption, that he was prevailed upon to allow this precaution to be taken. For the last two days he appeared in higher spirits, and performed his last mile with apparently more ease, and in a shorter time, than he had done for some days past.

"With the change of weather he had thrown off his loose greatcoat, which he wore during the rainy period, and walked in a flannel jacket. He also put on shoes thicker than any which he had used in the previous part of his performance. When asked how he meant to act after he had finished his feat, he said he should that night take a good sound sleep, but that he must have himself awaked twice or thrice in the night to avoid the danger of a too sudden transition from almost constant exertion to a state of long repose. One hundred guineas to one, and, indeed, any odds whatever, were offered on Wednesday morning; but so strong was the confidence in his success, that no bets could be obtained. The multitude who resorted to the scene of action, in the course of the concluding days, was unprecedented. Not a bed could be procured on Tuesday night at Newmarket, Cambridge, Bury, or any of the towns or villages in the vicinity, and every horse and vehicle was engaged. Among the nobility and gentry who witnessed the conclusion of this extraordinary performance, were the Dukes of Argyle and St. Albans; Earls Grosvenor, Besborough, and Jersey; Lords Foley and Somerville; Sir John Lade, Sir F. Standish, &c., &c. The aggregate of the bets is supposed to have amounted to £100,000. Upon the whole, Captain Barclay must be viewed as a most extraordinary man, and shows the extent of vigour that the human frame derives from exercise."

OUT-OF-DOOR RECREATIONS.

SWIMMING.

The art of swimming is so exceedingly useful, not only as a bracing summer exercise, but as a means of preserving life when accidentally plunged into the water, that it should be acquired by every young person. It may be performed either in the sea or in rivers; but the sea is preferable, as salt water is of greater specific gravity than fresh, and has the greater power of buoying up the body. Whether in fresh or salt water, however, the body is lighter, bulk for bulk, than the mass of liquid displaced, and consequently will float if a small aid be given by the impulsion of the hands. It is also important to observe, that the more the body is immersed in the water, the more easily is it sustained. Thus, if only the face is left above the surface, the buoyancy will be much greater than if the whole head or the head and hands were exposed. When persons unskilled in swimming are plunged into the water, as, for instance, by the upsetting of a boat, they ought, for the reasons now mentioned, not to struggle, splutter, and hold the hands up, but remain tranquil, with as little above water as possible; draw in the breath so as to fill the lungs, and sustain themselves by a paddling motion with the hands.

Practical Directions for Swimming.

The best season for bathing in the sea or rivers is summer and autumn, and the time of day most preferable is the morning before breakfast; the next best time is before dinner. Immediately after dinner, or when the stomach is full, is injurious. A person, also, should never bathe twice in one day, or continue in the water more than twenty minutes at one time. To avoid the danger of propelling the blood to the head, by stepping suddenly into cold water, always wet the head first. Bathing is best performed when entirely naked; but if this be unsuitable, short drawers may be used.

Young persons or others unskilled in swimming should not on any account go beyond the depth of breast-high, till they are able to buoy themselves up freely. They can commence their lessons in swimming by throwing themselves forward, and trying what will be the effect of a throwing out of hands and feet, keeping only the head above the surface. Some persons tie corks or bladders about their neck or breast, but this we discommend as dangerous. A preferable plan of learning to swim is to receive the aid of a person skilled in the art, who will help to buoy up the learner with his hand, and withdraw his assistance gradually. In ordinary circumstances, however, any young person may acquire the art himself.

The learner having thrown himself forward, he must draw his head back, elevate his chin clear of the surface, project his breast, hollow his back, and be firm and collected. Fear must be entirely thrown aside. Instead of putting down the hands, as if to grope for something, which is a very common error, throw the hands boldly forward, and strike out with them. The plan of doing this is first to bring the hands together, with the fingers close, and the thumbs closed to the forefingers; then strike out with the palms undermost and slightly hollowed. The hands must not touch the surface in striking, but make a sweep level with the breast, and as far out as possible. Next, they are to be drawn back with a rapid movement; in this retraction, the elbows are to be bent and the hands drooping downwards, so that as little obstacle as possible may be presented to the water. The hands being brought together as before, they are to be struck out in the same manner; and so on.

The hands furnish only half the means of advancing. The other half are the legs, which must be sent out behind with a jerk to their full extent, the soles pushing against the water. The position of the swimmer in the water is indicated in the adjoining cut, fig. 11, in which

Fig. 11.

it will be seen that the body slopes from the neck to the feet. To advance properly, and secure regular buoyancy, the hands and feet must act alternately, the arms descending while the legs are rising, and the arms rising while the legs are descending.

Besides regulating the action of the hands and feet, the swimmer must regulate his breathing. The breath is to be inhaled when the body is rising by the descent of the hands, and when the mouth is clearly above the ruffle of the water. This fills the chest with air at the moment most advantageous to do so. The breath is to be expended at the next impulse forward by the legs. Some persons, in learning to swim, acquire the habit of *breasting*, or rising high out of the water at every stroke of their arms; this mode of swimming is not only ungraceful but fatiguing; a good and tasteful swimmer advances smoothly through the water, with a moderate rise, and at a moderate and steady rate of speed.

There are various fanciful modes of swimming; one of these is swimming with the back downwards, as represented in fig. 12. In this case the head is more immersed than in ordinary swimming, and consequently less labour is required to buoy up the body. The method employed is to lie gently back in the water, with the hands on the thighs, and to strike out the legs as in front swimming. By swimming on the back little progress is made; and it is chiefly useful as a relief to the arms.

Fig. 12.

Another means of relieving the fatigue of swimming is to float on the back with a very gentle motion of the legs, in the position represented in fig. 13. The arms are extended, the chin and mouth elevated higher than the forehead; and the water is to be agitated as little as possible, so as not to enter the mouth.

Fig. 13.

Swimming with one arm is sometimes useful. To perform this feat, the head should be held more backward than usual; the swimmer hold himself more erect; the legs and arm must be exercised pretty quickly; and with force the hand should be struck out against the body, and so brought down before, the arm extended its full length for every stroke. The swimmer must, however, be very careful to keep his breast inflated, as this mode of swimming requires more than ordinary dexterity. Should the swimmer draw in his breast imprudently, when his arms are raised, he would immediately sink to the bottom.

Diving is the art of descending rapidly in the water, and requires to be done with address. The best method consists in drawing in the breath, placing the two hands together as a cut-water in front, and then to plunge head foremost, causing the forehead to receive the force of the fall. In taking the water, the eyes, for safety, should be shut; but they may be opened when beneath the surface, when the body assumes the swimming attitude. Swimming below the water is so exceedingly easy that it requires no directions.

Mr. Frost, in his small work on "Scientific Swimming," presents the following practical rules for sportive swimming:—"To spin with ease, the person should be somewhat buoyant; the breast must be well inflated, and the attitude may be that of sitting with the feet crossed. It is effected by embracing the water with each hand, alternately, on the same side. In order to turn to the right, the water must be embraced with each hand, alternately, on the right side; and to turn to the left, on the left side. . This action causes a circular or spinning movement, which increases in velocity as it is continued. Of all the playful ways of swimming he ever knew, the author considers this to be the most curious. He has seen boys sportively rolling along the stream, and conceived it very much to resemble the juvenile amusement, on a summer day, of rolling down a declivity. The stream is the most favourable situation for rolling, as it very much assists the turn. To achieve this, the person must lay himself straight across the current; he must inflate his breast, and hold his head very backward; his legs may either lie together or be crossed; he must exercise his hands in the same manner as in spinning. By this alternate action of the hands, with the assistance of the stream, some persons will roll along in a pleasing and extraordinary manner." He then mentions quadruped swimming; but neither the posture nor action is agreeable.

In some cases cramp takes place in the water, and the swimmer requires to be prepared for its attacks. The following directions by Walker, acted upon with due self-possession, comprise all that need be said on this subject:—

"As to cramp, those chiefly are liable to it who plunge into the water when they are heated, who remain in it till they are benumbed with cold, or who exhaust themselves with violent exercise. Persons subject to this affection must be careful with regard to the selection or the place where they bathe, if they are not sufficiently skilful in swimming to vary their attitudes, and dispense instantly with the use of the limb attacked by cramp. Even when this does occur, the skilful swimmer knows how to reach the shore by the aid of the limbs which are unaffected, while the uninstructed one is liable to be drowned.

"If attacked in this way in the leg, the swimmer must strike out the limb with all his strength, thrusting the heel downward and drawing the toes upward, notwithstanding the momentary pain it may occasion; or he may immediately turn flat on his back, and jerk out the affected limb in the air, taking care not to elevate it so high as greatly to disturb the balance of the body. If this does not succeed, he must paddle ashore with his hands, or keep himself afloat by their aid, until assistance reach him. Should he even be unable to float on his back, he must put himself in the upright position, and keep his head above the surface by merely striking the water downward with his hands at the hips, without any assistance from the legs."

SKATING.

This is a highly exhilarating and healthful out-of-door pastime in winter, when rivers and ponds are frozen, and offer a clear surface of ice. The art of skating consists in poising the body on a sharp ridge of iron beneath the sole of the foot, and advancing on the ice in that position, one foot relieving another. As a very slender base will support any mass of matter kept in motion, skating is by no means a difficult art, and requires only courage, quickness of eye, and delicacy of taste, to render the performances elegant.

A skate is a well-known apparatus of wood and iron, with straps and buckles to attach it to the foot. The skate for each foot must be alike. The iron should not be deeper than three quarters of an inch, and smooth or flat along its under edge; only boys' skates should be grooved, to take better hold of the ice. The iron should be a quarter of an inch thick. The edges should be smooth, free from rust, and sharply ground.

Practical Directions for Skating.

We beg to offer the following directions to the young skater, chiefly from the work of Mr. Walker:—

"Either very rough or very smooth ice should be avoided. The person who for the first time attempts to skate must not trust to a stick. He may make a friend's hand his support, if he require one; but that should be soon relinquished in order to balance himself. He will probably scramble about for a half an hour or so, till he begins to find out where the edge of his skate is. The beginner must be fearless, but not violent, nor even in a hurry. He should not let his feet get far apart, and keep his heels still nearer together. He must keep the ankle of the foot on the ice quite firm; not attempting to gain the edge of the skate by bending it, because the right mode of getting to either edge is by the inclination of the whole body in the direction required; and this inclination should be made fearlessly and decisively.

"The leg which is on the ice should be kept perfectly straight; for though the knee must be somewhat bent at the time of striking, it must be straightened as quickly as possible, without any jerk. The leg which is off the ice should also be kept straight, though not stiff, having an easy but slight play, the toe pointing downwards, and the heel within from six to twelve inches of the other.

"The learner must not look down at the ice, nor at his feet to see how they perform. He may at first incline his body a little forward, for safety, but hold his head up, and see where he goes; his person erect, and his face rather elevated than otherwise.

"When once off, he must bring both feet up together, and strike again, as soon as he finds himself steady enough, rarely allowing both feet to be on the ice together. The position of the arms should be easy and varied, one being always more raised than the other; this elevation being alternate, and the change corresponding with that of his legs; that is, the right arm being raised as the right leg is put down, and *vice versa*, so that the arm and leg of the same side may not be raised together.

"The face must be always turned in the direction of the line intended to be described. Hence in backward skating, the head will be inclined much over the shoulder; in forward skating, but slightly. All sudden and violent action must be avoided. Stopping may be caused by slightly bending the knees, drawing the feet together, inclining the body forward, and pressing on the heels. It may also be caused by turning short to the right or left, the foot on the side to which we turn being rather more advanced, and supporting part of the weight.

"The first attempt of the beginner is to walk, and this walk shortly becomes a sliding gait, done entirely on the inside edge of the skate.

"The first impulse is to be gained by pressing the inside edge of one skate against the ice, and advancing with the opposite foot. To effect this, the beginner must bring his feet nearly together, turn the left somewhat out, place the right a little in advance, and at right angles with it, lean forward with the right shoulder, and at the same time move the right foot onwards, and press sharply, or strike the ice with the inside edge of the left skate—care being taken instantly to throw the weight on the right foot. While thus in motion, the skater must bring up the left foot nearly to a level with the other, and may for the present proceed a short way on both feet.

"He must next place the left foot in advance in its turn, bring the left shoulder forward, inclining to that side, strike from the inside edge of the right skate, and proceed as before.

"Finally, this motion has only to be repeated on each foot alternately, gradually keeping the foot from which he struck longer off the ice, till he has gained sufficient command of himself to keep it off altogether, and is able to strike directly from one to the other, without at any time having them both on the ice together. This must be practised till he has gained some degree of firmness and power, and a command of his balance."

Thus accomplished in the rudiments of the art, the skater may proceed to learn the *forward roll*, which is the first step towards figure skating. "The impulse is gained in the same manner as for the ordinary run; but to get on the outside edge of the right foot, the moment that foot is in motion, the skater must advance the left shoulder, throw the right arm back, look over the right shoulder, and incline the whole person boldly and decisively on that side, keeping the left foot suspended behind. As he proceeds, he must bring the left foot past the inside of the right with a slight jerk, which produces an opposing balance of the body; the right foot must quickly press, first on the outside of the heel, then on the inside, or its toe; the left foot must be placed down in front before it is removed more than about eight or ten inches from the other foot; and by striking outside to the left, giving at the same moment a strong push with the inside of the right toe, the skater passes from right to left, inclining to the left side in the same manner as he did to the right. He then continues to change from left to right, and from right to left, in the same manner. At first he should not remain long upon one leg, nor scruple occasionally to put the other down to assist; and throughout he must keep himself erect, leaning most on the heel."

Having attained this proficiency, there will be little difficulty in describing any figure, formed by a combination of circles or semicircles. The figure 8 is a favourite among clever skaters, and also the figure 3, both forward and reversed.

Skating on ice of doubtful strength is accompanied with great danger, as in an instant the skater may find himself sunk to the neck in water, and be drowned before assistance can be rendered. Much of this danger may be obviated by wearing a *safety-cape*, which is a loose cape inflated with air, the invention of a member of the Edinburgh skating club. We recommend every skater to use by all means a cape of this kind while pursuing his amusement on the ice.

CURLING.

Curling is a game of great antiquity and popularity in the southern and western parts of Scotland. It is a winter game, played on the ice; and where the rivers and ponds are frozen, usually supersedes all other out-of-door amusements. As the ice requires to be much thicker than for skating, it is usual to form ponds so shallow that the whole water in them becomes a frozen mass capable of bearing up any weight.

The game is played by a party forming rival sides, each individual being possessed of a circular hard stone, of about nine inches in diameter, flat and smooth on the under side, and, on the upper, having a handle fixed to the stone. Each player is likewise armed with a broom to sweep the ice, in order to accelerate the progress of the stones; and his feet are ordinarily furnished with trampets, or crampets, which help to steady him in taking his aim. A large long open space of ice, of from thirty to forty yards in length, and eight or nine feet across, called a *rink*, being cleared, and a mark or *tee* being made at each end to play to, the contest takes place by each person hurling or causing his stone to slide towards the opposite end of the rink. A certain number being the game, the object of each side is, which will have the greatest number of stones nearest the tee; and all play from end to end alternately, till this is ascertained. To hurl these stones with precision, in this species of sport, is exceedingly difficult; much depending on the keenness of the frost, the tone of the ice, and the truth of the stone. Sometimes the best and oldest players are baffled by beginners, simply by their curling-stones having taken a bias to one side or another; and frequently, after the best players have placed their stones in a cluster round the tee, one rapid shot from an antagonist will disperse the whole in all directions round. Occasionally it also happens that, in hurling, the stones come far short of the mark; but if they do not get beyond a line, called the *hogg score*, they are dragged aside, and are not counted. A more than usually extensive match is called a *bonspiel.*

Curling.

Such is a meagre outline of the game of curling, which, all over the west and south of Scotland during the keen frosty days of winter, engages all classes of persons in exciting sport. Parish contends against parish, county against county, club against club, in universal mirthful rivalry. At Edinburgh, where there are neither rivers nor ponds, the inhabitants resort for the amusement of curling, as well as skating, to the adjacent beautiful small lake at Duddingstone, lying at the south-eastern base of Arthur Seat. Here a most animated scene is exhibited during the period that the waters of the lake are frozen. Numbers of rinks are cleared, at which may be seen playing together persons in almost every shade of society—professors of the university, clergymen, private gentlemen, merchants, tradesmen, and artisans—all meeting on a common level, and engaged in the same spirit-stirring pursuit; for in curling there is no aristocracy of feeling, and so, for the time, a universal saturnalia prevails. The game of curling is eulogized by more than one Scottish poet, particularly by Grahame who thus commences a description of the sport:—

> "Now rival parishes and shrievedoms keep
> On upland lochs, the long-expected tryst,
> To play their yearly bonspiel. Aged men,
> Smit with the eagerness of youth, are there,
> While love of conquest lights their beamless eyes,
> New-nerves their arms, and makes them young once more."

In Mr. M'Diarmid's "Sketches of Nature," we find the following spirited account of this delightful winter game:—

"The time is not distant when the game of curling was little known out of Scotland, or even within it, benorth the Forth. But the taste for this manly sport has increased greatly of late years; and in various parts of England, as well as America, the broom and the channel-stone are put in requisition with the same regularity that winter comes round.

"In the whole range of rural sports, I know nothing more exhilarating than a *spiel* on the ice, where the players are numerous and well-matched—the stakes a dinner of beef and greens—and the forfeit the honour of rival parishes. All around is blank and dreary—the snow-flake freezes as fast as it falls—the sun seems level with the horizon's verge—the hills make the spectator cold to look at them—and every thing, in one word, conspires to complete the picture of a winter's day. But the courage of men bent on the favourite amusement of curling, is not easily damped by the inclemency of the elements; on the contrary, their spirits seem to mount as the thermometer falls, and nothing pleases them more than a feeding storm, and, along with that, the prospect of a long lease at 'their roaring play.' Arrived at the scene of action, all is bustle and animation, till the stones have been distributed, assorted, claimed—rinks measured, tramps fastened, tees fixed, and the order of battle completely arranged; and as these preliminaries are speedily settled, to it the parties set with all the anxiety of those who contend for a much higher prize. Lots, perhaps, are cast for the first shot, and the greatest novice invited to deliver the first stone; and should his arm lack the proper pith, that instant a dozen brooms are raised to help the laggard over the *hogg score.* A second, a third, a fourth, succeeds, and so on, till the line stretches a tolerable length; and each man is warned by his respective friends to plant, if possible, an excellent guard—dislodge this stone and cover that—open up one port and close another—play soft or strong, outside or inside, as the occasion may require—and steer as closely by the signal broom as the mariner, when warned by similar devices, threads his watery way through sand-banks and shallows.

"As the animating sport deepens, it is amusing to contrast the bustle that obtains in one little spot with the stillness that broods over the external world; while the hills above are silent and dark, the shining lake below is instinct with life, and resounds with sounds of mirth and glee, which, borne along on the elastic air, invade the solemn loneliness that reigns around, till echo itself takes up the tale, and repeats in broken fragments the curler's vocabulary. At length, as the more veteran players advance to decide by their skill the fate of the *side*, the interest becomes intense, and gives rise to so many calculations of what is to be done and what avoided, such bustling to and fro, as must appear a perfect mystery to the uninitiated. The last wary shot hooms athwart the ice as if impelled by magic, and while every port, to an onlooker, seems closed, finds its way under the guidance of a powerful arm and steady eye, through passages rivalling the intricacy of the walls of Troy. Then fol low the shout of victory and the murmur of defeat, till the contest is renewed under the mingled emotions of hope and fear—the vanquished trusting that the tables will be turned, and the conquerors confident that they will remain the same. Speedily the eager players are marshalled, and the brooms put in requisition as before; again the stones boom away and away, meandering here, meeting there, and whirling from the collision like the urchin's top at school; again shot succeeds shot, and game follows game, until the conclusion of the *bonspiel*, or the approach of evening proclaims that it is time the sport should surcease, and the combatants wend their way to the nearest *clachan*, to enjoy their favourite feast of beef and greens. And now the scene changes entirely, though as the savoury viands load the board, all feel the effects of the keen mountain air, and make so good a use of their time while the opportunity serves, that the business of eating becomes nearly as noisy as the business of play; rounds of corn-beef, flagons of home-brewed, disappear with a rapidity that is truly astonishing, and of which no adequate conception can be formed by persons whose appetites were never whetted by a day on the ice."

Laws and Regulations for Curling.

In the year 1838 was instituted the Grand Caledonian Curling-Club, for the purpose of uniting all curlers into a "brotherhood of the rink," and of regulating the game by general laws, which it was hoped would be adopted by all local curling associations. From the Annual published by the club, we extract the following as the rules of the game:—

"1. The length of the rink shall be forty-two yards: any deviation occasioned by peculiar circumstances to be by mutual agreement of parties. When a game is begun, the rink is not to be lengthened nor shortened, unless by consent of the majority of players.

[It is advisable that rinks have double tees at each end, the one at least two yards behind the other, the whole four to be as nearly as possible in the same line. The stones are to be delivered from the outer tee, and played towards the inner; this saves the ice from being injured around the tee played up to.]

"2. The rink shall be changed in all cases when, from the springing of water, the majority of players cannot make up. Neither the winning nor losing party have right to object, as all contests must be decided on the fair and equitable principle of science, not of strength.

"3. The number of shots in a game, if not otherwise mutually fixed upon, shall be twenty-one.

[A game more frequently consists of thirteen shots, or even of seven, than of any others, when an hour or two's practice only is intended; but this is a matter of private arrangement.

In a bonspiel or match, when a considerable number of players appears on each side, the aggregate number of shots gained in a fixed time is not only as equitable a method, but affords amusement to all the rink to the conclusion, and ought to be universally adopted.]

"4. The hogs' score to be one-sixth part of the length of the rink from the tee. Every stone to be considered a hog which does not clear a square placed upon the score.

"5. Every rink to be composed of four players a side, each with two stones, unless otherwise mutually agreed upon. In no case shall the same individual or party play two stones in succession, and every player shall deliver both his stones alternately with an opponent, before any other of the same side or party play one.

"6. Parties to draw cuts which shall fill the ice at the first end; after which the winning party of the last end or game of that day's play shall do so. No stone to be counted which does not lie within seven feet from the tee, unless it be previously otherwise mutually agreed upon. In cases where each party has a stone equally near the tee, neither to be counted, and the winning party of the previous end is again to fill the ice. Measurements to be taken from the centre of the tee to that part of the stone which is nearest it.

"7. Each player to place his feet in such a manner as that, in delivering his stone, he shall bring it over the tee. A player stepping aside to take a brittle (or wick), or other shot, shall forfeit his stone for that end. A player, after delivering his last stone, shall not remain longer than to see his next opponent fit his tee, but shall take his place at the other end between the score and the previous player of his own party; and shall on no account remain to give directions to the next of his party who plays.

"8. If any player shall improperly speak to or interrupt another while in the act of delivering his stone, one shot shall be added to the score of the party so interrupted.

"9. The rotation of play adopted at the beginning must be observed through the whole game.

"10. All curling stones shall be of a circular shape. No stone must be changed throughout the game, unless it happen to be broken, and then the largest fragment to count, without any necessity of playing with it more. If a stone rolls and stops upon its side or top, it shall not be counted, but put off the ice. Should the handle quit the stone in the delivery, the player must keep hold of it, otherwise he will not be entitled to replay the shot.

"11. If a player plays out of turn, the stone so played may be stopped in its progress, and returned to the player. If the mistake shall not be discovered till the stone is again at rest, the opposite party shall have the option to add one to their score, and the game proceed in its original rotation, or to declare the end null and void.

"12. In double-soled stones, the side commenced with shall not, under forfeit of the match, be changed during the progress of the game.

[Double-soled stones are those in which the handle can be shifted from one side to another; one side being slightly concave for keen ice, and the other convex for dull ice.]

"13. The sweeping department to be under the exclusive control of the skipper. No sweeping to be allowed by any party till the stone has passed the hogs' score, except when snow is falling or drifting, in which case it shall be admissible to sweep from tee to tee. The player's party may sweep when the stone has passed the further hogs' score, his adversaries' when it has passed the tee. Sweeping to be always to one side. Previous to each direction being given, either party are entitled to sweep the rink clean.

"14. Parties, before beginning to play, to take different sides of the rink, which they are to keep throughout the game; and no player, on any pretence, to cross or go upon the middle of the rink. The skippers alone to stand about the tee. Their respective parties, according to their rotation of play, shall take their position down to the hogs' score.

"15. If in sweeping, or otherwise, a running stone be marred by any of the party to which it belongs, it shall be put off the ice. If by the adverse party, it shall be placed where the skipper of the party to whom it belongs shall direct. If marred by any other means, the player shall take his shot again. Should a stone at rest be accidentally displaced at any part of the end before the case provided for in rule 13 comes into operation, it shall be put as nearly as possible in its former position.

"16. Every player to come provided with a besom, to be ready to play when his turn comes, and not to take more than a reasonable time to throw his stones. Should he accidentally play a wrong stone, any of the players may stop it while running; but if not stopped till it is again at rest, it shall be replaced by the one which he ought to have played.

"17. No measuring of shots allowable previous to the termination of the end. Disputed shots to be determined by the skippers; or, if they disagree, by some neutral person mutually chosen by them, whose decision shall be final.

"18. Should any played stone be displaced before the last stone is thrown and at rest, by any of the party who are lying the shot, they shall forfeit the end; if by any of the losing party who have the stone yet to play, they shall be prevented from playing that stone, and have one point deducted from their score. The number of shots to be marked by the winners to be decided by the majority of the players, the offender not having a vote.

"19. The skippers shall have the exclusive regulation and direction of the game, and may play in what part of it they please: but having chosen their place at the beginning, they must retain it till the end of the game. The players may give their advice, but cannot control their director; nor are they upon any pretext to address themselves to the person about to play. Each skipper, when his own play comes, shall name one of his party to take charge for him. Every player to follow implicitly the direction given him.

"20. Should any question arise, the determination of which is not provided for by the words and spirit of the rules now established, it may be referred to the three nearest members of the representative committee, unconnected with the disputing parties, who shall form a district committee of reference, and whose decision shall be binding on all concerned till the annual general meeting of the representative committee, to whom either party may appeal the case."

CRICKET.

This is perhaps the best of all out-of-door sports for youth. It requires quickness of mind and eye, great agility of limb, and, properly conducted, is highly exhilarating and amusing. The game is played on an open well-shaven green, which is level and free from stones or shrubs; it should also be dry, and of sufficient dimensions to allow of a good blow to the ball and run—a square field of three or four acres is a good size. The apparatus required in the game consists of balls, bats, and wickets. The dress of the players should be light and easy—a white woollen jacket, cap, linen trousers, and shoes provided in the soles with points to prevent slipping in running; in London there are shoes made purposely for cricketing.

Cricket is played in two distinct forms; one is called *Single Wicket*, and the other *Double Wicket*. We shall first give an outline of Single Wicket.

Single Wicket.—This game is played by a number of persons, but generally *five* are on each party or side. Three straight rods or *stumps*, twenty-seven inches high, are stuck in a row in the ground; on the top of the stumps are laid two pieces of wood called the *bail*, and so placed that they will readily fall off if the stumps be hit by the ball. This apparatus is called the *wicket*. At the distance of four feet four inches in front of the wicket is a mark on the ground, called the *popping-crease*. In a straight line with the wicket is a mark on the ground called the *bowling-crease*, which is parallel to the popping-crease.

An individual taken from one party is appointed *bowler;* his duty is to bowl his ball towards the opposite wicket, which he does by a short run. An individual from the antagonist party is appointed *batter;* his duty is to stand with his bat placed with its tip on the ground at the popping-crease, and to oppose the progress of the ball, or to prevent it from knocking down his wicket. He must also endeavour to strike the ball smartly, so as to send it to a distance on the field. The field is in charge of the party to which the bowler belongs; these are termed *field-men* or *field-keepers*, and each has an appointed place from which he takes a peculiar designation: one is named the *leg-hit*, or *long stop*, another the *off-hit*, a third the *long field on*, a fourth the *long field off*. Their duties are to catch the ball when either struck or missed by the batter.

If the ball be missed by the batter, he remains at his wicket, and the ball is returned by the long stop to the bowler. If the ball be struck, and to such a distance that the batter thinks he could run to the bowling-crease, touching it with his bat, and return to his popping-crease, touching it also before the ball is returned and strikes the wicket, he does so, and if he perform this feat successfully, it is called *one run*, and counts one towards the game. Sometimes he strikes the ball to such a great distance that he can run to and fro twice, and this counts two; if three times, it counts three; and so on. These are termed *runs* or *notches*.

Should the bowler knock down the wicket, the batter retires, and this finishes his *inning*. His inning is also finished by the wicket being knocked down with a ball by any of the field-keepers, if he be off his ground. The inning may likewise be finished if the batter strikes the ball into the air, and it be caught by any of the batter's antagonists before it reaches the ground, and retained long enough to be thrown up again.

Double Wicket, which is considered the true game of cricket, is like two games of single wicket playing at one time, there being two wickets from which to bowl; also two batters, but only one ball. This game is played as above, with this difference, that the batter runs only to the opposite end, exchanging places with the other batter, who is of the same party. The number of persons engaged is properly eleven on each side. As in single wicket, the game is determined by the number of runs made in two innings by each player; the party gaining the greater number of runs being the victor.

Such is an outline of the two kinds of the game; but there are many minute differences in playing in different parts of England, which it would be tedious to describe. It has been conceded by general consent to follow, in case of dispute, the laws and regulations of the "Mary-le-bone Cricket Club," an association in London which has taken a leading part in this truly English sport. The following are the laws of the club:—

"Laws and Regulations of Single Wicket.

"1. When there shall be fewer than five players on a side, bounds shall be placed, at twenty-two yards each, in a line from the off and leg stump.

"2. The ball must be hit before the bounds to entitle the striker to a run; which run cannot be obtained unless he touch the bowling stump or crease in a line with it with his bat or some part of his person, or go beyond them; returning to the popping-crease, as at double wicket, according to the twenty-second law.

"3. When the striker shall hit the ball, one of his feet must be on the ground, and behind the popping-crease, otherwise the umpire shall call 'no hit.'

"4. When there shall be less than five players on a side, neither byes nor overthrows shall be allowed; nor shall the striker be caught out behind wicket, nor stumped out.

"5. The fieldsmen must return the ball, so that it shall cross the play between the wicket and the bowling stump, or between the bowling stump and the bounds. The striker may run till the ball be so returned.

"6. After the striker has made one run, he must touch the bowling stump and turn, before the ball shall cross the play, to entitle him to another.

"7. The striker shall be entitled to three runs for lost ball, and the same number for ball stopped with hat, with reference to the twenty-ninth and thirty-fourth law of double wicket.

"8. When there shall be more than four players on a side, there shall be no bounds. All hits, byes, and overthrows, will then be allowed.

"9. The bowler is subject to the same laws as at double wicket.

"10. Not more than one minute shall be allowed between each ball.

"Laws and regulations of Double Wicket.

"1. The ball must not weigh less than five ounces and a half, nor more than five ounces and three quarters. It must not measure less than nine inches, nor more than nine inches and one-eighth in circumference. At the beginning of each innings, either party may call for a new ball. (But in matches the same ball must go through the game.)

"2. The bat must not exceed four inches and one quarter in the widest part; it must not be more than thirty-eight inches in length.

"3. The stumps, three to each wicket, must be twenty-seven inches out of the ground, the bails eight in length; the stumps of sufficient thickness to prevent the ball from passing through.

"4. The bowling-crease must be in a line with the stumps, six feet eight inches in length; the stumps in the centre, with a return crease at each end towards the bowler, at right angles.

"5. The popping-crease must be four feet four inches from the wicket, and parallel to it; unlimited in length, but not shorter than the bowling-crease.

"6. The wickets must be pitched opposite to each other by the umpires, at a distance of twenty-two yards.

"7. It shall not be lawful for either party during a match, without the consent of the other, to alter the ground by rolling, watering, covering, mowing, or beating. This rule is not meant to prevent the striker from beating the ground with his bat near to the spot where he stands during the innings, nor to prevent the bowler from filling up holes with saw-dust, &c., when the ground shall be wet.

"8. After rain, the wickets may be changed, with the consent of both parties.

"9. The bowler shall deliver the ball with one foot behind the bowling-crease, and shall bowl four balls before he change wickets, which he shall be permitted to do once only in the same innings.

"10. The ball must be bowled. If it be thrown or jerked, or if the hand be above the shoulder in the delivery, the umpire must call 'no ball.' (This is not reckoned as one of the four balls.)

"11. The bowler may require the striker at the wicket from which he is bowling to stand on that side of it which he may direct.

"12. If the bowler toss the ball over the striker's head, or bowl it so wide that it shall be out of distance to be played at, the umpire (even though he attempt to hit) shall adjudge one run to the parties receiving the innings, either with or without an appeal from them, which shall be put down to the score of wide balls, and such ball shall not be reckoned as any of the four balls. When the umpire shall have called 'Wide ball' one run only shall be reckoned, and the ball shall be considered dead.

"13. If the bowler shall deliver a 'no ball,' the striker may play at it, and be allowed as many runs as he can get; and be shall not be put out except by running out. In the event of no run being obtained by any other means, then one run shall be scored.

"14. In the event of a change of bowling, no more than two balls shall be allowed for the sake of practice.

"15. If the bowler bowl one ball, he shall be obliged to bowl four.

"16. The striker is out if either of the balls be bowled off, or if a stump be bowled out of the ground.

"17. Or if the ball, from a stroke of the bat or hand below the wrist, be held before it touch the ground, although it be hugged to the body of the catcher.

"18. Or if in striking, or at any other time while the ball is in play, both his feet be over the popping-crease, and his wicket put down, except his bat be grounded within it.

"19. Or if in striking at the ball he hit down his wicket.

"20. Or if, under pretence of running or otherwise, either of the strikers prevent a ball from being caught, the striker of the ball is out.

"21. Or if the ball be struck, and he wilfully strike it again.

"22. Or if in running, the wicket be struck down by a throw or by the hand or arm (with ball in hand) before his bat (in hand) or some part of his person be grounded over his popping-crease. But if the bails be off, a stump must be struck out of the ground.

"23. Or if any part of the striker's dress knock down the wicket when striking.

"24. Or if the striker touch or take up the ball while in play unless at the request of the opposite party.

"25. Or if with any part of his person he stop the ball, which in the opinion of the umpire at the bowler's wicket shall have been delivered in a straight line to the striker's wicket, and would have hit it.

"26. If the players have crossed each other, he that runs for the wicket which is put down is out.

"27. A ball being caught, no run shall be reckoned.

"28. If a 'lost ball' be called, the striker shall be allowed six runs; but if more than six shall have been run before 'lost ball' shall have been called, then the striker shall have all which shall have been run.

"29 After the ball shall have been lodged and definitively settled in the wicket-keeper's or bowler's hand, it shall be considered dead. If, when the bowler is about to deliver the ball, the striker at his wicket shall go outside his popping-crease before such actual delivery, the said bowler may put him out.

"30. If the striker be hurt, he may retire from his wicket, and return to it at any time during that innings.

"31. If a striker be hurt, some other person may stand out for him, but not go in.

"32. No substitute in the field shall be allowed to bowl, keep wicket, stand at point, cover the point, or stop behind, in any case.

"33. If any fieldsman stop the ball with his hat, the ball shall be considered dead, and the opposite party shall add five runs to their score. If any be run, they shall have five in all.

"34. The ball having been hit, the striker may guard his wicket with his bat, or with any part of his body, except his hand; but the twenty-fourth law, by which he is forbidden to touch or take up the ball, may not be disobeyed.

"35. The wicket-keeper shall not take the ball for the purpose of stumping, until it has passed the wicket. He shall stand at a reasonable distance behind the wicket, and shall not move till the ball be out of the bowler's hand; he shall not by any noise incommode the striker; and if any part of his person be over or before the wicket, although the ball hit it, the striker shall not be out.

"36. The umpires shall not stand more than six yards from the wicket; they are sole judges of fair and unfair play, and all disputes shall be determined by them, each at his own wicket; but in case of a catch which the umpire at the wicket bowled from cannot see sufficiently to decide upon, he may apply to the other umpire, whose opinion shall be conclusive.

"37. The umpires in all matches shall pitch fair wickets, and the parties shall toss up for the choice of innings.

"38. They shall allow two minutes for the striker to come in, and fifteen minutes between each innings. When the umpire shall call 'play,' the party refusing to play shall lose the match.

"39. They are not to order a striker-out, unless appealed to by the adversaries.

"40. But if one of the bowler's feet be not entirely behind the bowling-crease, within the return-crease, when he shall deliver the ball, the umpire at his wicket, unasked, must call 'no ball.'

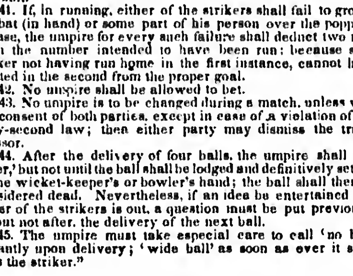
"41. If, in running, either of the strikers shall fail to ground his bat (in hand) or some part of his person over the popping-crease, the umpire for every such failure shall deduct two runs from the number intended to have been run: because such striker not having run home in the first instance, cannot have started in the second from the proper goal.

"42. No umpire shall be allowed to bet.

"43. No umpire is to be changed during a match, unless with the consent of both parties, except in case of a violation of the forty-second law; then either party may dismiss the transgressor.

"44. After the delivery of four balls, the umpire shall call 'over,' but not until the ball shall be lodged and definitively settled in the wicket-keeper's or bowler's hand; the ball shall then be considered dead. Nevertheless, if an idea be entertained that either of the strikers is out, a question must be put previously to, but not after, the delivery of the next ball.

"45. The umpire must take especial care to call 'no ball' instantly upon delivery; 'wide ball' as soon as ever it shall pass the striker."



Names of parties indicated by the figures—*, Strikers; 1 Bowler; 2, Wicket-keeper; 3, Long Stop; 4, Short Slip; 5, Long Slip; 6, Point; 7, Cover; 8, Middle Wicket; 9, Long Field, off side; 10, Long Field, on side; 11, Leg; O, Umpires; †† Scorers. This is the usual placing of the field-men, but Bowlers make such alterations as they deem best to oppose the Strikers.

The preceding diagram represents the field during a cricket match, with the proper position of the parties playing, also the technical names of these parties.

BOWLS.

Games with bowls are of great antiquity, and have existed in many different forms. That which has ultimately become the proper English game of bowling is performed with balls of fine hard wood on a smooth shoven lawn called a *bowling-green*. There are two parties, and each individual possesses a bowl. One of each party plays alternately. The object is to deliver the ball from the hand along the surface of the green, and in such a manner as to place it close by an appointed mark. The party which first gains the specified number of points, by being nearest the goal, is victor. The goal or object played to is a small ball called the *jack*. It is not fixed upon any particular spot, but is bowled by one of the party to a certain distance.

A bowling-green requires to be remarkably level, and kept closely shaved by the scythe. The length of space played in, called sometimes a *rink*, may be about thirty yards. The balls are not altogether spherical; they are spheroids, or flattish on two opposite sides. They are usually made of *lignum vitæ*, and are sometimes handsomely mounted with silver plates on the sides, bearing the names or arms of the owners. The size varies from about four to six inches in diameter.

A knowledge of the value of forces, which can be gained only by experience, is necessary in bowling; but a not less important requisite is a knowledge of the art of giving a bias to the bowl. A person skilled in this art will, by a peculiar pressure of the fingers in delivering his ball, cause it to roll in a kind of semicircle, so as to go with a sweep round the clusters of balls in front of the jack, and come to its place of rest close by the jack or goal.

The game is healthful and exhilarating, and, played in moderation, seems well adapted for the recreation of sedentary persons. In many towns in England and Scotland there are beautiful bowling-greens, the property of the citizens at large, or maintained by private clubs. In Glasgow there are several bowling clubs, and the following are a few of the regulations laid down for the game by a most respectable association in that city, namely, the "Wellcroft Bowling Club:"—

Regulations for Bowls.

"The game to consist of nine points, unless otherwise agreed; and the throwing of the jack and playing first to be decided by lot.

"If the jack is thrown into the ditch on any occasion after the first throw, the opposite party have the privilege of throwing it anew, and not afterwards moved if three feet clear of the ditch in front of the players. This rule not to apply to the side ditch, from which the jack must be sufficiently distant to allow both fore and back hand play.

"All players, when throwing their bowl, to have one foot on the aftermost white ball marked on the cloth; the position of the cloth not to be changed during an end; and if by accident removed from its situation, to be placed as near as possible to the same spot.

"A bowl touching the jack at any time during its course on the green, is what is called a toucher, and counts the same as any other bowl, though in the ditch.

"If the jack, or bowl after touching the jack, is run into the ditch, the place where either rests may be marked, the jack placed at the edge of the ditch, and both replaced when the end is played out.

"If the jack is *burned*, or displaced otherwise than by the effect of the play, the opposite party to have the option of playing out the end, or beginning it anew.

"When a bowl is burned, if belonging to the party guilty, it is to be put off the green; if belonging to the opposite party, to be replaced as near its original position as possible by the party to whom it belongs. If the jack is burned by a non-player, the end to be played over again.

"If a bowl is accidentally marred by an opponent, it shall be in the option of the party playing to let it rest, or play it over again: if it is marred wilfully by an opponent, it may be placed anywhere, at the pleasure of the player. If a bowl is marred in either case by the player's party, the opponents to have the same privilege.

"If a bowl (without touching the jack) rebounds from the ditch, it shall be put off the green; and if it has disturbed either jacs or bowls, they shall be replaced as near as possible by the opponent's party.

"After an end is played, neither jack nor bowls to be touched until the game is counted and all parties satisfied. And no measuring till the end is played.

"No player to change his bowls during the game; the party doing so loses the game."

GOLF.

The game of golf is believed to be peculiar to Scotland, though most likely derived from Germany; the term *golf* being from the German word *kolbe*, or the Dutch *kolf*, a club. The popular pronunciation of the Scotch word is *goff*, or *gowf*. Strutt, in his "Sports and Pastimes of the People of England," observes that "there are many games played with the ball, that require the assistance of a club or bat, and probably the most ancient among them is the pastime now distinguished by the name of goff. In the northern part of the kingdom goff is much practised. It answers to a rustic pastime of the Romans, which they played with a ball of leather stuffed with feathers, and the goff-ball is composed of the same materials to this day. In the reign of Edward III., the Latin name *cambuca* was applied to this pastime, and it derived the denomination, no doubt, from the crooked club or bat with which it was played."

It seems to be quite uncertain at what period the game of golf was introduced into Scotland; but it may be fairly presumed that this amusement, as well as football and archery, were practised to a considerable extent in the reign of our King James the First.

King Charles I. was much attached to the amusement of golfing, and, on his visit to Scotland in 1641, was engaged in it on Leith Links when intimation was given him of the rebellion in Ireland; whereupon he threw down his club, and returned in great agitation to Holyrood House. The Duke of York, afterwards James II., also delighted in the game.

Golf is played upon a large piece of open ground, covered with short herbage, but not necessarily level. It is considered that skill is best shown by playing over a surface on which there are certain irregularities or *hazards*. The grounds on which the game is played are called *links*, a term nearly equivalent to downs in England. The open downs of Blackheath, near Greenwich, seem a fair specimen of the kind of ground suitable for the sport, and there we believe it is now played. Bruntsfield Links, a common near Edinburgh, slope somewhat, and are irregular in form, but they afford a fine opportunity of showing skill in playing "up and down the green," a greater force being required in strokes in impelling the ball in one direction than in another.

Golf is entitled to be called a "respectable" game. It is played almost exclusively by gentlemen, and is conducted leisurely and without any appearance of boisterousness. A stranger would call it a spiritless sport, little better than walking. It possesses, however, the usual fascination of a game of skill and chance, and might appropriately be compared to billiards—the table being a green of a mile in length, the billiard rods clubs, the balls, instead of ivory, hard stuffed leather, and the pursee holes in the ground.

Golfs are formed of wood. The handle, which is straight, is generally about four and a half feet long, and made of ash or hickory. To the lower part of this stalk is united, by compact tying, a flattish curved end, which is the striking part; it is faced with horn, and to give force is loaded with lead. To give a hold to the hands, the upper extremity of the stalk is wrapped with a rind of cloth. In regular practice, players use several golfs. Each has his set of three, four, five, or even as many as ten, which is carried by an attendant boy called a *cadie;* and from this set the golf appropriate for the stroke is selected. Sometimes the ball lies fairly on the grass, at other times it may have got into a hollow, or behind a stone or bush, and an instrument best adapted for sending it forward, or lifting it from its *hazard* or awkward situation, is in requisition. One of the golfs is technically called the *spoon*, from its use in lifting the ball from hollows; another is called the *iron;* and so on.

The ball is small, being not more than an inch and a half in diameter; it is made of leather, stuffed almost as hard as a stone with feathers; the outside is smooth, and painted white. At Edinburgh and St. Andrews, the making of golfs and balls is a regular profession.

There are generally two players, one matched against the other. Each has his own ball. The game consists in driving the ball into certain holes made in the ground, which he who achieves in the fewest strokes obtains the victory. When four persons play, two of them are sometimes partners, and have but one ball, which they strike alternately. The holes are situated at the different ends and sides of the green, at irregular distances, and their number is optional. The usual number is five. A player must never touch his ball, unless in very particular circumstances, or when he takes it out of one of the holes. When commencing from a hole, the ball may be cogged up on the point of a dot of mud or turf, to allow of a commanding stroke; and this is called *teeing* the ball; but on all other occasions the ball must be struck or impelled by the golf from the place in which it happens to lie. Much depends on the first blow, and it should be given with great firmness of person and a good aim. Properly performed, the first stroke will send the ball two hundred yards, while at other times a blow in an awkward situation will advance it only a few feet. When the balls at length get near a hole, great skill is shown in *putting* or giving those delicate strokes which will not make the ball go beyond the hole, but if possible into it. A knowledge of the value of forces, the nature of the green, the influence of wind or weather, &c., is important in this and all other parts of the game, and is only to be gained by long experience.

At Edinburgh, Leith, Musselburgh, St. Andrews, Perth, and perhaps some other towns, there are associations or clubs of golfers, whose proceedings are governed by certain laws and regulations. The oldest in Edinburgh are the "Edinburgh Burgess" and "Bruntsfield Links" Golfing Societies. The Bruntsfield Links Society was instituted in 1761, and is limited to forty members, the uniform of which is declared "to be a red jacket with green velvet collar and badge, bearing the arms of the society; namely, vert two golf clubs in saltier, with heads in chief proper, between four golf-balls argent: motto in an escroll below the shield, *Inde Salus* (Thence Health). The affairs of the Society are managed by a captain, treasurer, secretary, and six councillors, elected annually. A gold medal, played for annually on the last Saturday of March, is retained by the winner for one year. A silver medal, played for annually on the last Saturday of September, is retained by the winner as his property. The following are the regulations prescribed by the society for playing the game:—

"1. No golfer, or cadie, to be allowed to dig tee within ten yards of the hole, and no ball to be teed nearer the hole than two club lengths, nor farther from it than four, unless by consent of parties, and the ball to be teed on the ground.

"2. Two or more parties meeting at the hole, the party who plays first to be allowed to play their second strokes before the succeeding party strikes off. But should the first party's ball be in a hazard, that party shall allow the second party to pass.

"3. Every hole must be played out with the same ball that is struck from the tee.

"4. All loose sticks, stones, filth, nuisance, or other movable impediments, may be removed, if within one club length of the ball; and in putting, all movable obstructions may be removed within four club lengths of the hole—the distance to be measured with the club which the party is to play with. In the event of a ball getting into a hole, or any other hazard, the party shall be allowed to take it out, and standing immediately behind the hazard, drop it over his shoulder, and play it, losing a stroke.

"5. No hole is gained unless the ball be holed (except by consent of parties), and a party losing his ball loses the hole.

"6. In case of doubt as to the ball belonging to either party, neither ball shall be lifted unless by consent of parties, and the ball farthest from the hole must be played first.

"7. If a ball be struck or moved by any one not of the party, it shall be brought back and played from where it was so struck or moved, the party previously dropping it over his shoulder.

"8. In a match of more than two players, if a ball be struck twice or oftener, successively by one player, that side of the match loses the hole.

"9. If a party play the adversary's ball, the adversary gains the hole.

"10. If a party personally, or by his cadie, stop or touch any ball of the match, the adversary gains the hole.

"11. If a ball stick fast into the ground, it may be loosened.

"12. In playing for prizes, no competition to be allowed unless the parties be dressed in the uniform of the society.

"13. In putting, the ball, if practicable, shall be played directly for the hole, but if the adversary's ball oppose the player, it shall be lawful to play upon it."

Enthusiastic and long-experienced cultivators of golf at Edinburgh have been known to perform some remarkable feats in their favourite sport. "Bets of a novel nature, which set the ordinary routine of the game entirely aside, are occasionally undertaken by the more athletic. An amusing and difficult feat, sometimes attempted from Bruntsfield Links, is that of driving the ball to the top of Arthur's Seat [a hill 800 feet high.] In this fatiguing undertaking, being a species of steeple-chase over hedges and ditches, the parties are usually followed by bottle-holders and other attendants, denoting the excessive exertion required. In 1798, bets were taken in the Burgess Golfing Society that no two members could be found capable of driving a ball over the spire of St. Giles's steeple. The late Mr. Sceales of Leith, and the present Mr. Smellie, printer, were selected to perform this formidable undertaking. They were allowed to use six balls each. The balls passed considerably higher than the weathercock, and were found nearly opposite the Advocate's Close. The bet was decided early in the morning, in case of accident, the parties taking their station at the south-east corner of the Parliament Square. The feat is described as one of easy performance. The required elevation was obtained by a barrel-stave suitably fixed; and the height of the steeple, which is one hundred and sixty-one feet, together with the distance from the base of the church, were found to be much less than a good stroke of the club."*

SHINTY—HURLING.

Shinty in Scotland, Hockey in England, and Hurling in Ireland, appear to be very much the same out-of-door sport. We shall describe shinty:—Two parties armed with sticks or clubs crooked at the lower extremity, and generally termed *gouffs* (golfs), throw down a little ball of wood, called a *shinty*, midway between two points, and the struggle is, which party will drive the ball to their "hail," as it is called, or the point allotted as their goal. It may be guessed by those who have never seen it, that there is smart smashing work at this game of shinty—most appropriately named so, seeing that the shins of the players are exposed to ticklish cracks from the clubs of their opponents when a lock takes place, and a dozen boys, perhaps, are struggling to get the ball out from among each other's feet. Hard though the ball be, and smart the strokes given, the activity and quick eyes of the players usually prevent any great injury from being received at shinty. By far the most serious mischief commonly resulting from it consists in the damage which it brings upon the neighbouring hawthorn hedges, which are sadly cut to pieces in order to provide clubs for the sport. The worst of it is that young hawthorn slips, with the root cut for the striking part, make by far the best clubs, and accordingly the evil done is radically ruinous to the unfortunate hedgerows.

Hurling is alluded to as follows by Mr. and Mrs. Hall, in their work on Ireland:—"The great game in Kerry, and indeed throughout the South, is the game of 'Hurley'—a game rather rare, although not unknown, in England. It is a fine manly exercise, with enough of danger to produce excitement, and is, indeed, *par excellence*, the game of the peasantry of Ireland. To be an expert hurler, a man must possess athletic powers of no ordinary character; he must have a quick eye, a ready hand, and a strong arm; he must be a good runner, a skilful wrestler, and withal patient as well as resolute. In some respects, it resembles cricket; but the rules and the form of the bats are altogether different; the bat of the cricketer being straight, and that of the hurler crooked.

"The forms of the game are these:—The players, sometimes to the number of fifty or sixty, being chosen for each side, they are arranged (usually barefoot) in two opposing ranks, with their hurleys crossed, to await the tossing up of the ball, the wickets or goals being previously fixed at the extremities of the hurling-green, which, from the nature of the play, is required to be a level extensive plain. Then there are two picked men chosen to keep the goal on each side, over whom the opposing party places equally tried men as a counterpoise; the duty of these goal-keepers being to arrest the ball in case of its near approach to that station, and return it back towards that of the opposite party, while those placed over them exert all their energies to drive it through the wicket. All preliminaries being adjusted, the leaders take their places in the centre. A person is chosen to throw up the ball, which is done as straight as possible, when the whole party, withdrawing their hurleys, stand with them elevated, to receive and strike it in its descent; now comes the crash of mimic war—hurleys rattle against hurleys—the ball is struck and re-struck, often for several minutes, without advancing much nearer to either goal; and when some one is lucky enough to get a clear 'puck' at it, it is sent flying over the field. It is now followed by the entire party at their utmost speed; the men grapple, wrestle, and toss each other with amazing agility, neither victor nor vanquished waiting to take breath, but following the course of the rolling and flying prize; the best runners watch each other, and keep almost shoulder to shoulder through the play, and the best wrestlers keep as close on them as possible, to arrest or impede their progress. The ball must not be taken from the ground by the hand; and the tact and skill shown in taking it on the point of the hurley, and running with it half the length of the field, and, when too closely pressed, striking it towards the goal, is a matter of astonishment to those who are but slightly acquainted with the play. At the goal is the chief brunt of the battle. The goal-keepers receive the prize, and are opposed by those set over them; the struggle is tremendous—every power of strength and skill is exerted; while the parties from opposite sides of the field run at full speed to support their men engaged in the conflict; then the tossing and straining are at their height, the men often lying in dozens side by side on the grass, while the ball is returned by some strong arm again, flying above their heads, towards the other goal. Thus, for hours, has the contention been carried on, and frequently the darkness of night arrests the game without giving victory to either side. It is often attended with dangerous and sometimes with fatal results.

"Matches are made sometimes between different lands or parishes, sometimes by barony against barony

* Biographical sketches of "Kay's Portraits."

and not unfrequently county against county; when the crack men' from the most distant parts are selected, and the interest excited is proportionably great. About half a century ago, there was a great match played in the Phœnix Park, Dublin, between the Munster men and the men of Leinster. It was got up by the then lord-lieutenant and other sporting noblemen, and was attended by all the nobility and gentry belonging to the vice-regal court, and the beauty and fashion of the Irish capital and its vicinity. The victory was contended for a long time with varied success; and at last it was decided in favour of the Munster men, by one of that party running with the ball on the point of his hurley, and striking it through the open windows of the vice-regal carriage, and by that manœuvre baffling the vigilance of the Leinster goalsmen, and driving it in triumph through the goal. This man is still living; his name is Mat. Healy, and he has been many years a resident in London. Between twenty-five and thirty years ago, there were several good matches played on Kennington Common, between the men of St. Giles's and those of the eastern parts of the metropolis; the affair being got up by the then notorious Lord Barrymore and other noblemen who led the sporting circles of the time."

FIVES—RACKETS—TENNIS.

The sport of striking a soft ball covered with leather against the wall, or throwing it upwards and catching it with the hand, seems to be of great antiquity, and in progress of time was regulated into the character of certain games. One of these, the most simple of the whole, is the striking of a ball against a wall, rebounding from which it falls with force on the ground, and in the rise is again struck in the same manner. The sustaining of this action for a specified number of times constitutes the game. In England it has been customary to call a game of this kind *fives*, from the ball being struck with the five fingers and palm of the hand. In Scotland it has for ages been called *cage* or *caitch* ball. James I., in his quaint production descriptive of what should constitute the education and recreations of a prince, refers to caitch ball. He remarks—"The exercises I would have you to use, although but moderately, not making a craft of them, are running, leaping, wrestling, fencing, dancing, and playing at the *caitch* or tennise, archerie, pallemalle and such like other fair and pleasant field sports."

Rackets is the same game as fives; but instead of striking the ball with the open hand it is struck by a racket, which is an implement held in the hand formed of a frame and catgut. It is played against a high and broad wall, even in surface, with a smooth stone or earthen ground, from which the ball will rise evenly to the hand. Two persons play the match, each striking the ball alternately, and each strikes it in such a way as that his adversary may not be able to return it. But the adversary is supple of limb and quick of eye, and darting to the spot on which the ball is about to fall, endeavours to strike it with his racket, and preserve it from rolling on the ground. He who does not return the ball, either loses a point (or, as it is termed, an *ace*) or has his *hand out*, that is, forfeits the situation in which he would be able to add to his score of the game. Neither fives nor rackets are now played to the extent that they formerly were. There are still, however, several courts laid out for these games in the metropolis; and nowhere are they played so well as in the court-yards of the Queen's Bench and Fleet prisons, where many of the inmates endeavour to kill time by this species of amusement.

Tennis is a game similar with ball; it is played with a racket, but instead of striking the ball against a wall, it is struck over a central net, on each side of which the players stand. The game, which was once fashionable we believe, is now scarcely ever practised.

TRAP-BALL.

This game, which is traceable as far back as the commencement of the fourteenth century, is played chiefly by boys. A wooden object, called a trap, resembling a shoe in shape, with a spring slip or tongue fastened in it by a joint, is laid on the ground. The ball is laid on one end of the spring; the other end is struck with a bat, and the ball rising is to be smartly struck. "It is usual," says Strutt, "in the present game of trap-ball, when properly played, to place two boundaries at a given distance from the trap, between which it is necessary for the ball to pass when it is struck by the batsman, for if it falls withoutside of either, he gives up his bat and is out; he is also out if he strikes the ball into the air and it is caught by one of his adversaries before it grounds; and again, if the ball, when returned by the opposing party, touches the trap, or rests within one bat's length of it; on the contrary, if none of these things happen, every stroke tells for one towards the striker's game." In some country parts of England trap-ball is a favourite sport of the rustic population.

FOOT-BALL.

Foot-ball is an old English sport, now little known in some parts of the country, but keenly played in others. It is played by means of a distended ox-bladder, tightly covered with dressed leather, and sewed up in a strong and secure way, so as to retain its full elasticity. This ball is thrown aloft in the air between two parties of players, equidistant from each other; on one side and the other there is a fixed point or line, called, as in the preceding case, the hail or hailing spot. The object, then, of each party is, by vigorous kicks to propel the ball to the hailing place behind their adversaries, on the attainment of which object the game is won. This game is less hazardous than shinty, and exercises fully both the strength and speed of the players. It is amazing how dexterous even very young boys become by continual practice at foot-ball; and skill in the application of a slight degree of force avails much more at this sport than greater strength unskilfully directed. The young men of the Scottish Border yet practise this game annually in various places; and few sights can be more exhilarating than to behold a strong body of them so employed, when the fleet foot of the shepherd vies for conquest with the vigour of the ploughmen, and health and enjoyment beam unequivocally from every countenance.

QUOITS.

Contests in throwing or pitching heavy pieces of metal were practised by the ancient Greeks at their great periodical assemblages for athletic exercises. The piece of metal thrown was called the *discus*, from its round form. The main object in these contests was the cultivation of strength of arm, and victory was gained more from the ability of throwing heavy weights to a distance than from skill in attaining a particular mark.

From these ancient practices, first pursued by the Greeks and then by the Romans, the game of quoits, or coits, appears to have been derived. The quoit is a circular plate of iron perforated in the middle, or, more properly, a flattish iron ring, concave on one side and convex on the other, the concave or hollow side being undermost in throwing; and a notch being in the edge for the finger to press upon in delivering the throw. Quoits are of different sizes, to suit the different tastes and powers of players. "To play this game," says Strutt, "an iron pin, called a nob, is driven into the ground within a few inches of the top; and at the distance of eighteen, twenty, or more yards (for the distance is optional), a second pin of iron is also made fast in a

similar manner; two or more persons, as four, six, eight, or more, at pleasure—who, divided into two equal parties, are to contend for the victory—stand at one of the iron marks and throw an equal number of quoits at the other [the quoit being delivered from the hand by an upward and forward pitch with a steady aim at the pin, near which it should sink with its sharp edge in the turf]; the nearest of them to the hob are reckoned towards the game. But the determination is discriminately made: for instance, if a quoit belonging to A lies nearest to the hob, and a quoit belonging to B the second, A can claim but one towards the game, though all his other quoits lie nearer to the mark than all the other quoits of B; because one quoit of B being the second nearest to the hob, *cuts out*, as it is called, all behind it; if no such quoit had interfered, then A would have reckoned all his as one each. Having cast all their quoits, the candidates walk to the opposite end and determine the state of the play; then, taking their stand there, throw their quoits back again, and continue to do so alternately as long as the game remains undecided." The dress in quoiting should be loose and easy, with no restraint from braces.

In some of the rural districts of England horseshoes used to be employed as quoits; and in some parts of Scotland the quoits consist of round flat stones, games with which are called the "penny-stanes."

IN-DOOR AMUSEMENTS.

CHESS.

It has been justly observed, that among all the in-door amusements invented by man for the employment of the idle or the relief of the studious, chess stands pre-eminent. It is the most refined and ingenious of all games, and possesses a charm which has rendered it a favourite of the greatest characters, whether kings, warriors, or philosophers. As an amusement, it possesses an advantage as great as it is singular: being highly interesting in itself, and played with leisure, it requires no inducement of gain, and in consequence is rarely played for money. The glory of conquest is allowed to form a sufficient attraction.

Chess is of unknown origin and antiquity. Some writers have ascribed its invention to the Greeks, some to the Hindoos, others to the Chinese, and a fourth class to the Persians. There can be little doubt that it originated in the east, and at a very remote period of history; and it is certain that it has been known in Hindostan and adjacent regions for at least two thousand years. From the Persians it was introduced by the Arabians into Spain; thence it found its way to France; and was made known in England during the reign of William the Conqueror.

The name of the game, and also the names of the pieces with which it is played, have undergone many mutations in travelling from country to country; nevertheless, in the present terms which we employ, the semblance of the original eastern appellations may be seen. In Hindostan it possesses the Sanscrit name of *Chaturanga*, which imports the four members of an army—elephants, horses, chariots, and foot-soldiers; the game being a scene of mimic warfare, in which these elements respectively act a peculiar part. The Persians corrupted the Sanscrit word into *chatrang*, which the Arabians softened into *shatranj*; from that appellation it passed into *scacchi*, *echecs*, and finally chess. By the French it is called *echecs*, and a chess board they term *echiquier*.

According to the modern European arrangement, the idea of elephants, horses, chariots, and foot-soldiers has been abandoned, and there have been substituted a king, queen, bishops, knights, castles or rooks, and pawns, forming six distinct classes of pieces. The term *bishop* is only English, being a substitution for elephant. The knights represent the horse-soldiers. The term *rook* is from the eastern word *rokh*, a hero, and represents an armed chariot or fortification; the English give the piece the form of a castle. The pawns are the foot-soldiers, the name being from *peon*, an attendant.

The chess pieces made in India or China for sale to wealthy Europeans are sometimes made of solid ivory, five or six inches high, and are exceedingly beautiful, no degree of labour being spared in the carving. The king and queen are seated on elephants, under a canopy; the bishops are camels, with archers as their riders; the knights are on horseback; the castles are elephants, with castles on their backs filled with warriors; and the pawns are soldiers, one a sergeant, another a drummer, another a fifer, and the rest ordinary fighting men.

In England the pieces are usually made of bone or boxwood, with more or less taste, and from a low to a high price. The following is a representation of their common form.

Pawn. *Rook.* *Knight.* *Bishop.* *Queen.* *King*

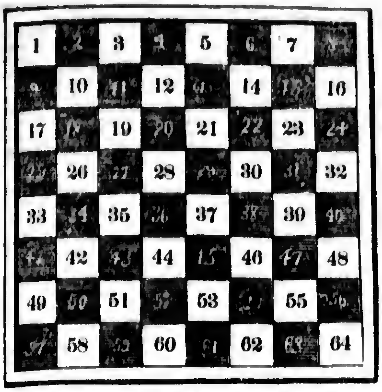
Chess Men and Board.

There are two sets of pieces, of different colours; one is usually white, and another red. A set consists of sixteen pieces, so that the entire number with which the game is played is thirty-two pieces. A set includes one king, one queen, two bishops, two knights, two rooks or castles, and eight pawns. Two parties play, each having a set of a different colour.

The game is played on a square board, divided into sixty-four squares, checkered black and white, as represented in the following figure. The *numbers* which are here shown on the squares do not exist on the chess-board; we have only marked them thus in order to illustrate the subjoined explanations of the method of playing the game.

In beginning to play the game, the first thing is to set the board. This is done by placing it before you, with a white square in the right hand corner. As the players sit opposite each other at a table on which the board is placed, each has a white square on his right.

Next, place the men in their appointed places. Let us suppose it is the white set of men. On the white corner square marked 64 place a rook or castle, and on the black corner, 57, place the other rook; on the black



square, 63, place a knight, and on the white square, 58, place the other knight; on the white square, 62, place a bishop, and on the black square, 59, place the other bishop; on the black square 61, place the king, and on the white square 60, place the queen. This completes the first row, in which the king and queen stand supported on each side by their officers. The second row, marked 49, 50, 51, 52, 53, 54, 55, 56, is filled entirely with the eight pawns, which thus form a front guard to the pieces behind.

The red or dark set of pieces are placed in precisely the same order—a castle on 1 and 8, a knight on 2 and 7, a bishop on 3 and 6, the queen on 4, and the king on 5. It is a rule of the game that the queen must be placed at first on a square of her own colour—the white queen on a white square, and the dark queen on a dark square. The pieces and pawns on the side and front of each king and queen take their names from them; as king's bishop, king's knight; queen's bishop, queen's knight; king's pawn, &c.

When properly placed, four rows of squares are left unoccupied in the middle of the board, and these form a space on which the early evolutions of the men take place.

The Moves.

It is a leading peculiarity of chess that each class of pieces has its own peculiar value and style of moving; some can move one way and some another, a system very different from that of the ordinary movements on a draught board.

A *pawn* moves only one square at a time, in a straight line forward, and takes the enemy diagonally. On being first moved, however, a pawn has the power of advancing either one square or two, as the player thinks fit, unless the square over which he leaps is commanded by a hostile pawn; so that if he were to rest on that square instead of leaping over it, he might be captured. In such a case, the adverse pawn has the option of taking him, and placing himself on the square leaped over. A pawn cannot move backwards; but on getting to the further side of the board, upon the first line of the enemy, which is styled *going to queen*, he may be changed for any one of the pieces lost in the course of the game, and the piece chosen must be placed on the square at which the pawn has arrived. If not exchanged, he remains idle. The power of taking diagonally, possessed by a pawn, differs from that of all other pieces, who take in the direction in which they move: after every capture he continues to go forward as before. The king's bishop's pawn is reckoned the most valuable.

A *knight* moves obliquely, either backward or forward, upon every third square, including the square on which he stood; from black to white, or white to black, over the heads of the men, which no other piece is permitted to do. For example, a knight may leap from 36 to 19, 21, 26, 30, 42, 46, 51, or 53, passing over pieces in the intermediate squares. This property of leaping renders the knight particularly useful at the beginning of a game, as he can be brought into the enemy's ranks, and retire, notwithstanding any blockade; and should he check a king, without being himself liable to be taken, the king must remove, and cannot afterwards castle.

The *bishop* moves only diagonally over any number of squares as far as they are open, forward or backward, but always on the colour he is first placed on. He can take at any distance when the road is open. For example, the bishop may move from 29 to 2, 8, 56, or 57. The king's bishop is usually considered the better one, as he can check the king on his original square, which the queen's bishop cannot.

The *rook* moves backward, forward, or sidewise, and as far as the squares are open. He is viewed as not very useful at the beginning of a game, but is particularly so towards the conclusion, by possessing the power of giving *checkmate* with the king alone, which neither the bishop nor knight can do.

The *queen* is the best piece on the board. She unites the powers of the bishop and rook, and her moves are therefore unlimited, provided the squares are open in her line of motion. As an example, she may be moved from 37 to 1, 5, 16, 23, 40, 58, 61, 64, or any other number in the direction of these, so that the squares are not blocked up. The preservation of the queen is always a matter of great importance in the game.

The *king* moves only one square at a time, but in any direction, either forward or backward, sideways or diagonally. But once in a game, he can move two squares to the right or left, which is termed castling. He can take any of the enemy's men in any square adjoining to him, provided he does not place himself in check. This *check* is a peculiarity in his condition. He has the privilege of never being taken; but this can scarcely be considered a benefit, since it only means that he must not move into or continue in a situation of danger. To be in such a situation, and liable to be captured if he were an ordinary piece, is called being in *check*. On the avoidance of this perilous situation the whole game depends; for the instant the king is checkmated, without the means of moving into a place of safety, the game is at an end. The adversary has the victory.*

To the foregoing account of the moves and powers of the respective pieces, may be added the following explanation of terms:—

Castling.—This, as above hinted at, is allowed once in the course of a game: it consists in moving the king to the second square to the right or left of that where he originally stood, and placing the castle or rook on the square over which he leaped. Castling is a means adopted to secure the king from attack; but it is not allowable—1. When the king or the rook with which you would castle has already been moved; 2. When the king is in check; 3. When the king would require to pass over a square in which he would be checked; and 4. When the king has a piece between himself and the rook.

Check.—When the king is in a situation that, were he an inferior piece, he would be taken, notice is given by the adversary, by saying the word "*check*," and the player

* In a battle between the French and English, in the year 1117, an English knight seizing the bridle of Louis le Gros, and crying to his comrades, "The king is taken!" the prince struck him to the ground with his sword, saying, "Ne sçais tu pas qu' aux echecs on ne prend pas le roi?" (Dost thou not know that at chess the king is never taken?) The meaning of which is, that at the game of chess, when the king is reduced to that pass that there is no way for him to escape, the game ends; because the royal piece is not to be exposed to an imaginary affront.—*Philidor on Chess.*

must adopt some means of removing him from this position.

Double check is when the king is in check by two pieces at once. He may emancipate himself from single or double check—1. By capturing the piece which is attacking him, either by himself or one of his party—and this is only available in double check, if one of the pieces does not guard the other; 2. By interposing a piece between him and the attacking piece; and 3. By removing to another square, of which no hostile piece has the command.

Checkmate is when no means of escape or conquest is available; the king is then said to be checkmated, and the game terminates. One king cannot give check to another, as it would place him in a similar situation. The term checkmate is said to be a corruption of the eastern words *chah-mat* (the king is dead).

Stale-mate (from *stall*, a place of fixture) is applied to the condition of the king when he is compelled to remain in his place, by being surrounded in such a manner by his own or his adversary's pieces that he could not move without going into check, and has at the same time no means of moving other pieces. The game is then considered *drawn*, that is, not won by either party.

Laws of Chess.

The game commences by the two parties determining by lot, or concession, which shall have the first move. After this, the moves are taken alternately, one piece at a time. The principle of advance is to push forward the men gradually against those of the enemy, each party calculating beforehand what will be the effect of any particular move. The following are old established laws in reference to playing:—

1. If you touch your man you must play it, except it would expose your king to check, in which case you can only move the king, if it be practicable.

2. As long as you retain a hold of your man, you are at liberty to place him where you think proper, though you may have him set down on a square.

3. If you have removed your hand from a man, he must remain where he is.

4. If you touch one of your adversary's men, he may insist on your taking it, if you can, and when you cannot, then you must move your king, provided the move do not put him in check.

5. If you make a false move, by accident or otherwise, your adversary can oblige you to move the king; but if he plays without having noticed the false move, it cannot be recalled.

6. If your adversary challenge you with a check, while in reality the king is not in check, and you move your king or any other man in consequence, you may retract it if you discover the error before he has made his next move.

7. You are not to give check to your adversary's king, when, by doing so, you would expose your own king to check.

8. If your adversary give check, but without giving the usual warning of "check," you are not obliged to notice it till he does; but if he discover that he should have done so on his next move, and then warn you, each must retract his move, and the king be removed out of check or protected.

9. After your king or rook has moved, you cannot castle.

10. In each fresh game the players have the first move alternately; but if a player give the advantage of a piece, that is, agrees to start with one piece less than his antagonist, he who gives the advantage has the first move.

Hoyle's Rules for Chess.*

1. Move your pawns before your pieces, and afterwards bring out the pieces to support them: therefore the king's, queen's, and bishop's pawns should be the first played, in order to open the game well.

2. Do not therefore play out any of your pieces early in the game, because you thereby lose moves, in case your adversary can, by playing a pawn, make them retire, and he also opens his game at the same time; especially avoid playing your queen out, till your game is tolerably well opened.

3. Avoid giving useless checks, and never give any unless to gain some advantage, because you may lose the move, if the adversary can either take or drive your piece away.

4. Never crowd your game by having too many pieces together, so as to prevent your men advancing or retreating, as occasion may require.

5. If your game should be crowded, endeavour to free it by exchanges of pieces or pawns, and castle your king as soon as convenient; afterwards bring out your pieces, and attack the adversary where weakest.

6. When the adversary plays out his pieces before his pawns, attack them as soon as you can with your pawns, by which you may crowd his game, and make him lose moves.

7. Never attack the adversary's king without a sufficient force; and if he attack yours, and you cannot retaliate, offer exchanges; and should he retire when you present a piece to exchange, he may lose a move. It may also be sometimes expedient to act in this manner, in case of other attacks.

8. Play your men in guard of one another, so that if any be taken, the enemy may also be captured, by that which guarded yours, and endeavour to have as many guards to your piece as your adversary advances others upon; and, if possible, let them be of less value than those he assails with. When you cannot well support your piece, see if by attacking one of his that is better, or as good, you may not thereby save yours.

9. Never attack but when well prepared, for thereby you open your adversary's game, and prepare him to pour in a strong attack upon you, as soon as your weaker one is over.

10. Never play till you have examined whether you are free from danger by your adversary's last move, nor offer to attack till you have considered what harm he would be able to do you by his next moves, in consequence of yours.

11. When your attack is in a prosperous way, never be diverted from it by taking any piece, or other seeming advantage, your adversary may purposely throw in your way, with the intent that, by your taking the bait, he might gain a move which would make your design miscarry.

12. When, in pursuing a well-laid attack, you find it necessary to force your adversary's defence, with the loss of some pieces, if, upon counting as many moves forward as you can, you find a prospect of success, sacrifice a piece or two to gain your end: these bold attempts make the finest games.

13. Never let your queen stand so before the king as that your adversary, by bringing forward a rook or a bishop, might check your king if she were not there; for you could hardly save her, or perhaps at best must sacrifice her for an inferior piece; as, for example place the white king on 61, the queen on 53, the black king on 4, and the rook on 16; which last, if moved to 13, must be taken by the white queen, who in return would be taken by the black king, because the white queen could not otherwise be moved without putting the king on check to the black rook.

14. Let not your adversary's knight fork your king and queen, or king and rook, or queen and rook, or your two rooks, at the same time; for in the two first cases, the king being forced to go out of check, the queen or the rook must be lost; and in the two last, a rook must be lost, at best, for a worse piece. Place the white queen on 5, the rook on 7, and a black knight on 37. The latter piece, if moved to 22, will fork both the queen and rook, and consequently one of them must be lost for the knight.

15. Take care that no guarded pawn of your adversary's fork two of your pieces; knights and rooks are particularly liable to this mode of attack; also guard against either a check by discovery or a stale-mate.

16. When the kings have castled on different sides of the board, attack with the pawn you have on that side where the adversary has castled, advancing the pieces, especially the queen and rooks, to support them; and if the adversary's king have three pawns on a line in front, he should not stir them till forced to it.

17. Endeavour to have a move in ambuscade; that is, place the queen, bishop, or rook, behind a pawn or a piece in such a manner as that, upon playing that pawn or piece, you discover a check upon your adversary's king, and consequently may often get a piece or some other advantage by it. Suppose the black king on 6, a white bishop on 41, and a pawn on 34, by moving the pawn to 26, a check by the white bishop is discovered upon the black king.

18. Never guard an inferior piece or pawn with a better, if you can do it with a pawn, because that better piece may in such a case be, as it were, out of play.

19. A pawn pushed on and well supported often costs the adversary a piece; but one separate from the others is seldom of any value. And whenever you have gained a pawn or other advantage, and are not in danger of losing the move thereby, make as frequent exchanges as you can.

20. If each player have three pawns upon the board, and no piece, and you have a pawn on one side of the board, and the other two on the other side, and your adversary's three are opposite to your two, march with your king to take his pawns; and if he move to support them, go on to queen with your single pawn; and if he attempt to hinder it, take his pawns, and push yours to queen: that is, to move a pawn into the adversary's back row, in order to make a queen.

21. At the latter end of the game each party having only three or four pawns on different sides of the board, the kings are to endeavour to gain the move, in order to win the game: for example, the white king placed on 54, and the black king on 37, white would gain the move by playing to 53, or black to 38, and in both cases the adverse king would be prevented from advancing.

22. When the adversary has no more than his king and one pawn on the board, and you a king only, you can never lose that game if you bring and keep your king opposite to your adversary's, when he is immediately either before or on one side of his pawn, and only one square between the kings. This must, then, be a stale mate or drawn game.

23. Never cover a check with a piece that a pawn pushed upon it may take, for fear of only getting that pawn for it; put a black rook on 7, and a pawn on 40; the white king on 63, and a knight on 61: the white king being on a check to the rook, if the check be covered by moving the white knight to 56, the black pawn could then be moved to 48, and take the knight.

24. Do not crowd your adversary's king with your pieces, or you inadvertently give a stale-mate, which is a drawn game.

25. Do not be too much afraid of losing a rook for an inferior

* Hoyle is a very old author, and his works on chess and other games are well known: they are now found in all forms, abridged or altered to suit modern players.

piece; though a rook is better than any other except the queen, yet it seldom comes into play, so as to operate, until the end of the game; and it is generally better to have a worse piece in play than a superior out.

26. When you have moved a piece which your adversary drives away with a pawn, that is a bad move, your enemy gaining a double advantage. At this nice game no move can be indifferent. Though the first move may not be much between equally good players, yet the loss of one or two more, after the first, makes the game almost irretrievable; but if you can recover the move or the attack (for they both go together), you are in a fair way of winning.

27. If ever your game be such that you have scarce any thing to play, you have either brought out your piece wrong, or, what is worse, not at all: for if you have brought them out right, you must have variety enough.

28. Do not be much afraid of doubling a pawn: two in a direct line are not disadvantageous when surrounded by three or four others; three together are strong (as three white pawns on 28, 35, and 37); but four (as 44 in addition) that make a square, with the help of other pieces, well managed form an invincible strength, and probably may produce you a queen: on the contrary, two pawns, with an interval between (as on 35 and 37), are no better than one: and if you should have three over each other in a line (as 26, 34, and 42), your game cannot be in a worse situation.

29. When a piece is so attacked that it is difficult to save it, give it up, and endeavour to annoy your enemy in another place; for it often happens, that whilst your adversary is pursuing a piece, you either get a pawn or two, or such a situation as ends in his destruction.

30. Supposing your queen and another piece are attacked at the same time, and by removing your queen you must lose the piece, if you can get two pieces in exchange for her, rather do that than retire, for the difference is more than the worth of a queen; besides, you preserve your situation, which is often better than a piece; when the attack and defence are thoroughly formed, if he who plays first be obliged to retire by the person who defends, that generally ends in the loss of the game on the side of him who attacks.

31. Do not aim at exchanges without reason; a good player will take advantage of it to spoil your situation and mend his own; but when you are strongest, especially by a piece, and have not an immediate check-mate in view, then every time you exchange your advantage increases. Again, when you have played a piece, and your adversary opposes one to you, exchange directly, for he wants to remove you: prevent him, and do not lose the move.

32. Every now and then examine your game, and then take your measures accordingly.

33. At the latter end of the game, especially when both queens are off the board, the kings are capital pieces; do not let your king be idle; it is by his means generally you must get the move and the victory.

34. As the queen, rooks, and bishops, operate at a distance, it is not always necessary in your attack to have them near your adversary's king; they do better at a distance, as they cannot be driven away.

35. When there is a piece you can take, and that cannot escape, do not hurry; see where you can make a good move elsewhere, and take the piece at leisure.

36. It is not always right to take your adversary's pawn with your king, for very often it happens to be a safeguard and protection to him. Place a black rook on 5, with a pawn on 45, and the white king on 53, and he will be sheltered by the black pawn from the attack of the rook.

Recommendations as to some of the foregoing Rules.

1. Whether you play the open or close game, bring out all your pieces into play before you begin the attack; for if you do not, and your adversary should, you will always attack or be attacked at a great disadvantage; this is so essential, that you had better forego an advantage than deviate from it; and no person can ever play well who does not strictly practise this. In order to bring out your pieces properly, push on your pawns first, and support them with your pieces, by which your game will not be crowded, and all your pieces will be at liberty to play and assist each other, and so co-operate towards obtaining your end; and either in your attack or defence, bring them out so as not to be driven back again.

2. When you have brought out all your pieces, which you will have done well if you have your choice on which side to castle, then consider thoroughly your own and adversary's game, and not only resolve where to castle, but likewise to attack where you appear strongest and your enemy weakest. By this it is possible you will be able to break through your adversary's game, in which some pieces must be exchanged. Now, pause again, and survey both games attentively, and do not let your impetuosity hurry you on too far; at this critical juncture (especially if you still find your adversary very strong) rally your men, and put them in good order for a second or third attack, still keeping them close and connected, so as to be of use to each other. For want of this method, and a little coolness, an almost sure victory is often snatched out of a player's hands, and a total overthrow ensues.

3. At the last period of the game, observe where your pawns are strongest, best connected, and nearest to queen: likewise mind how your adversary's pawns are disposed, and compare these things together; and if you can get to queen before him, proceed without hesitation; if not, hurry on with your king to prevent him. I speak now as supposing all the higher pieces are gone; if not, they are to attend your pawns, and likewise to prevent your adversary from going to queen.—*See Hoyle, Jones, &c.*

To these rules and recommendations we add the following advice:—Conduct your game with coolness, take time to consider the chances for and against in moving, and do not give up the contest till all hope is gone of retrieval. An anecdote has been told of two gentlemen playing at chess, one of whom found his game so hopeless that he declared himself beat; when an onlooker of more skill said he would undertake to win the game for him by three moves, without the possibility of being counteracted. The offer was accepted, and the game at once retrieved and won. As this is a particularly instructive incident, we shall state the positions of the pieces on the board in reference to the numbers of the squares on the diagram.

The black rook was at 9, the black knight at 18, the black bishop at 20, the black king at 22, the black rook at 40, black pawns at 25, 26, 30, 35, and 36, and the black queen at 42. The white king was at 7, the white rooks at 61 and 63; the white knight at 47, and a white pawn at 38. The white has the move. The white knight at 47 gives check at 32; the black rook at 40 takes it. The white rook at 63 gives check at 23; the black king takes it. The white rook at 61 gives checkmate at 21. Thus, the white, by a few dexterous moves, completely paralyzes the adversary, and wins the game.

By writing an account of moves, it is possible for adversaries to carry on games at chess though at a great distance from each other. Thus, chess clubs in London are known to carry on matches with clubs in Edinburgh or Paris, or even with a club in India. Games of this kind sometimes last for years

The Morals of Chess, by Dr. Franklin.

The game of chess is not merely an idle amusement; several very valuable qualities of the mind, useful in the course of human life, are to be acquired or strengthened by it, so as to become habits, ready on all occasions; for life is a kind of chess, in which we have often points to gain, and competitors or adversaries to contend with, and in which there is a vast variety of good and ill events that are, in some degree, the effects of prudence or the want of it.

By playing at chess, then, we may learn,

1. *Foresight*, which looks a little into futurity, and considers the consequences that may attend an action; for it is continually occurring to the player, "If I move this piece, what will be the advantage or disadvantage of my new situation, what use can my adversary make of it to annoy me? What other moves can I make to support it, and to defend myself from his attacks?"

2. *Circumspection*, which surveys the whole chess-board, or scene of action; the relation of the several pieces, and their situations; the dangers they are respectively and repeatedly exposed to; the several possibilities of their aiding each other; the probabilities that the adversary may make this or that move, and attack this or the other piece; and what different means can be used to avoid his stroke, or turn its consequences against him.

3. *Caution*, not to make our moves too hastily. This habit is best acquired by observing strictly the laws of the game, such as, "If you touch a piece, you must move it somewhere; if you set it down, you must let it stand." And it is therefore best that these rules should be observed, as the game thereby becomes more the image of human life, and particularly of war; in which, if you have incautiously put yourself into a bad and dangerous position, you cannot obtain your enemy's leave to withdraw your troops and place them more securely, but you must abide all the consequences of your rashness.

And, lastly, we learn by chess the habit of *not being discouraged by present bad appearances in the state of our affairs*, the habit of *hoping for a favourable change*, and that of *persevering in the search of resources.* The game is so full of events, there is such a variety of turns in it, the fortune of it is so liable to sudden vicissitudes, and one so frequently, after long contemplation, discovers the means of extricating one's self from a supposed insurmountable difficulty, that we are encouraged to continue the contest to the last, in hopes of victory from our own skill, or at least of giving a stale-mate, by the negligence of our adversary; and whoever considers, what in chess he often sees instances of, that success is apt to produce presumption and its consequent inattention, by which more is afterwards lost than was gained by the preceding advantage, while misfortunes produce more care and attention, by which the loss may be recovered, will learn not to be too much discouraged by any present success of his adversary, nor to despair of final good fortune upon every little check he receives in the pursuit of it.

That we may, therefore, be induced more frequently to choose this beneficial amusement in preference to others which are not attended with the same advantages, every circumstance which may increase the pleasure of it should be regarded; and every action or word that is unfair, disrespectful, or that in any way may give uneasiness, should be avoided, as contrary to the immediate intention of all parties, which is to pass the time agreeably.

Therefore, 1. If it is agreed to play according to the strict rules, then those rules are to be exactly observed by both parties, and should not be insisted on for one side while deviated from by the other; for this is not equitable.

2. If it is agreed not to observe the rules exactly, but one party demands indulgences, he should then be as willing to allow them to the other.

3. No false move should ever be made to extricate yourself out of a difficulty or to gain an advantage; for there can be no pleasure in playing with a person once detected in such unfair practices.

4. If your adversary is long in playing, you ought not to hurry him, or express any uneasiness at his delay. You should not sing, nor whistle, nor look at your watch, nor take up a book to read, nor make a tapping with your feet on the floor or with your fingers upon the table, nor do any thing that may distract his attention; for all these things displease, and they do not show your skill in playing, but your craftiness or your rudeness.

5. You ought not to endeavour to amuse and deceive your adversary, by pretending to have made bad moves, and saying that you have now lost the game, in order to make him secure and careless, and inattentive to your schemes; for this is fraud and deceit, not skill in the game.

6. You must not, when you have gained a victory, use any triumphing or insulting expression, nor show too much of the pleasure you feel; but endeavour to console your adversary, and make him less dissatisfied with himself, by every kind and civil expression that may be used with truth, such as, "You understand the game better than I, but you were a little inattentive;" or, "You had the best of the game, but something happened to divert your thoughts, and that turned it in my favour."

7. If you are a spectator while others play, observe the most perfect silence; for if you give advice you offend both parties—him against whom you gave it, because it may cause the loss of his game; him in whose favour you gave it, because, though it be good, and he follows it, he loses the pleasure he might have had if you had permitted him to think until that had occurred to himself. Even after a move or moves, you must not, by replacing the pieces, show how they might have been placed better; for that displeases, and may occasion disputes or doubts about their true situation. All talking to the players lessens or diverts their attention, and is therefore unpleasing. Nor should you give the least hint to either party by any kind of noise or motion; if you do, you are unworthy to be a spectator. Should you have a mind to exercise or show your judgment, do it in playing your own game, when you have an opportunity, not in criticising, or meddling with, or counselling the play of others.

Lastly, if the game is not to be played rigorously according to the rules as afore-mentioned, then moderate your desire for victory over your adversary, and be pleased with one over yourself. Snatch not eagerly at every advantage offered by his unskilfulness or inattention; but point out to him kindly, that by such a move he places or leaves a piece exposed and unsupported; that by another he will put his king in a dangerous situation, &c. By this generous civility (so opposite to the unfairness before forbidden) you may, indeed, happen to lose the game to your opponent, but you will win what is better, his esteem, his respect, and his affection, together with the silent approbation and good-will of impartial spectators.

When a vanquished player is guilty of an untruth to cover his disgrace, as "I have not played so long—his method of opening the game confused me—the men were of unusual size," &c., all such apologies (to call them no worse) must lower him in a wise person's eyes, both as a man and as a chess-player; and who will not suspect that he who endeavours to shelter himself under such untruths in trifling matters, is no very sturdy moralist in affairs of greater consequence, where his fame and honour are at stake? A man of proper pride would scorn to account for being beaten by one of these excuses, even were it true; because they all at the moment have the appearance of being untrue.

DRAUGHTS.

Draughts is a game with a checkered board and men, of much less antiquity than chess, and is perhaps to be considered a degenerate descendant of that noble sport. In France it is called *les dames*, from having been a favourite game with the ladies; and in Scotland, this signification is preserved in the term *dam-brod*, the name universally applied by the common people to the draught board.

Draughts is played on a chess-board, or a board checkered precisely in the same manner, with thirty-two white and thirty-two black squares. The board, however, is placed before the players differently; in chess there must be a white square in the right-hand corner, but in draughts the right-hand corner must be black (that is, supposing you to play on the white squares).

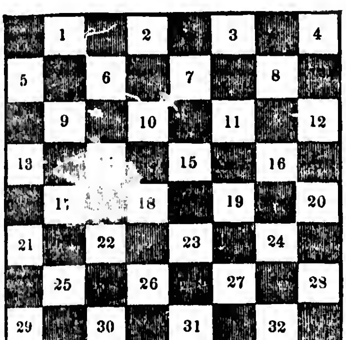
The game is played by two persons, who sit opposite to each other. Each party has a set of twelve men, the colour of the two being different for the sake of distinction. The men are generally round and flat pieces of wood; one set white, and another black: those of the neatest kind are turned out of boxwood and ebony.

The men may be placed either on the white or black squares, but the whole must be put on one colour only. It is customary in England to place all upon the white, and to have, as above, a black square on the right. In Scotland the black are played upon, when there is consequently a white square to the right. We go upon the supposition that the play is upon the white squares, and have numbered them in the annexed figure accordingly.

The movements in draughts are very simple: a man can move only one square at a time, and diagonally, never straight forward or sideways. If an enemy's man stand in the way, no move can take place, unless there be a vacant square beyond, into which the piece can be ated In this case the man leaped over is taken; he is removed from the board.

The grand object of the game, then, is to clear the board of the enemy's men, or to hem them in so that they cannot move; and which ever party does so first gains the victory. As no piece can move more than one step diagonally at a time, there can be no taking till the two antagonists come to close quarters; and the pushing them incautiously into each other's neighbourhood is the principal art of the game.

When the men on either side have cleared their way by taking, or found an open path to the opposite side of the board, they become invested with a new power of movement: by reaching the first row of squares on the opposite side, the piece is entitled to be *crowned*, which is done by placing a man on the top of it. Thus crowned, the man may move backwards, but always diagonally, and one square at a time, as before. This power of moving and taking either forwards or backwards, renders it of consequence to get men crowned; and if two or three on each side gain this honour, the game becomes more interesting, and may speedily be determined. The following is a representation of a draught board, numbered for the sake of illustration, and placed as it should be in playing.



Draught-Board.

Immediately after crowning, great art is shown in blocking up one or more of your adversary's men, by the aid of which to accomplish a series of decisive moves. For instance, supposing you have detained your adversary's piece at 4, while he has others situated on 25 and 26—and supposing you have pieces on 12 and 19, with a crowned man at 14, you may, by giving him your 12 and 19, exchange two pieces for three, which is commonly equivalent to winning the game. Again, supposing you have pieces on 13, 22, 30, and a crowned one on 26, and your adversary a piece on 5, with others scattered in the direction of 16, 8, 7, you may, by successively pushing before him your pieces on 13 and 22, gain a formidable exchange.

In beginning to play, much depends on having the first move; and the rule is, that in playing several games each party takes the first move alternately.

If a player touch one of his men he must play it. If a player omit to take a man when it is in his power to do so, his adversary can *huff*, or *blow*, him; that is, either take the man or insist upon his own man being taken. The practice is at once to lift the man which ought to have taken yours.

We present the following as an example of playing a game in which white loses. The letters N C F, T, at the head of the columns, signify Number, Colour, From, To:—

N	C	F	T	N	C	F	T
1	B	11	15	28	W	30	25
2	W	22	18	29	B	29	22
3	B	15	22	30	W	26	17
4	W	25	18	31	B	11	15
5	B	8	11	32	W	20	10
6	W	29	25	33	B	15	18
7	B	4	8	34	W	24	12
8	W	25	22	35	B	18	27
9	B	12	16	36	W	31	24
10	W	24	20	37	B	14	18
11	B	10	15	38	W	16	11
12	W	27	24	39	B	7	16
13	B	16	19	40	W	20	11
14	W	23	16	41	B	18	23
15	B	15	19	42	W	11	8
16	W	24	15	43	B	23	27
17	B	0	14	44	W	8	4
18	W	18	9	45	B	27	31
10	B	11	25	46	W	4	8
20	W	32	27	47	B	31	27
21	B	5	14	48	W	24	20
22	W	27	23	49	B	27	23
23	B	6	10	50	W	8	11
24	W	16	12	51	B	23	18
25	B	8	11	52	W	11	8
26	W	28	24	53	B	18	15
27	B	25	29	&c.	W	loses.	

It is not considered fair for any bystander to advise what motions should be taken, or for a player to wait longer than five minutes between each move. The draught player, therefore, must on all occasions act with much more promptitude and decision than in the case of chess. In short, draughts is a very ticklish game. A single false step may lead to irretrievable ruin; and it is only after long experience in figuring in the mind what would be the result of particular movements that proficiency is attained.

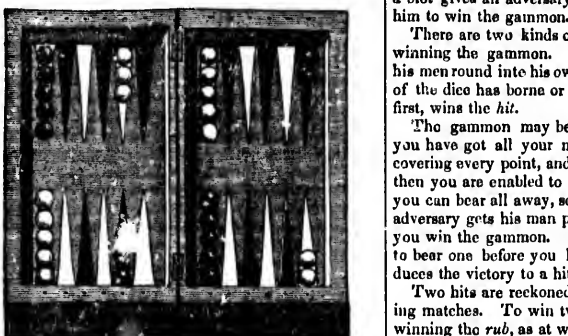
BACKGAMMON.

Backgammon is the modern name of a game of considerable antiquity in England, where it was formerly known by the appellation of "the tables." The words *back-gammon* have been ascribed to the Welsh tongue, in which they are said to signify *little-battle;* but Strutt, with greater plausibility, traces the term to the Saxon "*bac* and *gamen*, that is, back-game; so denominated because the performance consists in the two players bringing their men back from their antagonist's tables into their own; or, because the pieces are sometimes taken up, and obliged to go back; that is, re-enter at the table they came from." Whatever be the etymology of the term, the game has been long established in the country; and, as a fireside amusement of a decorous and exciting nature, is a favourite among clergymen, squires, farmers, and retired professional persons.

Backgammon is played with an apparatus consisting of a board or tables, men or pieces, dice, and dice-boxes. The introduction of dice into the game, and their constant use in determining moves, makes backgammon essentially a game of chance, and therefore brings two players of unequal talents nearer a level than other diversions in which skill is the sole or predominant element.

The backgammon board consists of two parts or tables, generally united by a hinge in the middle, by which they can be shut up as a box. Each table possesses twelve points, six at each end. These points are coloured white and black alternately; but this variation of colour has no reference to the game, and is only done to make the points more easily counted.

The game is played by two parties, and with 30 pieces or men: each party has 15 men, one set of 15 being black and the other white. In beginning the game, the men are placed on certain points on the tables, as shown in the subjoined figure.



B

The Backgammon Table.

The game is played with two dice and two dice-boxes. The dice are common to both; but each party uses his own dice-box, and the throws are alternate.

Each die is a perfect cube, marked on its sides with dots from 1 to 6. The 1 is called *ace*, the two *deuce*, the three *tre* or *trois*, the four *quatre*, the five *cinque*, and the six *size*. At every throw the two dice are employed; consequently a person may throw from two up to twelve; that is, two *aces* up to two *sizes*.

If a player throw *doublets*, or both dice of one number, double the number of dots is reckoned; thus, by a throw of two aces, the player does not count two, but four.

These numbers thrown or accidentally turned up by the dice, bear a reference to the points on the tables. In order to understand this connection between the dice and the men, the learner must observe how the men are placed on the points, and the rules by which their shifting from one to another is governed.

The tables are here spread out as if two partners were seated and about to begin to play. The party owning the white men is seated at W, and the party owning the black men at B. We shall call one party White and another Black. White counts round from the ace point of Black, and Black counts round from the ace point of White. These ace points are respectively seen to have two men upon them in opposite corners of the same table.

The grand object of the game is for each party to get all his men played round into the table containing the aces, removing them from point to point agreeable to the throws of the dice.

In throwing, the number upon each die turned up may be reckoned by itself, or collectively, with the number on the other die. Thus, if quatre be thrown by one die and size by the other, a man can be advanced four points and another six points, or one man can be advanced ten points, always providing that a point is open to suit this movement to it. No point can be moved to, if covered by two men belonging to the adversary. If covered by only one man, which is called a *blot*, then that man can be hit, and be removed from the point, and placed on the bar between the tables, his place being taken by the man who has won it.

The removal of a man to the bars throws a player considerably behind in the game, because the man must remain out of the play till the dice turn up a number corresponding to one open point on the adversary's table. Being fortunate enough to get an open point by this means, the man must be entered and wrought round from thence, as in the case of others in the set to which he belongs. The frequent occurrence of this hitting of a blot gives an adversary a great advantage, and allows him to win the gammon.

There are two kinds of victory, winning the hit and winning the gammon. The party who has played all his men round into his own table, and by fortunate throws of the dice has borne or played the men off the points first, wins the *hit*.

The gammon may be explained as follows:—When you have got all your men round to your own table, covering every point, and your adversary has a man out, then you are enabled to *bear* or lift your men away. If you can bear all away, so as to clear your table before the adversary gets his man placed by a throw on your table, you win the gammon. If the adversary has been able to bear one before you have borne all your men, it reduces the victory to a hit.

Two hits are reckoned equal to one gammon in playing matches. To win two games out of three is called winning the *rub*, as at whist.

Hoyle's Directions for Bearing Men.

If a player has taken up two of the adversary's men, and happens to have two, three, or more points made in his own tables, he should spread his men, that he either may take a new point in his tables, or be ready to hit the man which the adversary may happen to enter. If he finds, upon the adversary's entering, that the game is upon a par, or that the advantage is on his own side, he should take the adversary's man up whenever he can, it being 25 to 11 that he is not hit: except when he is playing for a single hit only; then, if playing the throw otherwise gives him a better chance for it, he ought to do it.

It being 5 to 1 against his being hit with double dice, he should never be deterred from taking up any one man of the adversary's.

If he has taken up one of the adversary's men, and should happen to have five points in his own tables, and forced to leave a blot out of his tables, he should endeavour to leave it upon doublets preferable to any other chance, because in that case the odds are 35 to 1 that he is not hit; whereas it is only 17 to 1 but he is hit upon any other chance.

When the adversary is very forward, a player should never move a man from his own quatre, trios, or deuce points, thinking to bear that man from the point where he put it, as nothing but high doublets can give him any chance for the hit. Instead of playing an ace or a deuce from any of those points, he should play them from his own size or highest points; so that throwing two fives or two fours, his size and cinque points being eased, would be a considerable advantage to him; whereas had they been loaded, he must have been obliged to play otherwise.

It is the interest of the adversary to take up the player as soon as he enters. The blot should be left upon the adversary's lowest point; that is to say, upon his deuce point rather than upon his trois point; or upon his trois point rather than upon his quatre point; or upon his quatre point preferable to his cinque point, for a reason before mentioned; all the men the adversary plays upon his trois or his deuce points are deemed lost, being greatly out of play; so that those men not having it in their power to make his cinque point, and his game being crowded in one place and open in another, the adversary must be greatly annoyed by the player.

If the player has two of the adversary's men in his tables, he has a better chance for a hit than if he had more, provided his game is forwarder than that of his antagonist; for if he had three or more of the adversary's men in his tables, he would stand a worse chance to be hit.

When a player is running to save the gammon, if he should have two men upon his ace point, and several men abroad, although he should lose one point or two in putting his men into his tables, it is his interest to leave a man upon the adversary's ace point, because it will prevent his adversary from bearing his men to the greatest advantage, and at the same time the player will have a chance of the adversary's making a blot, which he may chance to hit. However, if a player finds, upon a throw, that he has a probability of saving his gammon, he should never wait for a blot, as the odds are greatly against his hitting it, but should embrace that opportunity.

BILLIARDS.

This sport may be said to combine the principles of bowls, golf, and some other games in which objects are impelled from the hand. Whether the game was invented in France or England is not clearly ascertained; but as it is mentioned by Shakspeare, it is at least as old in this country as the sixteenth century. In the present day, it is pursued in every civilized country, but principally by the higher or leisurely classes of society. In France, it is much more common than in England, where its character has suffered materially by the game having been made the subject of large gambling speculations. It is unfortunate that such should be the case, for no game is to be considered so purely scientific: it is *dynamics*, or certain laws of motion, put into practical operation; the hits are concussions of the balls exhibiting some of the finest examples of divergent forces.

Billiards is played with a table, certain kinds of rods, and balls. The table varies in size, that in most common use being from eight to twelve feet long, and from four and a half to six feet in width. Whatever be its dimensions, it requires to be perfectly level and smooth. It is ordinarily made of small pieces of wood joined together, so as to avoid warping, and these being brought to a dead level by planing, the surface is covered with fine green cloth. All round is a ledge two to three inches high, and stuffed as a cushion. The table is furnished with six pockets, one at each of the four corners, and one on each side at the middle. The mouths of these pockets or purses are level with the surface, so as to allow the balls to glide easily into them.

The balls are of ivory, about an inch and a half in diameter. Two are white, and one is red. One of the white is distinguished by a spot. There are usually two players; he who owns the plain ball is called *Plain*, and he who owns the spotted ball is termed *Spot*. The red ball belongs to neither, but is aimed at by both.

The rods or bills used by the players are of two kinds, and different lengths to suit different players. The ordinary kind of rod is called a *cue*. It is long and smooth, with one end thick and heavy, and the other more slender. The other kind of rod is termed a *mace*; it has a club-like extremity, and is much less frequently used. Almost all players employ cues of the length which suits them.

In playing, the left hand is rested with the palm undermost on the table. The palm is hollowed, and the thumb close to the forefinger is raised up to form a bridge or rest for the cue. The hand is to be at the distance of about six inches from the ball. The cue is lightly held in the right hand, the thick end uppermost, the blow being struck with the small extremity. Thus held, in a free but firm manner, and resting on the channel between the forefinger and thumb, the cue is given a sharp run forward so as to hit the ball in the required direction, and with that exact degree of force which will make it perform the desired feat. To prevent slipping, the point of the cue is generally chalked.

The table is laid out as follows for play:—At the distance of about a foot from one end, in the centre of the table, is a small dot or mark in the cloth, on which the red ball is placed. At a similar distance from the other, which we shall call the upper end of the table, a line is made across by a chalked string; and in the middle of this line there is a mark on which the white ball of a player is to be struck from.

The leading principle in the sport is for a player to impel his white ball against the red ball, and drive them into a pocket or pockets; or to perform a still greater feat of striking the red ball, the adversary's ball, and his own ball, into pockets. It must be understood that nothing is gained by a player striking his own ball direct into a pocket; anybody could do that, and there would be no science in it. The merit consists in impelling balls against each other, at such an exact angle that one or both may be pocketed; and the skill displayed in this is often very surprising.

In setting out in a game, the first stroke or lead is determined by lot. This is called *stringing* for the lead. Each player hits his ball from the *string* or line, and he who causes it to rebound from the bottom cushion and come back nearest to the upper cushion, has the lead and the choice of the balls.

The first player begins by striking his ball from the string against the red ball, as already mentioned; and if he pockets the balls, he scores a certain number and begins again. So long as he pockets, the adversary does not get a stroke. If the player miss, the adversary takes his turn. Both now play alternately, hitting the balls where they chance to lie; but when one pockets, he starts afresh by striking from the string.

A person in attendance *scores* or keeps reckoning of the play. He does this by means of two indices moving round a figured circle, and when one is gained he turns the index accordingly. Technically, he is told to score one for Plain or one for Spot.

Hitherto we have spoken of billiards as one game, but it is necessary to explain that at least twelve different games may be played. We shall notice the two following as those in common use.

Winning and Losing Game.

This is played by two persons, and twenty-one points are the game. The following are Hoyle's regulations for playing it:—

1. The game commences, as usual, with stringing for the lead, as well as the choice of balls. The ball in stringing to be placed within the circle, and the striker must stand within the corners of the table. The ball which rebounds from the bottom cushion, and comes nearest to the cushion within the baulk, takes the lead, and has the choice of balls.

2. If the adversary to the first person who has strung for the lead should cause his ball to touch the other, he loses the lead thereby.

3. When a player holds the ball in stringing or leading, his lead is forfeited.

4. If a ball is followed by either mace or cue beyond the middle hole, it is no lead; the adversary, of course, may force him to renew his lead.

5. After every losing hazard, the ball is to be replaced within the nails or spots, and within the ring.

6. The place for the red ball is on the lowest of the two spots at the bottom of the table.

7. The red ball being holed or forced over the table, is placed immediately on the lowest of the two spots; the present player is, besides, compelled to see it thus replaced, else he cannot score any points while it is off the spot; the stroke, of course, is foul.

8. When the player misses his adversary's ball, he loses one; but should he at the same time pocket his own ball, he then loses three besides the lead.

9. The adversary's ball, and the red ball also, being struck by a player.

10. When the striker, after making a hazard or carambole, accidentally forces his own or either of the other balls over the table, he loses all the advantages he has gained besides the lead.

11. When a ball is accidentally forced over the table, the striker loses the lead.

12. To strike your adversary's ball and the red one too, you score two; this is called a carom or carambole.

13 To hole the adversary's or the white ball, you score two. To hole the red ball you score three.

14. When the striker holes his own ball off his adversary's

he scores two points; but if he holes his ball off the red, he scores three. But if he holes both the red and his adversary's balls, he scores five. If the player holes the red and his own ball, he scores six.

15. If the striker holes his own and his antagonist's ball, he scores four.

16. When the striker plays at the white ball, and should hole the red after that, and his own ball besides, he scores five—two for holing the white and three for the red.

17. When the striker playing on the red ball first, should pocket his own as well as his adversary's ball, he scores five points; three for holing off the red, and two for holing his own.

18. If the player holes his adversary's ball, his own, and the red, he scores seven points; namely, two for holing off the white, two for the adversary's holing, and three for holing the red ball.

19. Should the striker hole his own ball off the red, and hole the red and his adversary's too at the same stroke, he scores eight points thus: three for holing himself off the red, three for the red itself, and two for holing his adversary.

*** All the above games, commencing with the thirteenth, are scored without the carambolea; the following are those in which the carambolea occur:—

20. When a carambole is made, and the adversary's ball is pocketed, four are scored; namely, two for the carambole, and two for the white.

21. If the striker pockets the red ball after making a carambole, he scores five; two for the carambole, and three for the red.

22. If the striker should hole both his adversary's and the red ball, after having caramboled, he scores seven; two for the carambole, two for the white, and three for the red ball.

23. When a carambole is made by striking the white ball first, and the striker's ball should be holed by the same stroke, four points are gained.

24. When the striker makes a carambole by striking the red ball first, and should hole his own ball at the same time, he gains five points; three for the red losing hazard, and two for the carambole.

25. If in playing at the white ball first you should make a carambole, and hole your own and adversary's ball at the same time, you score six points; namely, two for each white hazard, and two for the carambole.

26. The striker wins seven points when he caramboles off the red ball, and holes his own and his adversary's ball; namely, two for the carom, two for the white, and three for the red hazard.

27. When the player caramboles by playing first at the white, and should also hole his own and the red, he scores seven points: namely, two for the carom, two for the white losing hazard, and three for the red winning hazard.

28. When the player caramboles by hitting the red ball first, and also holes his own and the red, he scores eight; namely, two for the carom, three for the red winning hazard, and three for the red losing hazard.

29. Should a player carambole on the white ball first, and then hole his own ball and his opponent's, and the red ball besides, he then scores nine; thus, two for the carom, two for each white, and three for the red hazard.

30. If a carambole is done by striking the red ball first, and at the same stroke the player holes his own ball, the red ball, and his adversary's too, he gains ten points, upon the principle of the preceding rule.

31. When your adversary's ball is off the table, and the other two balls are upon the line or inside of the stringing nails at the leading end of the table, it is named being within the baulk. The player, therefore, striking from the ring, must make his ball rebound from the opposite cushion, so as to hit one of the balls within the baulk; if he misses, he loses a point.

32. Now and then it occurs that after the red ball has been forced over the table or holed, one of the white balls has so taken up the place of the red ball, that it cannot be replaced in its proper situation without touching it. In such, the marker holds the red ball in his hand, while the player strikes at his opponent's ball.

33. And directly after the stroke, replaces it on the proper spot, in order that it may not prevent a carambole from being made.

34. When the striker plays a wrong ball, it is reckoned a foul stroke.

35. When the player is about to strike at or play with the wrong ball, none in the room can with propriety discover it to him, his partner excepted, if they are playing a double match.

36. When the player, after making a carom or a hazard, should, either with his hand, cue, or mace, move either of the balls remaining on the table, the stroke is foul.

37. If the striker should play with the wrong ball, and this erroneous play should not be discovered by his opponent, the marker is obliged to score, and he is a winner of all the points he has gained by the stroke.

38. None can move or touch a ball without permission of the adversary.

39. Sometimes a ball happens to be changed in the course of the game, and it cannot be ascertained by which player; in that case, the balls must be used as they then are, and the game so played out.

40. It is a foul stroke when the striker, in the act of playing, should happen to touch his ball twice.

41. Sometimes the player accidentally touches or moves his ball, without intending to strike. In that case he loses no point, but his ball may be replaced as it originally stood.

42. When a striker's adversary or spectator impedes the player's stroke by accident or design, he has a right to renew his stroke.

43. Should a player, in the act of striking, hit his ball, and cause his cue or his mace to go over it or past it, he forfeits a point.

44. No striker can play upon a running ball; such stroke is foul.

45. An accidental stroke is to be considered good if attended with the proper effect, though, by missing the cue, &c., it is not intended as such.

46. Should a striker, in attempting to play, not hit his ball at all, it is no stroke, and he is to try again.

47. Should the striker or his adversary, in the act of playing, move by accident or design the opponent's white or red ball from the place it occupied on the table, the stroke is foul.

48. When the striker's ball and either of the other balls are so close as to touch each other, and in striking at the former, either of the latter is moved from its place, the stroke is foul.

49. Whoever stops a running ball in any way loses the lead, if the opponent does not like the situation of the ball he has to play at next time.

50. It may happen that a striker, after having made a carambole or a hazard, interrupts, by accident, the course of his own ball; in this case he scores nothing, as the stroke is foul.

51. Should a player impede the course of his own ball, after having made a miss, and it is running towards the hole, and it is so thought also by the marker, he loses three points.

52. To stop, retain, or impede the adversary in the act of striking, is deemed foul.

53. Should a player in any way interrupt, stop, or drive his adversary's ball out of its course when running towards a pocket, he forfeits three points.

54. Even blowing upon a ball whilst running makes a stroke foul; and should the striker's ball be making its way towards a hole, and he blow upon it, he loses two points by such act.

55. If a mace or cue is thrown upon the table during a stroke, it is baulking the striker, and the stroke is considered foul.

56. No play is deemed correct when both feet are off the ground.

57. If the table is struck when a ball is running, the stroke is deemed foul.

58. A player leaving a game unfinished loses that game.

59. Some tables are so uneven that they give way toward the pockets. In case a ball should go to the brink of a hole, and after there resting for a few seconds, should drop into it, such tells for nothing; and the ball must be again placed on the brink before the adversary strikes again; and should it fall into the hole again the moment the striker has played his ball, so as to frustrate the intended success of his stroke, the striker's and his opponent's balls must be placed as they were originally, and the strokes played over again.

60. When a player's mace or cue should touch both balls in the act of striking, the stroke is foul; and if noticed by his opponent, nothing is gained on the points made by the stroke; and the opponent may, if he pleases, part the balls also.

61. Those who agree to play with the cue must do so during the whole of the match; but if no conditions of this sort have been made, the player may change as he pleases. No player can, without permission of the adversary, break his agreement.

62. If a foul stroke is made, the adversary may either part the balls and play from the ring, or, if the balls should be favourably placed for himself, permit the striker to score the points he had gained, which the marker is bound to do in all cases where the balls are not broken.

63. All agreements are specially binding. For instance, those who agree to play with the cue point and point, cannot use the butt without permission; but they may use the long cue: and the same with those who agree to play with the butt only.

64. A striker wins, and the marker is obliged to score all the points he gains, by unfair strokes, if the adversary neglects to detect them.

65. He who offers to part the balls, and the adversary agreeing to the same, the offerer loses the lead by such proposal.

66. None (unless they belong to a four match) have a right to comment on a stroke, whether fair or foul, until asked; and in the above case, none but the player and his partner can ask it.

67. When disputes arise between the players, the marker alone decides, and there is no appeal from his decision. But, it may occur, he might have been inattentive to the stroke; in that case, he is to collect the sense of the disinterested part of the company; namely, those who have no bets on the stroke; and their decision is to be final.

The White Game.

Two players are engaged as above, and the striking is alternate. The general principle is, that you win if you pocket the red ball or your adversary's ball, but invariably lose if by any means you hole your own ball. The number of points in the game is twelve. The following are Hoyle's regulations:—

1. In beginning, string for the lead, and the choice of balls, if you please.

2. When a person strings for the lead, he must stand within the limits of the corner of the table, and also must not place his ball beyond the stringing nails or spots; and he who brings his ball nearest the cushion wins the lead.

3. If after the first person has strung for the lead, and his adversary who follows him should make his ball touch the other, he loses the lead.

4. Should the player hole his own ball either in stringing or lending, he loses the lead.

5. Should the leader follow his ball with either mace or cue past the middle hole, it is no lead; and if his adversary chooses, he may make him lead again.

6. The striker who plays at the lead must stand with both his feet within the limits of the corner of the table and must not place his ball beyond the stringing nails or spo[illegible] nd his adversary (only) is bound to see that he stands and [illegible] fair, else the striker wins all the points he made by that stroke.

7. When a hazard has been lost in either of the corner holes, the leader is obliged (if his adversary requires it) to lead from the end of the table where the hazard was lost; but if the hazard was lost in either of the middle holes, it is at the leader's option to lead from either end of the table he pleases.

8. If the striker misses his adversary's ball, he loses one point; and if, by the said stroke, his ball should go into a hole, over the table, or on a cushion, he loses three points: namely, one for missing the ball, and two for holing it, &c., and he loses the lead.

9. If the striker holes his adversary's ball, or forces it over the table, or on a cushion, he loses two points.

10. If the striker holes his own ball, or forces it over the table, or on a cushion, he loses two points.

11. If the striker holes both balls, or forces them over the table, or on a cushion, he loses two points.

12. No one has a right to take up his ball without permission from his adversary.

13. If the striker, by accident, should touch or move his own ball, not intending to make a stroke, it is deemed as an accident; and his adversary, if he requires it, may put the ball back in the place where it stood.

14. If the striker forces his adversary's ball over the table, and his adversary should chance to stop it, so as to make it come on the table again, the striker nevertheless wins two points.

15. When the striker forces his own ball over the table, and his adversary should chance to stop it, so as to make it come on the table again, the striker loses nothing by the stroke, and he hath the lead; because his adversary ought not to stand in the way, or near the table.

16. If the striker misses the ball, and forces it over the table, and it should be stopped by his adversary, as before mentioned, he loses one point, and has the lead if he chooses.

17. If the striker, in playing from a cushion or otherwise, by touching the ball, makes his mace or cue go over or past it, he loses one point; and if his adversary requires it, he may put the ball back, and may make him pass the ball.

18. If the striker in attempting to make a stroke, doth not touch his ball, it is no stroke; and he must try again to make a stroke.

19. If, when the balls are near each other, and the striker by accident should make his ball touch the other ball, it is nevertheless a stroke, though not intended as such.

20. If the striker who plays his stroke should make his adversary's ball go so near the brink of a hole as to be judged to stand still, and afterwards should fall into it, the striker wins nothing; and the ball must be put on the same brink where it stood, for his adversary to play from the next stroke.

N. B.—There is no occasion for challenging the ball if it stops, as some imagine.

21. If the striker's ball should stand on the brink or edge of a hole, and if, in playing it off, he should make the ball go in, he loses three points.

22. If a ball should stand on the brink or on the edge of a hole, and it should fall into the hole before or when the striker has delivered his ball from his mace or cue, so as to have no chance for his stroke, in that case the striker and his adversary's balls must be placed in the same position, or as near as possible thereto, and the striker must play again.

23. The striker is obliged to pass his adversary's ball, more especially if he misses the ball on purpose; and his adversary may, if he chooses, oblige him to place the ball where it stood, and play until he has passed.

24. If the striker plays both balls from his mace or cue, so that they touch at the same time, it is deemed a foul stroke; and if it is discovered by his adversary, and a dispute should arise thereon, he has an undoubted right to appeal to the disinterested company then present: and if determined by the majority of the disinterested company, and the marker, if needful, to be a foul stroke, then it is at his adversary's option (if not holed) either to play at the ball or take the lead. But if, by the above-mentioned stroke, his adversary doth not discover it to be a foul stroke, then the striker may reckon all the points he made by the said stroke, and the marker is obliged to mark them.

25. No person has a right to discover to the player whether the stroke is fair or foul, until it is asked.

26. If by a foul stroke the striker should hole his adversary's ball, he [illegible] the lead.

27. I[illegible] foul stroke the striker holes his own or both balls, or forces [illegible] own or both balls over the table, or on a cushion, he loses two points.

28. If the striker plays on a ball when it is running or moving, it is deemed as a foul stroke.

29. If the striker plays with both feet off the ground, without the permission of his adversary, it is deemed a foul stroke.

30. If the striker plays with a wrong ball he loses the lead, if his adversary requires it.

31. If the ball should be changed in a hazard or on a game, and it is not known by which party, the hazard must be played out by each party with their different balls, and then changed.

32. If the striker plays with his adversary's ball, and holes or forces the balls he played at over the table, &c., it is deemed a foul stroke.

33. If the striker plays with his adversary's ball, and holes or forces the ball he played with over the table, &c., he loses two points; and if he missed the ball, three points.

[illegible] If the striker plays with his adversary's ball, and misses it, he loses one point: and if his adversary discovers that he hath played with the wrong ball, he may part the balls, and take the lead if he pleases.

35. In all the before-mentioned cases of the striker's playing with the wrong ball (if discovered), his adversary must play with the ball the striker played at throughout the hazard, or part the balls and take the lead.

36. Whoever stops a ball when running with hand, stick, or otherwise, loses the lead, if his adversary does not like the ball, he has to play at the next stroke.

37. Whoever retains his adversary's stick when playing, it is deemed foul.

38. If the striker stops or puts his own ball out of its course when running towards either of the holes, and if adjudged by the marker and the disinterested company then present to be going into a pocket, if he missed the ball he loses one point, and, if going into a hole by the same stroke, three points.

39. If the striker stops or puts his adversary's ball out of the course when running towards or into a hole, or puts his adversary's ball into a hole, it is deemed a foul stroke.

N. B.—If the adversary doth the same as in the foregoing rules, he is subjected to the same penalties as the striker.

40. He who shakes the table when the ball is running makes it a foul stroke.

41. He who throws his stick upon the table, so as apparently to be of any detriment to his adversary, makes it a foul stroke.

42. He who blows on the ball when running makes it foul. And if his own ball was running towards or near the hole, he loses two points.

43. He who leaves the game before it is finished, and will not play it out, loses the game.

44. Any person may change his mace or cue in playing, unless otherwise previously agreed on.

45. When two persons are at play, and no particular terms of agreement have been made, neither party has a right to object to either mace or cue being played with in the said game.

46. When the parties agree to play mace against cue, the mace player hath no right to use a cue, nor has the cue player any right to use a mace during the game or match, without permission from his adversary.

47. When a person agrees to play with the cue, he must play every ball within his reach with the point thereof; and if he agrees to play with the butt of the cue, he has no right to play with the point thereof, without permission from his adversary.

48. When the parties agree to play point and point of the cue, neither of them has a right to use a butt during the game or match, without permission, &c., but they have a right to play with the point of a long cue over a mace, &c.

49. When the parties agree to play all point with the same cue, they have no right to use any other during the game or match.

50. Whoever proposes to part the balls, and his adversary agrees to it, the proposer thereof loses the lead.

51. Two missings do not make a hazard, unless it is previously agreed on to the contrary.

52. In all cases, the betters are to abide by the players on the determination of the hazard, or on the game; and the betters have a right to demand their money when their game is over, to prevent disputes.

53. Every person ought to be very attentive, and listen for the stroke, before he opens the door of a billiard-room.

54. The striker has a right to command his adversary not to stand facing him, nor near him, so as to annoy or molest him in the stroke.

55. Each party is to attend to his own game, and not to ask if his adversary's ball be close?—if he touches his ball?—if he can go round the ball?—nor any question of the like tendency; nor is any one to be set right, if going to play with the wrong ball.

56. When four persons play, the game is fifteen in number, and each p[illegible] has a right to consult with and direct his partner in any [illegible] respecting the game, &c., and the party who makes two missings before the hazard is made, is out, and it is his partner's turn to play; but if, after the two missings have been made by the party, his adversary should hole a ball, so as to make a hazard, the stroke following the said two missings have been made, yet the party who did not make the two missings is to play, as he cannot be supposed to be out who has not made a stroke.

BAGATELLE.

The large and inconvenient size of billiard-tables has led to the introduction of bagatelle-tables—*bagatelle* being the French word for any thing trifling. A bagatelle-table is usually about five feet long and eighteen inches broad; it is lined with cloth, and a game is performed on it with balls and a cue or mace. The balls are small ivory spheres, and the sport very much consists in striking one or more into holes at one end of the board. To perform this and other feats, some skill and experience are required, and the sport is far from unamusing in a cheerful parlour circle. Of late years, bagatelle-tables have become very common in the houses of the middle classes of society; they possess the recommendation of being purchaseable at a small expense.

GAMES WITH CARDS.

Playing cards are small oblong pieces of pasteboard, on which divers figures are impressed in two principal colours, red and black. Fifty-two cards form a *pack*, or complete set for playing any game. The pack consists of four *suits* or kinds of cards, thirteen in each, distinguishable by their respective marks. The suits are *hearts*, *diamonds*, *clubs*, and *spades*. Hearts and diamonds are red; clubs and spades are black. The thirteen in each suit consist of ten cards, distinguishable by spots, from one to ten; and three cards, ordinarily called *court cards*, from being impressed with certain figures having a semblance of court costume—one of these is the *king*, another the *queen*, and a third the *knave*, or *jack*.

Of the origin of playing-cards, and the signification of their respective markings, there has been no small controversy among antiquaries. The general opinion has been that cards were invented about the year 1392, for the purpose of amusing Charles VI. of France, at the time he was afflicted with a mental depression or derangement. But it has been ascertained that, in 1387, John I., king of Castile, issued an edict forbidding the playing of cards in his dominions; and from this, as well as from some of the names given to the cards, it is extremely probable that playing-cards were known in Europe as early as about the middle of the fourteenth century. At first, the outlines of the figures on the cards were made by stamps, and afterwards filled up by the hand; but soon after the invention of engraving on blocks, the devices were produced by wood, and sufficiently finished, so that the impressions did not require any assistance from the pencil.

The names—hearts, diamonds, spades, and clubs—which the English give to the cards, appear to be in a great measure a corruption of the original Spanish and French appellations, or a misapplication of terms to the original symbols. We find the following account given of the design and names of the cards in the work of an anonymous writer:—

"The inventor proposed, by the figures of the four suits, or colours, as the French call them, to represent the four states or classes of men in the kingdom.

"By the *Cœurs* (hearts) are meant the *gens de chœur*, choir men, or ecclesiastics; and therefore the Spaniards, who certainly received the use of cards from the French, have *copas*, or chalices, instead of hearts.

"The nobility or prime military part of the kingdom are represented by the ends or points of lances or pikes, and our ignorance of the meaning or resemblance of the figure induced us to call them spades. The Spaniards have *espadas* (swords) in lieu of pikes, which is of similar import.

"By diamonds are designed the order of citizens, merchants, and tradesmen, *carreux* (square stone tiles or the like). The Spaniards have a coin, *dineros*, which answers to it; and the Dutch call the French word *carreux*, *stieneen*, stones and diamonds, from the form.

"*Trefle*, the trefoil leaf, or clover grass (corruptly called clubs), alludes to the husbandmen and peasants. How this suit came to be called clubs, is not explained, unless, borrowing the game from the Spaniards, who have *bastos* (staves or clubs) instead of the trefoil, we gave the Spanish signification to the French figure.

"The history of the four kings, which the French in drollery sometimes call the cards, is *David*, *Alexander*, *Cæsar*, and *Charles* (which names were then, and still are on the French cards). These respectable names represent the four celebrated monarchies of the Jews, Greeks, Romans, and Franks, under Charlemagne.

"By the queens are intended *Argine*, *Esther*, *Judith*, and *Pallas* (names retained in the French cards), typical of birth, piety, fortitude, and wisdom, the qualifications residing in each person. Argine is an anagram for *regina* (queen by descent).

"By the knaves were designed the servants to knights (for knave originally meant only servant; and in an old translation of the Bible, St. Paul is called the knave of Christ); but French pages and valets, now indiscriminately used by various orders of persons, were formerly only allowed to persons of quality; esquires (*escuiers*), shield or armour bearers.

"Others fancy that the knights themselves were designed by those cards, because *Hogier* and *Lahire*, two names on the French cards, were famous knights at the time cards were supposed to be invented."

With the entire pack of fifty-two cards, or with only a portion of it, there have been innumerable games, and there are so still; to notice the whole of these, however would occupy too much of our space, and we propose to confine our explanations to what are considered respectable and harmlessly amusing games.

WHIST.

All games at cards, in our opinion, are insignificant in comparison with *whist*, which is believed to take its name from an old exclamation to keep silence; it must, at least, be conducted noiselessly, and with extreme attention. The whole structure of the game is ingenious, and a result of just calculation. Its rules have all been carefully studied, and there seems to be a sufficient reason why each has been instituted. The game is a happy blending of skill and chance; skill being the most important element, and chance only accessary, in order to impart a due relish or piquancy to the sport, and deprive highly-skilled players of being always certain of the victory.

Whist is played by four persons, two forming a party or side. The four sit at a square table, one on each side, partners being opposite to each other. The table should be covered with cloth, to permit an easy lifting of the cards. Before commencing the game, a pack of cards is laid on the table, the faces undermost. The parties then *cut* for partners; that is, they leave it to chance to determine who shall be partners. This is done by each person lifting or *cutting* a portion of the cards from the heap or pack, and the two who have the highest cards play together.

The *value* of the cards is as follows:—As already stated, there are four suits, each suit consisting of thirteen cards, ten being common, and three being court cards. The card in each suit which has but one mark is called the *ace*; and this ace is the highest in value in all cases except in cutting for partners, when it is the lowest. The next highest is the king, the next the queen, the next the knave; then the ten, nine, eight, and so on down to the two, or *deuce*, which is the lowest. In playing whist, one suite is of higher value than any of the other three; but which suit shall possess this temporary distinction depends on chance in dealing out the cards; the last card dealt out is turned up, and the suite to which it belongs is called *trumps*;* trumps, then, is the suite of the highest value. In the course of a game, the trump suit may of course vary at every deal.

The *cutting* of the pack, as above mentioned, determines who are to be partners, and at the same time determines who is to *deal*. The rule is, that he who had the lowest card in cutting is the dealer. This person *shuffles* the cards; that is, mixes them in any way he thinks proper, always keeping the backs towards him. Having done this, his adversary is entitled to shuffle the cards also; indeed, each person has a right to shuffle them, but this is seldom done. Being duly shuffled, the pack is laid on the table (always back uppermost) before the *youngest hand*, or the person sitting to the right hand of the dealer; and he cuts it, by lifting off a portion and laying it down. The dealer now puts the lower portion on the top of the portion laid off, and is prepared for dealing.

* The term *trump* is believed to be a corruption of *triumph* meaning the triumphant card.

Dealing must be neatly performed; the dealer holding the pack in his left hand, lifts off the top cards with the right, and distributes them, one to each, all round. He begins with the person on his left, who is called the *elder hand*, then the person opposite, then the youngest hand, and then himself. He thus goes thirteen rounds, the last card which he holds in his hand falling to his own share. This last card he turns up, and it determines the suit to be trumps. The dealer, therefore, has at least always one trump in his hand, but this advantage is supposed to be neutralized by the adversaries having a knowledge of one of his cards. The trump card lies on the table exposed till the first trick is played. Any exposure of a card in dealing, by real or pretended accident, is strictly provided against. The following are Hoyle's

Rules for dealing.

If a card is turned up in dealing, the adverse party may call a new deal if they think proper; but if either of them has been the cause of turning up such card, then the dealer has the option.

If a card is faced in the deal, there must be a fresh deal, unless it happens to be the last card.

It is the duty of every person who plays to see that he has thirteen cards. If any one happens to have only twelve, and does not find it out till several tricks are played, and that the rest have their right number, the deal stands good, and the person who played with the twelve cards is to be punished for each revoke, provided he has made any. But if any of the rest of the players should happen to have fourteen cards, in that case the deal is lost.

The dealer should leave his trump card upon the table till it is his turn to play; and after he has mixed it with his other cards, no one has a right to demand what card was turned up, but may ask what suit is trumps: in consequence of this law, the dealer cannot name a wrong card, which otherwise he might have done.

None of the players may take up or look at the cards while they are dealing out; when this is the case, the dealer, if he should happen to misdeal, has a right to deal again, unless it arises from his partner's fault: and if a card is turned up in dealing, no new deal can be called, unless the partner was the cause of it.

If any person deals, and, instead of turning up the trump, he puts the trump card upon the rest of his cards, with the face downwards, he loses his deal.

Playing the Game.

The cards being all dealt, each takes up his hand, which he must scrupulously prevent any of his antagonists or his partner from seeing. The cards should be ranged like a fan in the left hand, so that its holder can see all his cards at a glance. It is advisable, for the sake of order and convenience, to arrange the cards in the hand, all of a suite together. Each having his cards sorted, the game commences by the elder hand, or person on the left of the dealer, laying down a card. The person on his left follows, and so on to the dealer, who lays down last.

The principle of playing is as follows:—Whatever suit the first card is of, that suit must, if possible, be followed by each party round; but if one party has not a card of that suit, he can lay down one of any other suit. Should he do so, and afterwards lay down a card of the suit which he appeared to be deficient of, he has committed a *revoke*, and a penalty is exacted in loss of three tricks. It is necessary, for the sake of fair play, to be very rigorous in punishing a revoke.

The four cards laid down in a round is called a *trick*. The trick is won in various ways. The card of the highest value wins. For example, if the first player lays down a deuce of spades, the second a three of spades, the third a four of spades, and the fourth a five of spades, this last person wins; his party gains a trick. But should one of the players not have a spade in his hand, and lays down a deuce of the suit which happens to be trumps, that card wins. No matter how high in value the cards laid down are, the trick is always won by a trump card, though it were only a deuce. If several trump cards be laid down, or all be trumps, then the highest trump card wins. The ace of trumps is the highest card.

When the trick is played, it is lifted by the person who wins, and placed beside him in a heap on the table, back uppermost; and he continues to take up all other tricks his party wins. Thus, one on each side collects and reckons the tricks.

Whoever wins the trick becomes elder hand, and plays first in next round; and so on each winner plays first till all the cards are played out.

A pack produces thirteen tricks, but none is counted till after six. For instance, if one party wins four tricks, they do not count; and the other party which has nine tricks counts three. Should one party gain all the tricks, it counts seven.

The ace, king, queen, and knave of trumps, are called *honours*. These have a peculiar value in reckoning towards the game. Should each person hold one honour, honours do not count: but should two partners hold three honours between them, they score two points; when they hold four, they score four points.

The game consists of ten *points*, and these may be gained by tricks and by honours. Should a party make six tricks and hold four honours, it has won the game at one deal. It will therefore be perceived that honours, the possession of which is a matter of mere chance, exert a powerful influence in gaining the victory over an adversary.

Only at one time in the game do honours not count; this is when the party is at nine; the odd point to make up to ten being only gained by tricks. When a party is at eight, and the first trick has been played, one of that party, who holds two honours, may ask his partner if he has one honour; and if he says he has, the three honours are at once shown, which concludes the game. There are rules for calling honours, which we subjoin.

In the course of playing the game, no one must drop the slightest hint how he wishes his partner to play, or make any other observation calculated to mislead or direct. Neither may any one, before his partner has played, inform him that he has or has not won the trick; even the attempt to take up a trick, though won, before the last partner has played, is deemed very improper.

All parties must play by their own perceptions of what would be most judicious. There is only one exception to the rule of keeping silence, which is in the case of a revoke. If a person happens not to follow suit, or trump a suit, the partner is at liberty to inquire of him whether he is sure he has none of that suit in his hand. This indulgence must have arisen from the severe penalties annexed to revoking, which affects the partners equally, and is now universally admitted.

The great knack in playing whist is to *remember what is out*, and hence, by the play of both partner and adversaries, to have a shrewd guess of what each holds in his hand. A primary rule is to follow a partner's lead, as it is presumed that no one, in playing first, is without a good reason for tabling a particular suit.

The term *finessing* signifies the attempt to gain advantage; thus, if you have the best and third best card of the suit led, you put on the third best, and run the risk of your adversary's having the second best; if he has not, which is two to one against him, you are then certain of gaining a trick.

A *loose card* is a card of no value, and consequently the most proper to throw away; it would be folly to lay a good card down, when it must clearly be taken by a better card already tabled.

A *sequence* is a succession of cards in the same suit as ace, king, queen, knave.

Tenace is possessing the first and third best cards, and being last player; you consequently conquer the adversary when that suit is played.

Scoring is the method of reckoning the points in a game. The reckoning is made by four counters or pieces of money; and the way in which these pieces are dis posed, shows the score. The following is the ordinary method of scoring:—

1	2	3	4	5	6	7	8	9
				0	0	00	000	0
0	00	000	0000	00	000	0	0	0
								0

Rules for Playing.

If a person plays out of his proper turn, or shows a card, it is in the option of either of his adversaries to call that card; that is, cause him to lay it down at any time in that deal, provided it does not make him revoke; or either of the adversaries may require of the person who ought to have led, the suit the said adversary may choose.

If a person supposes he has won the trick, and leads again before his partner has played, the adversary may oblige his partner to win it if he can.

If a person leads, and his partner plays before his turn, the adversary's partner may do the same.

If the ace or any other card of a suit is led, and the last player should happen to play out of his turn, whether his partner has any of the suit led or not, he is neither entitled to trump it nor to win the trick, provided you do not make him revoke.

If a revoke happens to be made, the adversaries may add three to their score, or take three tricks from the revoking party, or take down three from their score; and if up, notwithstanding the penalty, they must remain at nine: the revoke takes place of any other score of the game.

If any person revokes, and discovers it before the cards are turned, the adversary may call the highest or lowest of the suit led, or call the card then played, at any time when it does not cause a revoke.

No revoke can be claimed till the trick is turned and quitted, or the party who revoked, or his partner, has played again

If a revoke is claimed by any person, the adverse party are not to mix their cards, upon forfeiture of the revoke.

No person can claim a revoke after the cards are cut for a new deal.

If any person calls except at the point of eight, the adversaries may call a new deal, if they think proper.

After the trump card is turned up, no person must remind his partner to call, on penalty of losing one point.

No honours in the preceding deal can be set up after the trump card is turned up, unless they were before claimed.

If any person calls at eight, and his partner answers, and the adverse party have both thrown down their cards, and it appears that the parties calling have not the honours, the adversaries are entitled, if they please, to compel the play to go on, or to have a new deal.

If any person answers without having an honour, the adversary may consult and stand the deal or not.

If any person calls at eight, after he has played, it is in the option of the adverse party to call a new deal.

If any person separates a card from the rest, the adverse party may call it, provided he names it, and proves the separation; but if he calls a wrong card, he or his partner are liable for once to have the highest or lowest card called in any suit led during that deal.

If any person, supposing the game lost, throws his cards upon the table with their faces upwards, he may not take them up again, and the adverse party may call any of the cards when they think proper, provided they do not make the party revoke.

If any person is sure of winning every trick in his hand, he may show his cards, but he is then liable to have them called.

If any person omits playing to a trick, and it appears that he has one card more than the rest, it is in the option of the adversary to have a new deal.

Each person, in playing, ought to lay his card before him; and if any of the adversaries mix their cards with his, his partner may demand each person to lay his card before him, but not to inquire who played any particular card.

Hints to Learners.

1. Lead from your strong suit (or that with which you could make the most tricks), and be cautious how you change suits.
2. Lead through an honour when you have a good hand—that is, cause your adversary on the left to lay down a good honour, in order that it may be taken up if possible by your partner.
3. Lead through the strong suit of the left-hand adversary, unto the weak of him who is on the right; but not in trumps, unless you are strong in them.
4. Lead a trump, if you have four or five, or a strong hand; but not if weak.
5. Sequences are eligible leads, and begin with the highest.
6. Follow your partner's lead, but not your adversary's.
7. Do not lead from ace queen or ace knave.
8. Do not lead an ace unless you have the king.
9. Do not lead a thirteenth card unless trumps are out.
10. Do not trump a thirteenth card unless you are last player, or want the lead.
11. The third to play always to put on his best card.
12. When you are in doubt, win the trick.
13. When you lead small trumps, begin with the highest.
14. Do not trump out when your partner is likely to trump a suit.
15. Having only a few small trumps make them when you can.
16. Make your tricks early, and be cautious how you finesse.
17. Never neglect to make the odd trick when in your power.
18. Never force your adversary with your best card, unless you have the next best.
19. If you have only one card of any suit, and but two or three small trumps, lead the single card.
20. Always endeavour to keep a commanding card to bring in your strong suit.
21. When your partner leads, endeavour to keep the command in his hand.
22. Always keep the card you turned up as long as you conveniently can.
23. If your antagonists are eight, and you have no honour, play your best trump.
24. Always take care to reckon and amend the score at conclusion of each deal; and do not speak or attempt to converse unless between the deals.

A *rubber*, or rub, generally consists of three games. The parties who have two out of the three win the rub. If the same party gain the first and the second game, that concludes the rub, without playing the third.

A rubber also consists of five *points*. If a party wins the game before the adversary has scored five, he is said to have won a *double*, or two points. Two games won in this manner count four points, and consequently concludes the rubber, for which one point is also reckoned. When an adversary has scored five or more at the termination of a game, you have won only a *single*, which counts but as one point.

Whist is sometimes played by three persons, the fourth place being termed *dumby*. The cards for dumby are exposed on the table and played by one who undertakes to act as dumby's partner throughout. This method of playing very much destroys the interest of the game, and is never resorted to but in cases of necessity, when four persons cannot be had.

CRIBBAGE.

This game is played with the whole pack of cards, and by two, three, or four persons, as the case may be. When there are three, they play as individuals; when four, we play as partners, as in the case of whist. The value of the cards in cribbage is the same as in whist, but there are no trumps, excepting the knave of the suit turned up. There are different modes of playing according to the number of cards dealt; the number is generally five or six. The game consists of sixty-one points, and to keep score or reckoning, an apparatus called a cribbage-board is employed. This board possesses holes for the scoring of each party, and the scoring is effected by means of pegs. The party who is able to bring his peg into the last hole first wins the game.

The following is an explanation of terms generally used in the game:—

Crib, the cards laid out by each party; and whatever points are made by them, the dealer scores.

Pairs are two similar cards, as two aces or two kings. They reckon for two points, whether in hand or playing.

Pairs royal are three similar cards, and reckon for six points, whether in hand or playing.

Double pairs royal are four similar cards, and reckon for twelve points, whether in hand or playing. The points gained by pairs, pairs royal, and double pairs royal, in playing, are thus effected: your adversary having played a seven, and you another, constitutes a pair, and entitles you to score two points; your antagonist then playing a third seven, makes a pair royal, and he marks six; and your playing a fourth is a double pair royal, and entitles you to twelve points.

Fifteens.—Every fifteen reckons for two points, whether in hand or playing. In hand, they are formed either by two cards, such as a five and any tenth card, a six and a nine, a seven and an eight; or by three cards, as a two, a five, and an eight, &c. And in playing thus, if such cards are played as make together fifteen, the two points are to be scored towards the game.

Sequences are three or four, or more successive cards, and reckon for an equal number of points, either in hand or playing. In playing a sequence, it is of no consequence which card is thrown down first, as thus: your adversary playing an ace, you a five, he a three, you a two, then he a four, he counts five for the sequence.

Flush is when the cards are all of one suit, and reckons for as many points as cards, for a flush in the crib, the card turned up must be of the same suit as those in hand.

The go is gained by the player when no other number can be played under thirty-one, in which case he takes one; but if the number makes thirty-one, he takes two. The turn-up card accounts in with both hand and crib.

Regulations for Playing.

1. In dealing, the dealer may discover his own cards, if he pleases, but not those of his adversary. If he does, that adversary is entitled to mark two points, and call a fresh deal, if he pleases.

2. If the dealer gives his adversary too many cards, the adversary may score two points, and also demand another deal, provided he detects the error previous to his taking up his cards.

3. When any player is observed to have in his hand more than the proper number of cards, in that case the person who discovers it may mark four points to his game, and call a new deal, if he thinks proper.

4. If the dealer gives himself more cards than he is entitled to, the adversary may score two points to his game, and call a fresh deal, if he thinks proper: if he does not, he is entitled to draw the extra cards from the dealer's hands. If the non-dealer observes his adversary has more cards than are his due, after they are taken off the table, he may score four points to his game, and call a new deal.

5. If either party meddle with the cards from the time they are dealt until they are cut for the turn-up card, his adversary is entitled to score two points.

6. If any player scores more than he is entitled to, the other party has a right not only to put him back as many points as were so scored, but also to score the same number to his own game.

7. If either party touches even his own pegs unnecessarily, the adversary may score two points to his game.

8. If either party take out his front peg, he must place the same behind the other.

9. Either party scoring a less number of points than are his due, incurs no penalty.

10. Each player has a right to pack his own cards; and should he place them on the pack and omit scoring for them, whether hand or crib, he must not mark for them afterwards.

FIVE CARD CRIBBAGE.

Proper cribbage is played with five cards, and we shall give a description of it in reference to two persons.

After the dealer has been determined by cutting, as in whist, they are dealt one alternately, to the extent of five for each individual. The elder hand takes three points on the board. Each player then proceeds to lay out two of the five cards for the crib, which always belong to the dealer. In doing this, always recollect whose crib it is, as the cards which may advantage your own are almost invariably prejudicial to your game when given to your adversary. This done, the non-dealer cuts the remainder of the pack, and the dealer turns up the uppermost. This card, whatever it may be, is reckoned by each party in hand or crib. When it happens to be a knave, the dealer scores two points to his game.

After laying out and cutting as above mentioned, the eldest hand plays any card, which the other endeavours to pair, or to find one, the points of which, reckoned with the first, will make fifteen; then the non-dealer plays another card, trying to make a pair, or pair royal, and so on alternately till the points of the cards played make thirty-one, or the nearest possible number under that.

When the party whose turn it may be to play cannot produce a card that will make thirty-one, or come in under that number, he then says, "go," to his antagonist, who thereupon is to play any card he has that will come in to make thirty-one, if he can, and take two points, or to score one for the end hole; and besides, the last player has often opportunities to take pairs or sequences. Such cards as remain after this are not to be played; but each party having, during the play, scored his points gained, in the manner as hereafter directed, proceeds, the non-dealer first, then the dealer, to count and take for his hand and crib as follows, reckoning the cards every way they possibly can be varied, and always including the turned-up card:—

For every fifteen, two points; for every pair, or two of a sort, two points; for every pair royal, or three of a sort, six points; for every double pair royal, or four of a sort, twelve points; for every sequence of any sort, according to the number; for every flush, according to the number; for every knave or noddy of the same suit as was turned up, one point; but when turned up it is not to be reckoned again, nor is any thing to be taken for it when played.

Three cards of the same suit in hand entitle the holder to reckon that number, and five for the crib when the turned-up card happens to be of the same suit.

It is always highly necessary, in laying out cards for the crib, that every player should consider not only his own hand, but also whom the crib belongs to, and what is the state of the game; because what might be proper in one situation would be extremely imprudent in another.

If you should happen to possess a pair royal, be sure to lay out the other two cards for either your own or your adversary's crib, except you hold two fives with the pair royal; in that case, it would be extremely injudicious to lay them out for your adversary's crib, unless the cards you retain insure your game, or your adversary being so near home that the crib becomes of no importance.

It is generally right to flush your cards in hand whenever you can, as it may assist your own crib or baulk your opponent's.

Endeavour always to retain a sequence in your hand, and particularly if it is a flush.

Always lay out close cards, such as a three and four, a five and six, for your own crib, unless it breaks your hand.

As there is one card more to count in the crib at five card cribbage than there is in hand, be sure to pay great attention to the crib, as the probability of reckoning more points for the crib than hand is five to four.

For your own crib, always lay out two cards of the same suit, in preference to two of different suits, as this will give you the chance of a flush in the crib.

Never lay out cards of the same suit for your adversary's crib.

Endeavour always to baulk your opponent's crib. The best cards for this purpose are a king and an ace, a six, a seven, an eight, a nine, or a ten; or a queen with an ace, a six, a seven, an eight, or a nine; or any cards not likely to form a sequence.

A king is generally esteemed the greater baulk; as, from its being the highest card in the pack, no higher one can come in to form a sequence.

Never lay out a knave for your adversary's crib, when you can possibly avoid it, as it is only three to one but the card turned up is of the same suit, by which he will obtain a point.

Even though you should hold a pair royal, never lay out for your adversary's crib a two and three, a five and six, a seven and eight, or a five and any tenth card. Whenever you hold such cards observe the state of your game, and particularly if it is nearly ended, whether your adversary is nearly out, or within a moderate show, and it is your deal. When this is the case you must retain such cards as will, in playing, prevent your adversary from making pairs or sequences, &c., and enable you to win the end-hole, which will often prevent your opponent from winning the game.

THREE AND FOUR HAND CRIBBAGE

Three and *four* hand cribbage differs only from two hand in as far as the parties only put out one card each to the crib; and when thirty-one, or as nearly as can be, have been made, then the next eldest hand leads, and the players go on again, in rotation, with any remaining cards, till all are played out, before they proceed to show their hands and crib.

In three-hand cribbage, a triangular board is used, with three lines of holes to allow of each scoring his own game.

SIX CARD CRIBBAGE.

Six card cribbage bears so great a resemblance to five card, that any one playing the one well must play the other equally so. It consists of pairs, fifteens, sequences, flushes, &c., and the points are reckoned and marked precisely in the same manner; all the cards must be played out; that is, when either party has made the end hole, the remaining cards in hand must be played, scoring for the pairs or fifteens they may form. When last player, you should endeavour to retain close cards in hand, as they may enable you to acquire four points in playing.

The dealer is supposed to have some trifling advantage.

The dealer is entitled to expect twenty-five points by his hand, crib, and next hand. Thus, at his second deal, if his peg is in the twenty-fifth hole of the board, he has his complement of points; the same at his third deal, if he is within eleven points of the game.

If the non-dealer by his first hand attain the eleventh hole in the board, he will have the best of the game; for he is entitled to expect that he shall make his second deal with his front peg in the thirty-sixth hole, and by which he will probably win the game by his hand, crib, and next hand.

If you are dealer, and your adversary has above his complement of points, you must play your game accordingly. Thus, if you have good cards, try to make as many points as possible by pairing, fifteens, &c. On the contrary, if your cards are indifferent, you must play off, to prevent your adversary from obtaining points.

ALL-FOURS.

This is a game at cards played by two, three, or four persons, with a complete pack of cards. If four, there are two parties, two in each. We shall suppose only two individuals are playing:—

After the cards have been dealt by three at a time, six to each, the dealer turns up the next card as the trump. If your adversary be not satisfied with his hand, he says, "I beg." In this case, if you do not wish to run the risk of changing the trump, you say, "I give you one," and you allow him to score one towards his game. If your own hand be bad, you then deal out three more cards to each, and turn up anothe trump, which supersedes the former. The adversary may propose to take the chance of dealing three more cards to each, but this can be refused by the dealer, without any forfeiture.

The cards are then played, the elder hand leading, and the party taking up the tricks which he wins. You must either follow suit or trump, if you can.

Ten points make the game, and they are produced by *high*, which is the highest trump dealt; *low*, or the lowest trump dealt; *jack*, or knave of trumps; and *game*, the number of pips on the counting cards. The counting cards are as follows:—ace, four; king, three; queen, two, knave, one; and the ten, which reckons ten. This counting applies to all suits. If the jack be in your hand, secure it as quickly as possible; as, for instance, do not lose an opportunity of trumping with it; for if it fall into the adversary's hand, he reckons it to his game.

Should the card turned up be a knave, the dealer scores one point to his game. Knave of trumps in hand does not reckon, unless you make a trick with it; for if your adversary takes it with the ace, king, or queen, he scores it.

SPECULATION.

This is a round game at cards, the term *round* meaning that it can be played by a large party round a table. The number most suitable is from seven to thirteen.

The principle of the game is this: A *pool* is formed by the dealer putting two counters, and every other player putting one counter, into a dish or treasury in the middle of the table; and this store is paid to the person who holds the highest trump. Thus it is the object of every person to get the highest trump, and the effort to do so is the *speculation*, from which the game derives its name.

After being duly shuffled and cut, and the dealer determined, he deals three cards to each person, one at a time. These cards must be placed before each person, and no one is allowed to look at them until after the trump is turned. Having finished the deal, the next card determines the trump; this card may be *sold* either before or after being seen. When this speculation is concluded, by some person *purchasing* it with counters, or the dealer retaining it, if he thinks proper, the eldest hand turns his uppermost card, and if this be a superior trump to the one turned, he may also speculate. Each player does the same, till all the cards have been exposed, when the pool is given to the possessor of the highest trump.

LOO.

Loo is a game played by five or six people; and a pool is made by the dealer putting in five counters. He then deals five cards to each person, and turns up a trump. Whatever suit the trump may be, the knave of clubs, called *pam*, forms the chief. Those who are dissatisfied with their hands can throw up their cards, and demand fresh ones from the pack.

When the ace of trumps is played, it is usual to say, "Pam, be civil;" the holder of pam is then expected to let the ace pass.

When any person holds a flush of trumps with pam, this individual can sweep the pool before playing. Then there is a new deal.

The next best hand to the above is trumps only, and this sweeps the pool, if there be not a pam flush; and there is also a new deal.

The next best hand is that of a flush of other suits, which sweeps the pool; and there is also a new deal.

When any of these flushes occur, each person, excepting those who hold inferior flushes or pam, is *looed*, and has to pay five counters into the pool.

When none of these flushes occur, and those who wish have changed their cards, the game goes on as at whist, the highest card taking the trick.

When all the cards are played out, they will make but five tricks; and all the counters in the pool are divided between the holders of these tricks, every other person being looed, and obliged to pay five counters to the pool for next deal.

DANCING.

Dancing, as one of the most healthful and elegant in-door amusements, cannot be too highly recommended. Among a rude or dissolute people it may degenerate into something worthy of condemnation; but all the blessings of Providence are similarly liable to abuse, and it would be most unjust to condemn a cheerful domestic amusement, merely because it has at times been degraded into immoral purposes. By all physicians, dancing, when pursued in moderation, is recommended as highly conducive to health; and it may be truly said, that, allied with music, nothing is more calculated to purge the mind of melancholy, and put the whole temper into good humour.

Dancing is the poetry of motion. It must be performed with ease and grace, and always with a perfect regard for propriety of movement. As an art, it is taught by professed masters; and one of the leading rules given to the learner is to raise and lower himself gracefully on the elastic part of his feet, that is, the toes never to leap or come down on the whole sole or heels also to keep exact time to the music. Dancing is therefore a simple and elegant gliding on the toes, these bending more or less to accommodate the steps, and to prevent every thing like harshness of motion. The body should not be held stiffly, and the hands ought to hang down easily by the sides.

Dancing takes the form of several distinct kinds or series of movements, some quick and some slow, and some more complex than others. The most popular of the old-established dances are termed

Country Dances.

This class of dances takes its name from the French word *contre* (against), from being danced by two parties standing in a row opposite or against each other. The general principle is for each couple in succession to go down the middle of the rows and up again, with some other movements, till all have danced down and into their original places. It is a rule for the top couple to dance down twice, thus leaving the couple that was the second to be at the top. This finishes the dance. If the party wish to dance another dance, the second couple, now at the top, begins, and so on. Thus, each couple in the party has the opportunity of choosing any particular dance or tune they may wish. The choice is left to the lady. In general, a party in a country dance do not remain up for more than two dances, when the partners are changed, and new dances begin.

A country dance should not consist of more than twelve or fourteen couples, as it is fatiguing to dance with a greater number. In standing up, the lady should always be on the gentleman's right hand, if they turn their faces to the top of the room. This is a simple rule to determine on which side the ladies and gentlemen should respectively take their places.

The principal figures in country dances are,

1. *Hands across:* that is, the top lady takes the second gentleman by the right hand, and the top gentleman, at the same time, takes the second lady by the right hand, and all go a half-circle round; then all change hands and back again.

2. *Hands four round;* the two top couples join hands, forming a circle; dance half round and back again.

3. *Right and Left.*—In this the top lady gives her right hand to her partner, changing places with him; then her left hand to the person below her, changing places; her partner performs a similar movement, and both return to their places.

4. *Set and change sides.*—The lady takes hold of both hands of the lady below her, and sets, that is, dances for a short time without changing her situation; then both ladies pass to the gentlemen's side, while the gentlemen pass at their backs to the ladies' side; all again set, and return to their places.

5. *Pousette.*—This signifies that the two top couples respectively join hands, each couple dancing round the other.

6. *Down the middle.*—The top couple go down hand in hand and return, stopping one couple lower than they commenced.

7. *Casting off* is the lady going down behind the ladies, and the gentleman behind the gentlemen, and returning to their places.

There are English, Irish, and Scotch country dances; but we know of no distinction among them except the tunes. All vary less or more in their figures. In each, however, as already observed, the plan is followed of the first or top couple dancing with each following couple in succession to the bottom of the room; and as soon as a sufficient number of couples are disengaged at top, another couple commences, and so on through the whole party. The following is an outline of the figures in a few of the more popular country dances. It will be understood that we always refer to what each couple does in succession:—

Voulez vous danser, Mademoiselle.—Set and change sides, down the middle, up again, and pousette.

John of Paris.—Right and left, down the middle, up again, and pousette.

Captain Fleming.—Hands across, down the middle, up again, and hands four round.

The Honey-moon.—Hands three round on the ladies' side, then on the gentlemen's side, down the middle, up again, pousette, right and left.

The Triumph.—Down the middle and up again; then the lady down with the next gentleman; her partner follows: the two gentlemen now lead the lady up between them, taking hold of her hands by one hand, and joining their other hands over her head; pousette.

Petronella.—First couple move to the right into the middle, and set; to the right again, and set at the side; to the right again and set in the middle; to the right again to places; down the middle, up again, and pousette.

Caper Fey.—Top couple go down backs and up again; down the middle and up again; set, and turn corners, and reel on the sides.

The Legacy.—Hands three round on the ladies' side; then on the gentlemen's side; down the middle and up again; set in the middle, and turn with both hands.

Sir Roger de Coverley or *the Haymakers.*—Top lady and the bottom gentleman advance to the centre of the dance, turn with both hands, and back to their places; the first gentleman and bottom lady do the same; the top lady and bottom gentleman again advance, turn with the right hand, and back to places; then the top gentleman and bottom lady do the same; top lady and bottom gentleman advance and turn with left hand and back to places; the top gentleman and bottom lady do the same. The top lady and bottom gentleman advance, the gentleman bows and the lady curtsies; the top gentleman and bottom lady do the same. The top lady and bottom gentleman advance, and pass back to back; top gentleman and bottom lady do the same. The top couple turn, the lady to the right and the gentleman to the left; all the ladies following the lady, and all the gentlemen following the gentleman to the bottom of the room, where they meet their partners and lead up the centre of the room. The top couple then half pousette with each couple, till they reach the bottom of the dance.

Scotch Reels.

These are rapid and rather fatiguing, but not ungraceful dances. They are danced by three, four, five, or six persons; but four is best and most common. The foursome reel is danced very much according to fancy; the two couples commencing by placing themselves opposite each other, or in a line, with the two ladies in the middle, back to back. In whichever way the dance begins, the plan is for each person to perform the figure of eight by winding round the others, and setting to partners alternately. The music, of course, guides the time for the setting and the moving.

Highlanders dance reels with great agility, and are fond of introducing the steps ordinarily called the *Highland fling*, which is of the character of dancing on each foot alternately, and flinging the other in front and behind the leg which is dancing.

Quadrilles.

These are modern dances of French origin, comparatively tranquil in character, and very suitable for small domestic parties. They are danced by four couples or eight persons, a couple standing on each side of a square. The lady is always on the gentleman's right.

There are many sets of quadrilles, the figures in each varying from the others; but in by far the greater number of instances one set is adhered to, which is termed Payne's first set. This set, of which we present an outline, consists of four figures, and a finale. The couples at top and bottom first perform a figure; then it is performed by the others; and so on.

La Pantalon.—First right and left, set and turn partners; ladies chain, which is performed by the two ladies giving their right hands to each other, and changing places; then their left hands so the gentlemen, and turn round; and the same back again to places. Now, promenade (each couple holding hands crossed) to the opposite side; then half right and left back to places.

L'Ete.—The first lady and opposite gentleman advance and retire, dance to the right, then to the left, cross over, lady and gentleman changing places. Dance to the right and left, cross again to their own places, and turn their partners. The second lady and first gentleman do the same.

La Poule.—The first lady and opposite gentleman cross over, giving their right hands; back again, giving their left and then right to their partners, and set, forming a line; promenade to opposite places. The two who begin advance and retire; advance a second time; the lady curtsies and the gentleman bows, and return. The two couples advance and retire; half right and left to their original places.

La Trenise.—Ladies chain; set and turn partners; first couple advance and retire; advance again; the gentleman returns, leaving the lady on the left of the opposite gentleman; the two ladies pass or cross to the opposite side, changing to opposite corners, during which the gentleman passes between them, and sets. The ladies cross over again, and pass to opposite corners, while the gentleman returns to his place, and sets. The first couple set and turn. During these performances, the gentleman at the bottom of the dance stands still. The movement being finished, a similar figure is performed by himself and partner.

La Finale.—All eight dance or chasse across, changing places with their partners, and set at the corners; back again to places, and set. After this, *L'Ete* is danced, concluding with chasse across.

This finale is danced in another way. All eight promenade round the room to their own places. The first and second couple advance and retire; advance again, the gentlemen taking the opposite ladies, or exchanging partners. Ladies chain; advance and retire; advance again, reclaiming partners, and promenade. This is called the *gallopade* finale.

The preceding embraces nearly all dances usually performed in private parties and balls of an ordinary kind. In the higher class of assemblies, various foreign dances are introduced, such as waltzes, mazourkas, pas seuls, minuets, and gallopades; but of these it is unnecessary to offer any description, as they require careful training under a master.

FOREIGN COSTUMES.

Among the many subjects of just and natural curiosity in the history of mankind, there is none more distinctive and characteristic of a people than the peculiar costume in which they are attired. The various articles of clothing have, from the earliest ages, formed the principal manufactures of every country—skill and industry in which, carried to a certain extent, mark, beyond almost any other circumstance, the advance of a people in arts and civilization. The savage wraps himself in the skins of the animals upon whose flesh he feeds; and even the most inhospitable regions furnish not only their natives with such rude clothing, but also supply the most civilized world; for example, the Danes obtain from Greenland seal-skins and fur, the eiderdown for the couch of the luxurious noble, and whalebone to complete the wardrobe of the court beauty. The processes by which plain substances shorn from an animal or gathered from a plant are converted into magnificent robes of the most brilliant tints, involve some of the most striking points in the history of human invention. But the entire subject of costume is replete with interest, from the rude skin-coverings of the natives of the icy north and south, to the exquisite fineness and beauty of the fabrics of the east, and the elegance and economy of those of the west. Ingenuity is not, however, exclusively the work of civilization; for we find the wild Indians of both the Americas, the South-Sea islanders, the negroes and Hottentots of Africa, and the poor savages of the Polar Regions, all acquainted with the art of plaiting wood, grass, or seaweed; and some of them producing, merely by hand, textures which we, assisted by all the aid of machinery, can scarcely rival.

The earliest clothing was coats of skins, from which the transition was to woollen tissues, linens, cotton, and silk, in the various forms which fancy suggested. Linen was made at a very early period in Egypt, as we see from the cloth wrappers of mummies, which are all linen; and early in the present century, there were found at Sakkara two Egyptian tunics, in the form of a shirt, and supposed to be the "linen ephod" of Scripture.* The Egyptians also knew the art of colouring and preparing leather, of which, as well as papyrus, they made sandals, and subsequently shoes. It is uncertain whether cotton was known to the Egyptians; but the cotton plant is found wild both in the old and new world. Herodotus mentions it as indigenous in India; and cotton cloth has been found in ancient Peruvian tombs. The country of the Hindoos has always been distinguished in the art of weaving; and thence, through the medium of Egypt, ancient Rome is stated to have been supplied with fine India cottons; whilst the beauty and durability of the Indian colours were as celebrated among the Greeks and Romans as among ourselves. Silk also was manufactured in India in very early times. In fabricating articles for ornamenting the person, the Egyptians professed great skill: their gold mines were worked under the early Pharaohs; beads and other ornaments of glass are found on many mummies; whilst, at a very early date, the rich gems of the east were conveyed thither, for which Egypt gave in return its manufactures of fine linen, its robes, and its carpets. Such were the principal articles of costume in earliest use; and although few, they denote convenience and even costliness and magnificence in dress to have characterized civilization in its remotest ages.

* Notes to Pictorial Bible, Samuel, ch. ver. 18.

EUROPEAN COSTUMES.

The form of dress throughout the civilized nations of modern Europe is generally far from picturesque, and has been adopted more for personal convenience than external effect. While in eastern countries the garments are light, flowing, and graceful, in those of the west they are stiff and formal, and generally composed of materials which are alike substantial and durable.

Northern Nations.—Commencing our survey at *Lapland*, we find that the wandering tribes of that remote and inclement region use a dress either of the skins of reindeer, or of thick woollen cloth. The men generally wear a gray conical cap, with eight seams covered with strips of brown cloth, the cap itself reaching only to the tips of the ears; and they rarely have any thing round their necks except their long black hair. Their tunic or short coat is mostly of sheep-skin, with the wool inwards, next the skin, and over this is a similar garment of woollen or skins, with a stiff collar. Their pantaloons are of woollen, tapering to their half-boots; they wear no stockings, but straw and rushes are stuffed into the shoe around the foot and ankle; and their gloves are of skin, lined with cypress-grass. They have no pockets, but a small bag hangs about breast-high, and a leathern belt is worn round the waist. The Lapland women have a peculiar fancy for gaudy colours, with which they work their skin or cloth caps, and gowns; they have a girdle containing their needles, scissors, and thread, hanging at their sides, and they wear small brass trinkets, which they prize highly.

The Laplander.

The clothing of the *Icelanders* is not very dissimilar, being equally substantial and homely; the chief difference being, that hats of a peculiar form are used instead of caps, and jackets instead of pelisses. The ladies of Iceland have also some gaudy trappings. Many of them wear about the waist a silver massive girdle, with an ornament above it, fastened in front on a belt of richly-worked velvet. These silver ornaments, in design and execution, are equal to any thing of the kind which a jeweller in England could fabricate, although they are the work of the peasantry. But the most distinctive portion of Icelandic dress is a kind of turban of white linen, stiffened with pins to about twenty inches in height, and sometimes terminated with a tassel, and fastened to the head by a dark silk kerchief, which completely hides the hair. Sometimes, instead of the above head-dress, the women wear a closely-fitting helmet-shaped worked cloth-cap, with a snow-white muslin termination, curved over in front.

Russia.—Throughout Russia the dress of the higher ranks is now formed on the European model; but the burghers, merchants, and peasants, wear the national costume of Asiatic character. This consists of a conical or square high-crowned hat or cap, a long coarse coat reaching to the calves of the legs, and girdles, with a sash, in which the wearer carries his purse, and often his hatchet; a woollen cloth is wrapped round the legs instead of stockings, and the boots or shoes are made of the rind of the young linden, plaited; each pair is rarely worn more than five or six days, so that many millions of these shoes are annually consumed.

Some of the costumes of the Russian peasantry are strikingly picturesque. The holiday dresses of the females are very gay, the principal garment being a loose jacket of sky-blue silk, the sleeves lined with spotted fur, and hanging loose from the shoulders. Among the Tartar population, the women wear embroidered velvet jackets over showy petticoats, and the little national tippet of red or yellow silk, lined with fur; gaudy colours are in great request, and even the poorest persons have their kirtles showily trimmed. The men, too, wear coarse cloth more frequently than skins. Towards Tula, however, the women wear the most dashing costume; a flat-fronted head-dress of gold or silver embroidery; the legs are swathed in folds of white worsted, and the feet are lodged in sandals; and the principal robe is a white eastern tunic, girdled round the waist, but floating loose below, and left open at the bosom, to display the top of a short petticoat trimmed with red; so that, "in gay tiara and flaunting robe, the maidens of Riazan strut about with all the dignity of tragic queens."*

The costume of the Cossack is gay. At home the Don Cossack wears a blue jacket lined with silk and edged with gold-lace, silk vest and girdle, ample white trousers, and a large cap of black wool, with a red bag floating behind. The women wear open silk tunics, white trousers, and yellow boots. The soldiers dress in a short Polish jacket, wide dark-blue trousers, and a huge sheep-skin cap.

The dress of *Swedes*, *Norwegians*, and *Danes*, is now similar to the costume of central Europe, but generally sober in tone and precise in fashion. As everywhere else, the costume of the humbler class of women is much gayer than that of the men. This is very observable at Stockholm, where a variety is displayed very different from the general monotony of northern attire. The boatwomen wear huge muslin caps, a bright scarlet boddice, a striped apron of blue, black, or red, over a grayish petticoat, thick stockings of flaming red, and "the largest and most marvellous shoes in the world," with birch-wood soles several inches thick, heavily shod with iron, and a round lump in the *middle*. But the Sunday full dress of the women is still more gaudy. A long kerchief is rolled round the hair like a turban, but with a loose end, and the long white robe, of thick cloth edged with red, thrown open at the girdle, and the lower corners pinned at the leg behind the petticoat, also of bright colours and ample dimensions—all give the wearer an Asiatic appearance among the blue skirts and homely linsey-woolsey of the general population. The holiday costume of the mountain maids of Norway is also pretty. They wear short loose scarlet or green cloth spensers, embroidered at the edges, and trimmed with shining buttons, and hanging over a coarse dark petticoat: the poorest women, however, wear a shapeless gown or sack of blue woollen, strapped tight up to the arm-pits.

Germany.—Advancing southwards to Germany and the Netherlands, the costume of the people is generally found to be modernized and reduced to that condition in which it is found in London and Paris. It is principally among certain classes of the fishing population, and the peasantry, that any striking peculiarity of costume exists.

In the mountainous territories of Austria, as in Styria, the national dress is, however, very picturesque. The women wear full short petticoats, with coloured boddices, tightly laced, and snow-white sleeves reaching to the elbows, and straw hats lined with green silk, and ornamented with flowers and feathers. The men usually wear a green hat, with a curious cockade of feathers, mixed with the hair of the chamois and the deer, and secured in the centre with gold tinsel, around which wave long red feathers: "green jackets, black chamois leather small-clothes, edged with green leather, striped stockings, and shoes tied with green ribbon, and a broad

* "Excursions in Russia."

leathern belt embroidered with green silk, complete the costume of a genuine mountaineer of Styria."* Among the peasantry of *Carniola*, too, may be seen some interesting primitive attire; as a short coarse linen tunic (which also serves as a shirt), confined by an untanned skin girdle, and sandals of the same rude material, and very wide small-clothes reaching only to the knee, but neither stockings nor hat.

In *Bohemia*, the general poverty of the peasants is apparent in their dress, which is rarely little better than tatters. The market at Prague, however, presents some picturesque costume; as the women wearing neatly trimmed jackets, ornamented boddices, and gayly-coloured petticoats and stockings, and head-dresses of kerchiefs fastened with large pins. The men wear very full small-clothes, ornamented jackets and vests, and broad-brimmed, low-crowned hats. The Moravian peasants of both sexes wear sheep-skin mantles in winter, but their summer dresses are of woollen and cotton of the gayest colours, the stockings and boddices being red, and the mantles blue or green; and the men wear a very short tunic, belted, tight pantaloons, and sandaled boots nearly to the knees, with a broad flapping hat, sometimes ornamented with bunches of gay ribbons. The materials of clothing are abundant in these countries; linen, including cambric, lawn, and tape, being the staple; and the woollen and cotton manufactures are very flourishing. The linens of Silesia, too, are the best in the world.

Prussia has little to distinguish it in the records of costumes from the other countries of Germany. From its capital, the fashionable embroidery known as *Berlin-work*, dates from the commencement of the present century; but this is mostly employed as ornamental furniture. It may here be mentioned, that in needle-work Germany stands first, then Russia, England, France, America, &c., the three first names on the list being by far the largest consumers; and in Germany, many ladies of rank add to their pin-money by executing needle-work for the warehouses.

Bavaria presents very beautiful and tasteful costumes. In the streets of Munich, on holidays, a washerwoman may be seen wearing a silver tiara, a blue satin brocade boddice, and a skirt and apron of worked muslin; and a waiting-maid will display a silver head-dress, and a gown, the whole of which, above the ceinture, is entirely of silver and gold; and these brilliant ornaments form the distinctive national costume of the pretty women of Munich. In the environs of the city, the men wear round blue jackets, tight black breeches, and white stockings; red waistcoats, with silver sugar-loaf buttons, outside which are worn braces gayly embroidered, or made of painted velvet: the leathern belts are also embroidered; and in the large round hats are worn artificial flowers. The women no longer wear the short petticoats of the mountaineer; and, instead of the broad-brimmed hat, is worn a cap of gold tinsel, projecting in fantastic forms, or a silver head-dress, forming a tiara in front; the boddice is of blue, red, or gold brocade, the skirt of smart-coloured cotton, and the apron of flowered muslin. Elsewhere in Bavaria, as in the mountainous districts, the peasants wear broad-brimmed hats, and coats of sylvan green. But the national costume must be sought in the provinces, where the Saxons wear "the stiff old-fashioned costumes which one still sees among the most primitive inhabitants of Germany. The women, like their Hungarian neighbours, wear long boots and thick woollen petticoats, their dress much resembling that which the 'broom-girls' have made familiar to our streets—a full cloth petticoat, stomacher buttoned or laced in front, and a closely-fitting cap; the unmarried girls wearing a long braid of flaxen hair down the back, with a small-crowned but broad-brimmed straw hat."† The men wear picturesque cocked hats, long antique coats, breeches, and large buckles in their shoes. Elsewhere, as in Lusatia, the women, who rank among the handsomest in the empire, set off their blond hair and rosy complexions with black velvet caps, and wear blue aprons flowered with white, red stockings, with green cloaks, and a hundred-folded petticoat terminating at the knee. Near Leipsic, the male peasants wear large loose breeches and tight jackets; and the women are distinguished by long pointed caps terminated with a tassel. The chief peculiarity in the costume of the peasantry in Darmstadt and adjoining districts on the Upper Rhine, is the wearing of cocked or broad-brimmed hats, which give even the youngest men an air of antiquity.

Small cloth caps are almost universally worn by the men throughout the towns of Germany; they are made of cloth, with low crowns, with small projections over the eyes, and have now become the common travelling cap in Europe.

In *Holland* and *Flanders* there is now little to remark in the costume. The fashion of wearing voluminous garments is abandoned, and the ordinary attire is universal. We stil find, however, the fish-women of Scheveling wearing large skuttle-shaped bonnets, and the women of the middle classes in Brussels covering their heads with black silk scarfs—a relic of Spanish manners. Throughout Holland and Belgium, the traveller rarely meets man, woman, or child in rags; neither are any seen barefooted. The shoes universally worn by children of the lower ranks are wooden *sabots*; these, formed out of a single piece of wood, and pointed like a canoe, are procurable at the easy charge of sixpence per pair. At the great annual fairs held in Holland, a few remarkable costumes make their appearance, from remote corners of the country. The most gay of these is the head-dress of the girls of North Friesland, which consists of a glittering plate of gold, bent and shaped to the head, and is of great value; they are also all decorated with fanciful gold ear-rings, twisted like a ram's horn, and pointing outwards from the face.

In *Switzerland* and the *Tyrol*, the population is generally dressed in plain apparel; but in certain quarters, and particularly on holidays, a picturesqueness of costume is far from uncommon among females. In the canton of Berne, the old-fashioned and peculiar costume of women is tasteful. Around the neck, and falling down on the breast, is worn a collar of black velvet, ornamented with gold beads, and which is held in its place by steel or silver chains passing beneath the arms. The head-dress consists of projecting pieces of black lace. In the cantons of Vaud and Friburg, the large chip bonnets of the women are a striking feature in the dress.

In the cantons of Thurgovia and Argovia, the male costume is very singular, the breeches being in the Turkish style, very large, and tied in just below the knee; the waistcoat is red, and remarkably long, as is also the large flapped coat. At Appenzel, the modern invention of braces is not yet adopted; the dress is a scanty jacket and short breeches, with a preposterous interval between the two garments. The canton of Grissons is said to derive its name from the gray colour of the men's dresses; but at present their coats and pantaloons are almost universally blue.

In the *Tyrol*, national costume appears to be more closely adhered to than in any other country of Europe except Spain, and perhaps Hungary. The peasantry strangely wear stockings without feet to them, tight black breeches, and leathern girdles with knives stuck in them; the hat tapers to the crown, whence hang on one side silk bands and tassels, generally green, and the blue smock-frock is tastefully worked, and worn not only by the peasantry, but by gentlemen. The men, too, wear flowers in their breasts, as well as in the

* "Germany and the Germans." † Paget's "Hungary."

hi der part of their hats. Th: aged wome.: wear huge white or red worsted caps, of sugar-loaf shape, and weighing six or seven pounds, and their dresses appear hooped, from often consisting of no fewer than ten petticoats. The young peasant women have round beaver hats, petticoats of rainbow hues, lace aprons, boddices with frills at the elbows, and figured blue and scarlet worsted stockings, which are sometimes worn in such enormous folds and plaits as to render the ankle as thick as the waist of a Parisian lady. The younger the women are, the fewer the number of petticoats they wear. The varieties of costume are best witnessed at the fairs, where may be seen the peasantry of almost all the Tyrolean valleys: "the ten-petticoated women (observes Inglis), with their great tapering white and red worsted caps: the black-breeched, white-stockinged, and girdled peasantry of the inn; and the bare-kneed peasant of the mountains; the men of Botzen, and its vale, with their broad-brimmed hats; the women of Meran, with their green cloth hats turned up at one side; and the peasant of the Italian Tyrol, with his less national costume and darker countenance."

Hungary.—Among the peasantry of Hungary the costumes still in use are remarkably picturesque, and trace their origin to that period when the country was a Roman province. One of the most characteristic articles of Hungarian costume is the *bunda*, or hairy cloak, made without a collar, and of sheep skins, with the long wool in its natural state, the leathern or skin side being ornamented with cords and flowers worked in coloured silks, and the cape being a black Transylvanian lamb-skin. To the Hungarian shepherd the bunda is his house, his bed, and all; for he wears it alike in all seasons and at all times. His under-dress is loose linen drawers, short shirt, and sometimes a gayly embroidered waistcoat or jacket, long boots or sandals, and a v..y broad-brimmed

Hungarians.

varnished hat, below which hangs two wide plaits of hair. The turned-up brim serves for a drinking cup, and around his neck hangs a bag to hold provisions.

T[illegible] peasants are mostly gayly dressed—the women in bright blue petticoats deeply edged with red, and neatly folded white handkerchiefs on their heads; and the men in tight blue pantaloons, embroidered jackets, and broad hats ornamented with artificial flowers. But almost every village in the mountainous countries has its peculiar costume; a white skirt, red and blue boddice, and white worsted boots, are common among the females, all of whom wear a little white cap at the back of the head. The men usually wear white cloth pantaloons embroidered with black, short woollen boots slit at the sides, and a dark short cloak or coat with sleeves, embroidered with red or light-green lace

In the mining countries, the women wear their short sheep-skin coats fastened in front with a silver chain and clasp, and ornamented with large silver filigree buttons, and high-heeled red, yellow, or black boots, reaching to the knees. The dress of the men is similarly ornamented with silver, and in "the good old times" the heels of their boots were shod with silver. The peasantry of these districts wear thick white pantaloons sandaled at the ankles, and a short-sleeved cloak lined with fur, and braided and fastened with a silver band; and the hat is wider than any part of the wearer's body.*

France must be viewed as the great fountain of European costume both in past and present times. However backward in many points, the French people, along with their neighbours, the Italians, naturally possess those qualities which lead to advancement in the fine arts, and the improvement of modes of dressing suitable to a civilized condition. England, the great competitor of France, as will be noticed at length in a succeeding sheet, has done little to alter or improve costume. In all ages its fashions have been mostly imitations of those first adopted in Italy or Paris. Hats, coats, nether garments, pantaloons, gloves, buckles, periwigs, stays, bonnets, &c., in all their varying shapes, are of French origin; and advanced as England is in refinement, till this hour it draws its fashions periodically from those current in the circles around the French court.

In speaking of French costume, it is always necessary to remember that the term applies only to the costume prevalent in Paris, and among the higher and middle classes in the country. Of that costume, the *species* of which other modern costumes are but the *varieties*, it is unnecessary here to speak, as it will be noticed in the article British Costumes. What we have to remark upon on the present occasion, are the costumes of a peculiar nature still lingering in the French provinces.

The most striking provincial costume in France is the head-dress of the women in Normandy. It is usually a kind of cap made of starched muslin, from half a yard to a yard in height, ornamented with long lace lappets called *coquilles;* the hair is braided in front, and gathered up in a mass behind. These caps have a very pretty effect, and are called *cauchoises, marmottes,* and *pierrots*, according to their height and form. The rest of the dress consists of a red, blue, or black corset, large wooden shoes, black stockings, and full scarlet woollen petticoat, and apron of different hues; pockets are worn outside; and occasionally the colour of the costume is still further diversified by a checkered handkerchief and white apron. Even on Sundays or feast-days, bonnets are seldom to be seen; but round the neck are suspended large silver or gilt ornaments, usually crosses or hearts, whilst long gold ear-rings drop from either side of their head, and their shoes frequently glitter with enormous paste buckles. In Lower Normandy the dress is nearly the same, with the exception of the cap, which is low and flat in the crown. In the former costume, the lover of antiquarian research will easily trace a resemblance to the attire of the women of England in the fifteenth and sixteenth centuries. In the adjoining province of Picardy, the head-dresses are equally antique. In Brittany, an old-fashioned style of

Women of Normandy.

* Paget's "Hungary and Transylvania," vol. i., p. 390.

dress prevails to a large extent; the hair of the peasant girls is fine and abundant, and is disposed of at fairs for large sums, to dealers who attend for the purpose.

In some parts of France, as in the neighbourhood of Lyons, the peasant women wear a flat, round black hat of cloth or velvet, and not unlike that worn in some parts of Switzerland; and a common article of male dress throughout the country is a *blouse* of blue stuff, like a wagoner's frock, buckled at the waist, and embroidered in white at the wrists and collar.

The female costume in La Vendee is thus noticed by Mr. Trollope:—"The women were dressed in short gowns of striped woollen stuff of various colours, chiefly red, yellow, and blue, with very high waists and tight sleeves. The gown ceases some inches above the ankle, and permits the exhibition of a pair of white ornamented linen stockings, knitted by the fair wearer's own hands, from flaxen yarn of her own spinning. A bright-coloured cotton handkerchief, manufactured at the neighbouring town of Chollet, in the department of Maine-et-Loire, is spread over her shoulders, and its ends secured in front within the bosom of her gown, in such fashion as to leave no portion of the neck or bosom uncovered. The sabot is, in this part of the country, an article of the peasant's costume, on which very great care is bestowed. They are small and slight, cut very low in the front, so as to show a great part of the foot, and shaped with as much care as a fashionable London artist could employ on the form of a pair of boots. They are, moreover, always painted black, in order the better to set off the white stocking. A good deal of lace is often displayed about their caps; and the 'barbes' of the coiffure, as they are termed, which are long strips of cotton, linen, or sometimes muslin, about six inches broad, falling on each side of the face, upon the shoulders, are frequently trimmed all round with it. The girls rarely hide their hair entirely here as they do in Brittany. It is for the most part beautifully black, and a specimen of it is generally seen in a broad band on each side of the forehead. This costume is very generally completed by a short black woollen cloak, made to keep open in front, and show the neat striped cotton apron beneath it."

Italy.—Throughout the Italian peninsula there is a remarkable variety of costume pertaining to different districts and professions. The garments, however, are more picturesque than cleanly; and rags and nakedness are everywhere conspicuous, more particularly in the Neapolitan territory. The dress of the bandits who frequent the Apennines consists of little more than a patched overall, cloak, and slouched hat; but the costume of their chief is a piece of studied coxcombery: upon the glossy curled hair is placed a cloth cap with a gold tassel hanging to the shoulders; around the throat is twisted a gaudy silk handkerchief, and the mustachios are carefully trimmed; the jacket is short, of cloth, or even velvet, and decorated with several rows of gilt filigree buttons; the breeches are tightly fitted and curiously braided; and in a broad particoloured sash are placed two silver-hilted pistols, and a sheathed knife mounted in ivory, elaborately carved; whilst a small carbine of handsome workmanship is slung across the shoulder, and sometimes the legs are sandaled with ribbons; and a high-crowned beaver hat, richly plumed, is worn over the cloth cap. The head-dress of the female peasantry is very striking. Sometimes, upon a long tasseled cap, is placed a little straw hat decked with red ribbons, or the straw hat is worn with a very broad brim. In Tuscany the women wear black beaver hats with high crowns and stiff black feathers, with streaming ribbons on holidays. But more characteristic is the square-topped muslin head-dress, like a university cap, with its embroidered drapery falling behind gracefully to the waist.

Rome offers a great variety of costume—in the dark sheep-skin dresses, shaggy goat-skin aprons, and ribboned hats of the carters, and the pretty square white muslin head-dress and scarlet boddice, laced with blue ribbons, of the peasant girl. But a more finished specimen of a Roman toilette includes a petticoat of delicate blue silk, with a brilliant scarlet boddice laced before and behind over a pure white chemisette, sleeves of silver tissue fastened with pink ribbons, and a shawl of embroidered muslin thrown over the shoulders; the black hair braided and hung in loops, with a silver bodkin and filigree flower, and over all a square of white muslin, trimmed with fine lace. The clerical habits contribute to the variety; you see the Franciscan friar in his brown or gray garment, with a cord girdle and sandaled feet; the Dominicans in white garments, with black cowls and girdles; the Carmelites entirely in white, even to their shoes and hats; the Jesuits all in black, with shovel hats; and other fraternities in black dresses and red crosses, violet robes and triangular hats, and red girdles and buttons on black garments; besides, the priests in black, the bishops in violet, and the cardinals entirely in fiery red, and the penitents enveloped in sackcloth, with only two holes for the eyes.

In Tuscany and Sardinia, the poorest females are rich in ornaments of pearl, coral, and gold; and the women and girls sit at their doors making "Leghorn bonnets." In Florence, the higher classes dress in the latest French fashion, except during the carnival, when the usual absurd and varied scene is exhibited, as in most other Italian cities. Part of the true costume of a Florentine *bourgeoise* is, however, a large broad-brimmed black hat of beaver or straw. Leghorn, however, presents greater variety than the Tuscan capital: here "many wear the oriental dress; priests, monks, and soldiers abound; mustachios, whiskers, and beards are seen in every variety; pretty female faces peep from beneath the bewitching *mezzaro* (shawl); the sunburnt tar mingles in the crowd; and the chained culprit, attired either in a rusty-red brown or a yellow habit, sweeps the streets, followed by his musket-bearing guard."* Throughout Tuscany, however, in costume we find no trace of the truly classic taste of its Etruscan masters.

At Naples, the most "open air" city in Europe, the poor are scantily dressed, but with picturesque effect; but children are sometimes seen in the streets with only a coarse shirt on, or even naked. The lazzaroni have gaudy holiday dresses, but some of them may be seen lying in the sunshine with merely white drawers, not reaching to the knee, such as are also worn by the fishermen. The restless Neapolitan crowd, with its grotesque popular exhibitions (including the national Punch), its groups of preaching, dancing, and story-telling, and its artisans at work in the open street, with the market-people from the environs in picturesque dresses—make up a scene of less interest for its costumes than for its other national characteristics. In the island of Procida, however, within a few miles of Naples, the females to this day wear the Greek costume, which, in that sequestered nook, has descended from their ancestors.

Spain.—Nothing strikes the traveller in Spain more forcibly than the character and diversity of costume among the people. Every province and class has its peculiarities, and so widely different from each other, that they almost appear to be inhabitants of two opposite hemispheres. It has been well observed, that "there exists as much difference between an inhabitant of Andalusia and one of Castile and Catalonia, as between an Englishman and a Russian;" and in no respect is this more evident than in dress.

Notwithstanding the general diversity of costume in

* Notes of a Ramble &c., by a Lover of the Picturesque

the provinces of Spain, of which the Catalonian, the Andalusian, and the Galician, are the most romantic and effective, yet the cloak is, after all, the most national feature; it is generally worn everywhere, and universally in Castile; and to the Spaniard, it seems his only garment for holiday and every day, for rain and sunshine, for winter and summer; the very children wear it; and are often encumbered with it at play; and so attached were the Spaniards in past ages to the cloak, that a minister of Charles III. was sacrificed to the popular clamour for attempting to cut down this article of dress to legal dimensions.


Spanish Peasantry.

Beneath the cloak is generally worn, in winter, a sheep or lamb-skin jacket, varying in price from four to forty dollars: in the summer this is replaced by a body-jacket, decorated with rows of small buttons or coins, and braided in various colours; round the waist is worn an immense bandana or shawl in the eastern fashion; the leather leggings are richly embroidered, and the hat is either high-crowned or oval, decorated with black velvet buttons, or trimming, with points.

The general female costume of Spain consists chiefly of a petticoat and a large mantilla or shawl, or a veil covering the upper part of the person; but this is rarely worn except at mass. The colour of the mantilla is black; it is of lace or silk, or both, and it is thrown over the head so as to display a large and costly comb. Neither bonnet nor ribbons are generally worn, although some ladies may be seen dressed in the French mode. The fan is carried by all females, from the lady in her carriage to the servant walking in the street; indeed, "a Spanish woman would be as likely to go out of doors without her shoes as without her fan." The neat stocking and small shoe are also much studied.

But the varieties of costume are almost endless: the Catalan wears a velvet jacket with silver buttons and long pantaloons; the Valencian loose breeches of linen, and a long sack unlike the full cloak; and the Castilian a black velvet cap, a black sheep-skin jacket, light breeches, a girdle, embroidered leather leggings, and stout nail-shod shoes. In the north is worn the red woollen cap, hanging down the back; in La Mancha the montero cap; and in the south the low-crowned hat, with a wide brim turned up. Among the eccentricities of costume, is the dressing of the hangman in green, from an ultra-Catholic aversion to the sacred colour of Mahomet.

The common mode of dress in Portugal is similar to that of Spain.

Greece.—The dress of the modern Greeks is a mixture of Turkish and Frank costume, with little to mark the classical origin of the people. The chief article of attire of the poorer Greeks is a capote, or large woollen garment, with a hood, shaggy with short threads of yarn; it is heavy when dry, but nearly insupportable when wet; it is as serviceable for home and bed to the wandering Greek as the *bunda* is to the Hungarian shepherd, and it is a perfect defence against cold and dew. All but the poor classes of Greeks, however, dress showily; and even a servant will expend every farthing of his wages in fine clothes. Thus, a physician's janissary may be seen in a rich robe of scarlet, his vest of blue velvet trimmed with gold lace, and in his silk girdle a brace of pistols embossed with silver; turban, short petticoats, and trousers of purest white, and gaiters or "leggings" of scarlet velvet, embroidered with gold; altogether, a costume that might suit a prince. The general dress consists of a short embroidered jacket, without collar, and with sleeves open from the elbow; an embroidered vest, a cotton shirt, a tunic of several folds, secured by a sash or shawl about the waist, and reaching to the knee; loose breeches or trousers, short socks, and slippers between sandals and shoes. In one corner of the sash, the common people carry their money, which the rich put into purses, and carry, with their handkerchiefs, watches, and snuff-boxes, in their bosoms. The head-dress is various: as the turban, *a la Turque;* the fur-cap, like a muff; the fez or tasseled cloth cap worn on one side; the plain caps of the peasantry; and skull-caps of velvet or gold, embroidered or tasseled. The young Greeks are the handsomest race in Europe; their long hair falls over their shoulders from under the cap; their embroidered jackets, vests, and buskins, their arms mounted with silver, and even jewels, and their white kilts, compose, on the whole, one of the most graceful and becoming costumes in the world.


The Greek.

The costume of the Greek female more closely resembles that of the Turks. She wears loose trousers of fine calico, embroidered with flowers, a closely-fitting vest, a jeweled zone about the waist, and a long-sleeved gown flowing off loosely behind, or a veil covering the body; and sometimes a rich pelisse trimmed with fur. Jewellery is worn to excess; and bracelets of gems, or strings of gold coins round the arm and neck, across the forehead, and in the hair, which the younger girls let fall down their backs and over their brows and cheeks. Little caps, similar to those of the men, are also worn by the females, studded with coins, but worn on one side of the crown, the girls wearing in them flowers, and the matrons heron-plumes or jewels. The young women often dye their hair auburn, and the old ladies red, with which colour the nails are also tinged. The females walk abroad in a robe of red or blue cloth and an ample muslin veil.

Turkey.—Although belonging to Europe, the Turks are properly an Asiatic people, and their garments, where their true national costume is preserved, are according to an eastern or Asiatic model. The outward Turkish garment is a long and loose robe; underneath is a wide vest bound with a sash; loose drawers, and a wide-sleeved shirt without wrist-bands. Slippers are worn abroad, but are left at the door on entering a house. This, with a turban, is the usual dress, though many classes have a different one, and an office is often denoted by a peculiar dress.


The Turk.

The turban was long the most characteristic feature of eastern dress: it was a cap surrounded by many folds of cloth or muslin, its form and ornaments not only distinguishing the rich from the poor, but distinguishing the various professions. The varieties of form were considerable, a barber of Constantinople having been known to arrange the drapery of a turban in sixty-six different fashions. The yatagan or sabre is invariably worn by the Turks.

The dress of the Turkish females has a general resemblance to that of the men, though a stiff cap is worn instead of a turban. When abroad, the women are closely veiled, but they unpin a corner of the muslin to enable them to eat sweetmeats and smoke the long *chibouk* or Turkish pipe; their white muslin turbans, too, are sprigged with gold, and decorated with red flowers; the hair is worn long, and plaited with embroidered gauze, knobs of gold, and spangles with diamonds and other gems.

A crowd in Constantinople was formerly a picturesque group; there was the graceful Effendi Turk with snow-white turban, jetty beard, sparkling and full eyes, long flowing caftan, scarlet trousers, yellow boots, rich Cashmere shawl round the waist, in which shone the gilded dagger; next was the gay but cunning-looking Greek, with short chin, black turban, enormous but short trousers, bare legs, and black shoes; then the grave Armenian, with his calpac of black felt balloon-like upon his head, his long Turkish robe, silver ink-horn in his girdle, and his feet in the crimson slipper or boot; next was the Jew, with his blue turban and slippers; and with these were seen the high taper calpac of the Tartar, the melon-shaped head-piece of the Nizam Djedid, the gray felt conical cap of the imaum and dervish, and occasionally the ungraceful hat of the Frank, with the bebuttoned and mean-looking costume of Europe.* Latterly, the costume of Turkey has been greatly infringed upon by the introduction of the Frankish dress.

ASIATIC COSTUMES.

Although the transit from Europe to Asia may be somewhat modified by our description of the journey still lying in the Turkish empire, the contrast of the oriental costume, but imperfectly adopted in one corner of Europe, soon becomes striking on entering Asia. Instead of our tight short clothes, we see long floating robes wrapped loosely round the body; the hat is displaced by a light turban, and sandals are worn instead of shoes. The oriental costume is simple, and, among the rich, of costly materials. India and China furnish abundance of silks and dyes, and the muslins of the former country are unrivalled, as are also the Asiatic wools, and the art of interweaving gold and silver with these fabrics; whilst the jewels and precious stones of their country enable the Asiatics to eclipse other nations in splendour of personal ornaments; whilst all over the east the beard is allowed to grow so as almost to be considered a feature of costume.

To notice the thousand varieties of fanciful costume prevailing in this vast continent, is altogether beyond our limits, and all we can do is to give a glance at those more strictly national.

Arabs.—The general dress of this interesting people is of a simple form. Their ordinary attire is a piece of linen over the shoulder, another round the middle, and a girdle, with a knife; sandals, sometimes of wood, merely covering the soles of the feet. Upon the coast, the whole dress consists of a napkin round the loins, and a kerchief fringed with silk on the head, the rest of the body being quite naked. Some wear only drawers and a shirt. This, however, is only the dress of the poorest classes; that of the rich resembles the Turkish costume, being loose and flowing. At Muskat, the inhabitants wear a carpet skull-cap and a white embroidered turban, a long white garment reaching to the ankles, a cloth girdle, and sandals of hide, with straps; and an Arab must be poor indeed if he has not a sabre hung over his shoulder, and a dagger by his side. The Muskat soldiers are distinguished by a circular shield of rhinoceros-hide, a foot and a half in diam[illegible] long thin sword, a dagger, and a pike from seven [illegible]n feet in length.

A captain of the Arab navy wears a blue check turban, bordered and fringed with red; a dark-green upper garment, with wide slashed sleeves, falls just below the knees, and beneath it is a wrapper of pink silk, the sleeves slashed with yellow satin, and secured about the waist with a girdle of cloth or silver, over which is worn a sword-belt and ornamented dagger. From half way below the knee the legs are bare; the feet are sandaled, the straps being fancifully ornamented; and the toe-nails, as well as those of the fingers, are stained reddish-yellow. Such is the costume of an Arab gentleman of the present day, and it has probably varied but little from the earliest times. Another picturesque dress is a large white turban, full white breeches, a frock buttoned straight upon the chest to the throat, girded above the loins, hanging half-way to the knee, and looped up on one side, the feet being sandaled. The Arab women of the same place (Muskat) shroud the greater part of their face with dominoes or hooded cloaks; their white long-sleeved gowns or robes reach half way below the knees; and they stain their eyelids dark, and their cheeks and hands yellow; or they wear a loose gauze robe over pantalettes fitting close at the ankles, which are ornamented, as among Jewish females of old, with silver bangles; the feet are cased in gay stockings and slippers, or they are bare, with rings on the toes; the short-sleeved spenser or jacket is tastefully bespangled and tinseled.*

A merchant of Jidda or Yemen wears a caftan or gown of silk, and a red scarf, and around the waist a Cashmere shawl, in which is fixed a long curved dagger; and sometimes the lower part of the face is muffled up in a woollen shawl. The rich also wear slippers. The profits from the pilgrimage enable the people of Mecca to dress very gaily; and from the Persian Gulf they obtain the finest pearls in the world.

But the most characteristic portion of the Arab costume is the head-dress, which is profusely ornamented, but has neither comfort, convenience, nor any adaptation to climate. A man of fashion will wear no fewer than fifteen caps piled one above another, the top one being embroidered with gold, and with a sentence of the Koran worked into it; around the whole is folded a muslin turban, with loose gold and silver-fringed ends. In the south, the turban is formed of a bordered square of silk, with a piece of India muslin coiled round it. The green turban, when worn by the head of an ancient tribe, denotes the highest dignity that can exist in Arabia. The poor wear only two caps; and the Bedouins, or wandering tribes, wear no caps, but only a hood in their cloaks, which are draped so as to keep off the cold and rain. The Arab sailors at Mocha and other ports of the Red Sea wear dark-flowing robes, and pale blue and red turbans of picturesque form. At Muskat, none except those of royal lineage may wear the turban above a prescribed height.

Persians.—The Persians are allowed to have once surpassed in pomp and show the other oriental nations; and this magnificence was nowhere more displayed than in the splendour of their attire and personal ornament. But this distinction now applies rather to the costliness of the materials of dress than to its colours; for however gayly the Persians may have dressed formerly, their present choice is confined to dark tints, as brown, olive, green, and blue.

The Persian dress has been considered effeminate, and not unreasonably so. The men wear very wide trousers, and a shirt extending below the hips, over the trousers; a tight-sleeved vest des[illegible] to the middle of the leg, and over all, a long ro[illegible]ing to the ankles, fitting tight as far as the hip[illegible]hen buttoned at the side, but flowing like [illegible] The sash around the waist is of flowered m[illegible]sh chintz, the common shaw

* Frankland's Travels to and from Constantinople.

* Dr. Rasch[illegible]er's Voyage round the World.

of the country, or a Cashmere shawl. It is eight yards long and one yard broad, and in it is stuck a dagger, without which, and a sabre, no Persian considers himself fully dressed; and these weapons are profusely jewelled. Great care is taken of the feet and legs: in winter, a thick woollen sock is worn, and the legs are bandaged with cloth; the slipper turns up at the toe, and has an iron heel an inch and a half in height. High-heeled boots are likewise worn; and it is customary to take off and leave at the door the slippers or boots before the wearer enters a room, this being done on account of the sacred character of the carpet. The head-dress is a black sheepskin cap, from a foot to a foot and a half in height, which was formerly encircled, turban fashion, with a shawl. They keep their head covered, a compliance with which etiquette has been troublesome to foreigners, who have thus been compelled to dine in their cocked hats and feathers. The Persians pay great attention to the hair and beard; the head is completely shaven except a small tuft on the crown, and two locks behind the ears; the beard is allowed to grow very large, and to spread about the ears and temples; the pride is to dye it a rich glossy black (which must be repeated once a fortnight), and then to adorn it with jewels.

Altogether, the Persians are fond of fine clothes, and will pay a liberal price for them. They prefer English manufactures to those of any other nation. English chintzes and broadcloths are much in demand; the latter for the outer garments of most respectable persons. The taste in colour varies much; one year blue and brown will be in favour, next year red and grey. The chintzes are invariably high coloured; but the patterns must be changed as often as in the Manchester market. Hence the British trade with Persia is considerable, although we have powerful competitors in the Russians and Americans.

Circassians.—In Circassia, where the distinctions of rank and birth lead the people to associate in septs or clans, the varieties and gradations of costume, as might be expected, are closely observed. The warlike spirit of the men likewise encourages this taste; their indulgence in dress never degenerates here, as in some other countries, into luxurious effeminacy, but fosters their chivalrous bearing and personal gallantry. The exquisite beauty of the women, and, above all, the active part which they take in the business of life, also ensure this attention to costume.

Circassian Lady.

A Circassian beauty, whose fine form and delicate complexion have almost exhausted eastern panegyric, is tall and well, though slightly shaped, and carries herself very erect, though somewhat ungracefully, from the practice of tightly compressing the loins from infancy, and thus giving an unseemly protrusion to the body and stiffness in walking. Her beauty is tenderly watched, her face being shaded from the sun, her feet protected by a wooden shoe, her hands by gloves, and her waist by a broad leathern girdle, fastened at an early age with clasps. Her costume is a bonnet or skull-cap of scarlet cloth, tasseled and covered with broad silver lace; a boddice of blue silk, with silver studs; a girdle with silver shell-shaped clasps; and beneath a petticoat of striped silk, loose Turkish trousers, from which peep her white and delicate feet, which, in-doors, are left uncovered, but ornamented pattens or morocco slippers are worn out of doors. The maiden is not veiled, whereas the married woman wears a veil and a piece of calico muffled to the nose. The hair is worn in braided tresses over the shoulders. Sewing, embroidery, and straw plaiting, are the occupations of all females above the rank of slaves

The male dress of the Circassian is the well-known Caucasian costume; the sheep-skin bonnet and collarless frock, with loose hanging sleeves, fitted closely to the body, fastened by loops in front. The trousers are wide above, and gathered tightly over the knee and calf, and covered to the middle of the leg with gayly-gartered galoches; the shoes are remarkably neat, of red morocco trimmed with silver, or of black leather or ox-hide, but they are without soles. On each breast is a row of ten cartridges; a rifle is slung over the shoulders, a pistol in the belt behind, a broad dagger in front, and a sabre at the side. The costume is uniform in its most trifling details and adjustment, so as to give a group of men the appearance of one family, except the calpac or bonnet, which is of lamb, sheep, or goat-skin, crisp and curly, long and shaggy, thick and bushy: the cloth of the dress is coarse, and of gray, straw, or brown colour. The winter garments are sheep-skin doublets, worn with the wool inwards under the tunic; a hood of stout frieze covering the calpac and shoulders; and a large cloak of thick brown felt.*

The costume of the mounted warrior is very picturesque; as a brown surtout silver-laced, sometimes open at the breast, and displaying a gleaming shirt of mail; black pantaloons, puce leggins, red shoes, sabre, bow, and quiver; and a white turban, with a red cap and long purple tassel. These coats of mail were doubtless introduced by the Egyptian Mamelukes, and we shall hereafter find them worn in the interior of Africa.

Tartars.—The wandering tribes of northern and middle Asia, consisting of Tartars, have little to boast of in the way of costly costume. The common dress is a cotton robe and drawers, sometimes trimmed with wool, and red is the favourite colour. Garments of skins are also worn; and a young Tartar has been known to have the fresh hide of a horse thrown over his naked body, and cut, fitted, and stitched into a dress in an hour or two, which only wanted to be tanned by continual wearing. The Calmucks have scarcely any clothing but a strip of cloth about the waist. The Mongols wear sheep-skin dresses, with the wool inwards, and the better classes furs. But the dress is nearly as various as the people. In the northern countries furs are much worn.

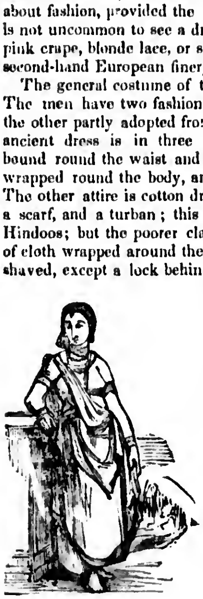
The warlike Toorkmans of the deserts between Balk and the Aral are a handsome race; they wear the *tilpak*, a square or conical black sheep-skin cap, which is far more becoming than a turban. They are very fond of bright-coloured clothes, and choose the lightest red, green and yellow, for their flowing pelisses. The head-dress of the ladies would grace an English ball-room; it consists of a lofty white turban, over which is thrown a red or white scarf that falls down to the waist; but they never veil. Ornaments are sometimes attached to the hair, which hangs in tresses. The other part of their costume consists of a long gown reaching to the ankle, and hiding both it and the waist, which are standard points of beauty in our country.

Siberia and Kamtschatka furnish rich and soft furs, which, however, are only worn by the higher classes, or exported for the wealthy of other countries. The most valuable fur is that of the weasel, called the *sable;* and next, the black fox. The dress of the poor Burettas, in Siberia, consists of a pelisse of dressed goat or sheep-skin, with the hair or wool worn inside or out-side, according to the season. It is mostly trimmed with common fur, and painted with black and red stripes about the neck and shoulders. The hair is worn in a long plait, hanging down the back from beneath a peaked shaggy goat-skin cap.†

* Abridged from "Longworth's Year in Circassia."
† Dobell's "Travels in Siberia," &c.

India.—The vast country of Hindostan presents innumerable circumstances favourable to the characteristics of costume; in its antiquity as the seat of oriental pomp, in the richness of its products, greater than those of any other country, ancient or modern, and in the variety of races and castes which distinguish its social state. These observations apply only to the natives of Hindostan, for no "Christian of European descent, however remote, ever wears a native dress. Rich Indo-British ladies, on the other hand, attire themselves in the latest and newest fashions of London and Paris, greatly to their disadvantage, since the Hindostanee costume is so much more becoming to the dark countenance and pliant figures of eastern beauties;"* those of an inferior class care less about fashion, provided the style be European, so that it is not uncommon to see a drummer's wife in blue satin, pink crape, blonde lace, or silver-lama dresses, and other second-hand European finery.

The general costume of the Hindoos is as follows:—The men have two fashions of dress, one very ancient, the other partly adopted from the Mohammedans. The ancient dress is in three pieces of cotton cloth, one bound round the waist and falling to the knee, another wrapped round the body, and the third round the head. The other attire is cotton drawers, a long robe tied with a scarf, and a turban; this is the regular dress of the Hindoos; but the poorer classes have often only a piece of cloth wrapped around the loins. The head is usually shaved, except a lock behind, and small mustachios are worn. The dress of the females is very elegant; the close part is a half-sleeved jacket, the remainder is a large piece of silk or cotton wrapped round the middle, falling gracefully below the ankle of one leg, while it gracefully displays a part of the other. The upper end crosses the breast, and is thrown forward again over the head or shoulder. The materials are generally cotton, but in some of the higher regions, the colder climate renders general the wearing of woollen cloth and even of furs. The clothes of the different classes differ mainly in degrees of fineness, the rank of the wearer being indicated by a profusion of jewels, embroidery, and gilding.



Hindostanee Woman.

The extreme ugliness of the dress adopted by the most refined nations of Europe, is nowhere more apparent than in British India, where it is contrasted with the flowing garments of the natives. The round sailor's jacket and tight trowsers, brought by the early factors from their ships, are worn to this day in India; and the men are clothed from head to foot in white cotton, in which the coxcomb can only distinguish himself by the quantity of the starch. The officers of the Indian army, when on duty, wear jackets of thin scarlet or blue Cashmere, China crape, or China silk; and young civilians sometimes appear in full dress swallow-tailed coats of China crape.

In India, dress is rarely varied; and accordingly few things surprise the natives more than the changes in European fashions. The dresses of the ladies, therefore, are plain, if not dowdy, in comparison with the gorgeous show of the Asiatic groups; and in warm weather bonnets are dispensed with, and the hair is worn in the plainest manner. There is not so great a variety of oriental costumes at Calcutta as might be expected; some of the Armenians appear in their national dress; a few Hindoo and Mohammedan gentlemen are clad in very picturesque attire; and a Chinese physician may be seen in an old tumble-down chariot. Some of the native shoes are very handsome, but can only be worn by foreign residents as slippers; the points are peaked and turned up, and the shoe itself of cloth or velvet, stiffened with embroidery. Most of the shoemakers of Calcutta are Chinese, who live in one wide street, and are always well dressed in the rich silk upper costume of their country.

Benares is celebrated for its rich displays of costume. A native noble wears a velvet turban, so richly embroidered as to resemble a cluster of precious stones; the vest and trowsers are of crimson and gold brocade, a Cashmere shawl is wound round the waist, a second shawl is thrown over the shoulder, and the belt of his scimitar, and the studs of his robe sparkle with diamonds. The costly gold and silver tissues of Benares are worn as gala-dresses by all the wealthy classes of Hindostan as robes or turbans; silver and gold lace are very cheap here; and the trinkets of Benares, as chains, necklaces, ear-rings, and bangles, are at once elegant and massive; pearls are much worn by the natives, and strings of the size of pigeons' eggs are frequently displayed round the necks of rich men; and diamonds are worn in similar profusion. The dress of the *nautch*, or singing and dancing girls, is very picturesque; it consists of gay silk trousers embroidered with silver; rich anklets strung with small bells; the toes covered with rings, and a silver chain across the foot; over the trousers is worn a petticoat of rich stuff, very full, and deeply trimmed and fringed with gold or silver; the vest is almost hidden by an immense veil of rich tissue, which crosses the bosom several times, and hangs, in broad end, at the front and at the back. The hands, arms, and neck, are covered with jewels, and in the hair are worn silver ribbons and bodkins. The ears are fringed with rings, and through the nose is worn a large gold wire ring, from which hang a pearl and two other precious gems.

Bombay, in its mixed population, presents several varieties of costume, as that of the wealthy Parsee, shown in the annexed cut, with collarless white muslin frock over scarlet silk trousers, long sharp toed slippers, and high purple or chocolate-coloured cap, figured with white flowers. A Parsee lady wears a tight satin spenser with short sleeves, embroidered and fringed with gold bells, and a satin mantle thrown round the body and over the head, like the Spanish mantilla; large pearls are worn in the ears, and emeralds in rings on the toes.

The Parsee.

The costume of the native islanders of Ceylon is attractive. The Cingalese women of rank wear, over coloured silks or satins, a white muslin robe embroidered with flowers and spangled with gold. The chemise has lace ruffles and trimming; and in the hair are worn gold and tortoise-shell combs, and pins set with gems. The men of the middle class wear muslin waistcoats and jackets, the women short shifts and petticoats of printed cotton. The poorer classes wear simply a thick fold of coarse muslin wrapped round their bodies. The poor Candian mountaineers go almost naked, but the higher classes are arrayed in superb tiss[illegible] and embroidered muslins, and a square cap or round turban co[illegible]ers the head. The Malabars wear gold ear-rings n[illegible] [illegible] foot in circumference set with large gems; but th[illegible] [illegible] by the women [illegible] much smaller. They wear a s[illegible] piece of muslin folded

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* Miss Roberts's "Scenes and Characteristics of Hindostan."

round the waist, hanging below the knee, and gracefully thrown over the shoulder, so as to cover the body and leave the arms bare; and the hair is merely combed and turned up behind and before.

The manufactures of India furnish the most costly materials for clothing, and her mines yield the finest diamonds in the world, and other gems in abundance. Ceylon, too, furnishes pearls and chank-shells, much worn by the Hindoos. Cotton, the native material of India, is there worked into the most elegant forms: in Dacca, muslin* is made richer, softer, and more durable than elsewhere; and the calicoes,† ginghams, and chintzes of Coromandel are unrivalled, though almost excluded from the European market by cheap and close imitations. Silk is manufactured in taffetas, brocades, and embroidered tissues. The woollen fabrics of the northern provinces have been already mentioned.

China.—The most familiar representations of these extraordinary people and their quaint costumes, are to be seen upon their "china;" and Viscount Jocelyn‡ remarks, that "it is wonderful how correct they are in the main features." Here they are shown to be well clothed; and they are more completely so than the other nations in the south of Asia.

The extremes of heat and cold which characterize the climate of China at opposite seasons of the year, have led to a marked distinction between the summer and winter dress of the better classes. But the difference is principally in the cap, which in summer is of finally-woven bamboo, of conical shape, with a blue, white, or gilt ball at its point, whence falls, all around, silk or red horse-hair fringe. The winter cap is circular-crowned, and a broad brim, turned up all round, and faced with velvet or fur; at the top of the crown is likewise a ball, whence falls just over the dome a bunch of crimson silk. The changing of these caps with the season is of such importance as to be notified in an official gazette. A small skull-cap is commonly worn within doors in cold weather. The summer garment is a long loose gown of light silk, gauze, or linen; in full dress, worn with a silken girdle, to which are fastened the fan-case, tobacco-pouch, bag for flint and steel, and sometimes a sheathed knife and chop-sticks. In winter a large sleeved spenser is worn to the hips, over a dress of silk or crape, which reaches to the ankles. This spenser is of fur, silk, or broad-cloth, lined with skins; and the neck, which is bare in summer, is in winter covered with a collar of silk or fur. The loose dresses fold over to the right breast, where they are fastened by buttons and loops; and the button, by its shapes and sizes, denotes the rank of the wearer. In summer the breeches are loose; and in winter a pair of tight additional leggings are worn. Woven silk or cotton stockings are worn; and in winter boots of cloth, satin, or velvet, with white soles, by persons of certain rank. On state occasions the under dress is splendidly embroidered in silk and gold, and the caps are crimson, with various coloured balls. The fur dresses of the higher classes are expensive, and descend from father to son. Little linen is worn, and the body garment, sometimes of light silk, is very rarely changed.


Chinese Tradesman.

Nevertheless, the costumes of all ranks and orders about the imperial palace are observed at Pekin with as much precision as in any court of Europe. Fashion, too, has its votaries; a Chinese fop being dressed in costly crapes and silks, boots or shoes of black satin of Nankin, embroidered knee-caps, cap of exquisite cut, and button of neatest pattern, an English gold watch, a tooth-pick attached to a string of pearls, and a scented Nankin fan; and such a personage is attended by servants in silk dresses.

The head of the men is shaven, except at the top, whence the tail hangs after the Tartar custom; they have little beard; but the shaving of the head employs a great number of barbers; in mourning, however, the hair is allowed to grow.

The dress of the women is modest, and of exquisite silks and embroidery, of bright and permanent gloss and colour. Pink and green are favourite colours, but they are never worn by men. The ordinary dress is a large-sleeved robe over a longer garment, under which are loose trousers fastened at the ankle, and embroidered shoe, proverbially small, about four inches in length and two in breadth, the feet being barbarously compressed from infancy. Unmarried women wear the hair in long flowing tresses down the back; after marriage it is twisted up towards the back of the head, and ornamented with bodkins, flowers, and jewels; and at a certain age, a silk wrapper is worn round the head. Females of all ages daub their faces with red and white paint. They pass most of their time at home in music, drawing, or embroidery; and the handsome crape shawls taken to England are entirely the work of women.


Chinese Women.

The general material of the dresses of the peasantry is nankeen, dyed of various colours, black and blue being the most common. The men wear loose trousers tied round the waist, underneath a smock-frock. They protect the head from the sun by a very broad umbrella-shaped hat of bamboo slips, which in winter is exchanged for a felt cap; and in rainy weather they have a flax or reed cloak, from which the water runs as from a pent-house.* Shoes are rarely worn by the peasants, but some protect the feet with sandals of straw. The women wear on the forehead a velvet peak, adorned with a bead, and the hair combed back, and kept together by a loop of leather, and ivory and tortoise-shell bodkins. The girls wear their hair in long plaits, but after marriage it is twisted into a hard knob at the crown, and ornamented with artificial flowers; and even the poor peasant girls pique themselves on their small feet, which they deck with embroidery, whilst the rest of their dress is poor and mean; even the poorest market-women of Canton, though clad in rags, protrude their little bandaged feet into notice.

The uniform of the Chinese soldiers is loose trousers and jacket, often with "valour" inscribed on the back, and a coloured cloth wrapped round the head; some dresses are studded with brass knobs, to imitate armour, and the cuirasses and helmets are of polished steel, the latter bearing red and brown plumes; they appear al[l]

* Muslin is said to have been named from Mosul, formerly the capital of Mesopotamia, on the western bank of the Tigris, and one of the greatest entrepôts of eastern commerce.

† So named from Calicut, the once proud capital of Malabar, whence this cotton cloth was first exported.

‡ Six months in China.

* Dewer's "Chinese."

arms—matchlocks, bows and arrows, swords, shields, and quilted breastplates; but the paper helmets, wadded gowns, quilted petticoats, and clumsy satin boots of other troops, are most unmilitary.

The islands upon the coast of China offer a few peculiarities worth notice. At Macao, the Chinese servants wear full white breeches and leggings, blue gartered, and wooden-soled shoes; and the porters blue shirts, short trousers, and straw or glazed hats tied under the chin. The Tartar women, who row the passage-boats, wear a long blue Nankin frock over black waterproof trousers, and a handkerchief is bound diagonally over the head, and tied under the chin. The Chinese pilot is sheltered from the storm by a broad-brimmed hat made of palm-leaves, somewhat like the husbandman's. The Portuguese women of Macao wear loose figured calico gowns and scarfs over their heads; and if not taking the air in sedan chairs, are followed by a slave bearing an umbrella.

The dress of the Loo Choo islanders is graceful and picturesque: it consists of a loose coloured robe, generally of cotton, wide and long sleeved, with which is always worn round the middle a belt wrought with silk and gold flowers; the robes of grown persons are mostly plain, but those of the children are gaudily printed with flowers. In rainy or cold weather, a sort of thick blue cloth great-coat is worn by the chiefs only, and buttons in front over the robe. All ranks wear straw-soled and banded sandals; the upper classes have white cotton socks, buttoning at the outside, and having a place like the finger of a glove for the great toe. The hair is invariably pulled tight up all round into a compact knot with two pins, so as to conceal the crown of the head, which is shaved. On state occasions only, is worn a kind of turban, made by winding a broad band diagonally. The poorer classes tie a coloured cloth or handkerchief round the head, and wear a thin cotton body dress. The men wear no ornaments, nor are they tattooed; they all carry fans, to keep the sun from striking hot upon their skulls, and short tobacco-pipes and pouches in their girdles. The women are much neglected, and even restricted from using fans. The islanders of Hainan and Formosa wear scarcely any clothes; the natives of the latter are almost savage, and tattoo their skin like the rudest of the South-Sea Islanders.

The manufactures for clothing in China are not numerous. Silk is the staple of the empire, and the Chinese fabrics are still unrivalled in richness, though they are very little worn in Europe: it is, however, stated that the Chinese keep the best silks for themselves. Nankin cotton (which grows of the yellow colour we wear it) is not so worn by the Chinese, but dyed blue, black, and brown, when it is the general clothing; some cotton is, however, imported. Woollen garments appear to be only worn by persons of rank. The beautiful crape shawls have been mentioned. In fans, tortoise-shell, mother-of-pearl, and silver filigree ornaments, the Chinese artisans are only rivalled by their Japanese neighbours. Furs to a great amount are received in China from North America; that of the red fox is used for trimmings and linings of robes, and is variegated with the black fur of the paws.

Japan.—The characteristic intelligence of the Japanese is strongly marked in their dress, which they aim at rendering substantial and becoming, instead of indulging that passion for glitter and show which is evident in all the rest of Asia. Their principal garment is a [illegible] silk or cotton robe, large and loose like a bed-gown, and a girdle. Within doors, socks are the only covering of the feet; abroad are worn shoes, or rather soles, of rice straw, matting, or wood, mainly kept on by an upright pin or button, held between the two principal toes, which, for this purpose, project through the socks. The difficulty of lifting a foot thus shod in walking may account for the awkward gait ascribed to the Japanese. Upon entering any house, these shoes are taken off.

The head-dress constitutes the chief difference, in point of costume, between the sexes. The men shave the front and crown of the head, and draw the rest upwards, and tie it in a tuft upon the bald skull. But priests and physicians shave off all their hair; while surgeons retain all theirs, gathered into a knot at the top of the head. The women arrange their luxuriant hair into the form of a turban, and stick it full of pieces of fine tortoise-shell, so highly polished as to resemble gold. No jewellery or trinkets are worn. The face is painted red and white; the lips purple, with a golden glow; and the teeth of a Japanese married lady are blackened, and her eyebrows plucked out. Neither men nor women wear hats, except as a protection from rain, or when on a journey; a conical hat of plaited grass or oiled paper is then tied with a string upon the head; and the fishermen generally wear these hats. The fan serves as a guard from the sun, and it is to be seen in the hand or the girdle of every Japanese; and soldiers and priests are no more to be seen without their fans than fine ladies are. The uses of the fan are almost endless: dainties are handed upon it; the beggar holds out his fan for alms; the fan [illegible] it instead of a switch; the school-master for [illegible]; by the presentation of a fan, death is announced to the high-born criminal, his head being struck off at the moment that he stretches it towards the fan. There is great pride in wearing swords, and they are never laid aside. The higher orders wear two swords on the same side: the next in rank wear one.*

Vast numbers of rice-straw shoes are consumed by all classes. They cost, however, a mere trifle; and the pedestrian supplies himself with new shoes as he goes along; whilst the more provident man always carries two or three pair with him for use, throwing them away as they wear out. The consumption must thus be very great; for the Japanese travel in their own country more than perhaps any other nation.

East India Islanders.—The dress of the native population of the East India Archipelago partakes somewhat of the close-fitting European and the loose flowing Asiatic costume. The principal tribes are the Javanese and Malays.

The poorer classes of the Javans wear a handkerchief neatly tied about the head, tight drawers reaching to the knee, and a *saroug* or sash of bright-coloured calico thrown over the shoulder, or around the hips, whence it falls like a petticoat. The saroug is not unlike the Scottish Highlander's plaid, being a piece of parti-coloured cloth, six or eight feet long, and three or four feet wide, sewed together at the ends.† In rainy weather, a basin-shaped basket-hat is worn; but in clear weather, it is carried in the hand. A loose jacket is also worn. The Mohammedans wear a turban-like cap; but the other inhabitants have the head naked. A Javan prince copies his dress from the European settlers; he wears a dark cloth jacket, with gold-laced cuffs and collar, a cravat of the fashion of fifty years ago, the only native taste being a handkerchief on his head, and a saroug hanging about the lower limbs. The native court-dress is, however, a full robe wrapped about the waist, and falling over pantaloons, the upper part of the body entirely naked, long flowing hair, a flower-pot cap, and a straight sword and curved dagger in the waistband. The body is smeared with yellow, and richly ornamented with gold trinkets. The war-dress consists of a long-sleeved robe, pantaloons, close cap, sword, dagger, and long spear.

Sumatra has some rude races, who tattoo their skins, and otherwise resemble the South-Sea Islanders; and some few wear no clothing at all. Yet in this island is wrought gold and silver filigree, the only fine manufac-

* Manners and Customs of the Japanese.
† De Ruschenberger's Voyage round the World

ture in the Archipelago. The Bugis, the best-armed natives, make their own guns, spears, daggers, and swords; and their chiefs wear a chain shirt of plaited iron or copper wire. Of this tribe, with Malays, Javans, Chinese, "head-hunting" Dayaks, and a few Europeans, is the population of Borneo made up; and with the addition of East Indians, that of Singapore.

It will be seen that Asia possesses an abundance of the superb materials of dress, which, conjoined with the semi-barbaric condition of a great proportion of its inhabitants, and the consequent taste for glittering distinctions, renders this by far the most striking portion of the earth in the characteristics of costume.

AFRICAN COSTUMES.

Africa presents fewer distinctions of costume than either of the other great divisions of the globe. This may be in consequence of its population consisting, in the main, of Moors and Negroes. The former inheriting the industry of the original Arab invaders, display most taste in their dress; but that of the gay and hospitable negroes has considerable picturesqueness, although consisting of few and simple materials.

Moors, Arabs, Berebers.—These distinct classes form the population of the Barbary States, the wandering tribes being distinguished as Arabs, and the inhabitants of cities as Moors.

The better class of Tripolines have a long and a short dress; the former worn by elderly men and persons of great consequence, and the short worn generally. This consists of a tight waistcoat resembling a Guernsey frock; over it a gold-laced waistcoat, and a jacket with embroidered sleeves; these are confined at the waist by immense trousers of silk or cloth, and a broad belt of silk or gold; and over the jacket is worn an embroidered sleeveless waistcoat. The long dress consists of the two under waistcoats, and over them a long-sleeved gown, embroidered. Over both dresses, which are of the gayest colours, are worn Bornouse or woollen cloaks, bordered with gold lace. The turbans are various; those of Cashmere shawls are the most splendid; green can only be worn by the descendants of the prophet; and blue is confined to the Jews. The boots, shoes, and slippers, are of yellow morocco leather, the staple manufacture of the country. The women dress magnificently, wearing a silk skirt of many colours in stripes, highly embroidered waistcoat, silk trousers, and a large silk wrapper of gaudy colour, so put on as to form a petticoat, and hang over the head and shoulders, showing only one eye; a cap of cloth of gold is worn with many rich ornaments on the head; the eyelids are stained with antimony; much rouge is used; and the ear-rings, anklets, and bracelets, of gold and silver, are very massive. The dress of the Jewish women varies from the preceding chiefly in showing both eyes instead of one; they can wear only black or yellow slippers, and boots are prohibited. Altogether, the above is a most gorgeous costume.

Algiers presents a picturesque variety in its population of Moors, negroes, Jews, and Kabyles, or Berebers. The costume of the Moors consists of a loose head-dress, a shirt, large breeches, an embroidered jacket of coloured cloth, a large white outer mantle, and slippers; and in winter, stockings. In the streets, the poorer Moorish women are veiled, and look like phantoms; the richer Mooresses wear fine linen, bordered with silk; the hair is bound with blue silk ribbon; and over an embroidered silk-velvet jacket, with silk lace ruffles from the elbows to the fingers, and silk pantaloons to the knees, is worn an embroidered silk gown, like that of a European lady; morocco slippers, a veil, shawl, ear-rings, bracelets, armlets, and a necklace, complete this costume, which differs from ours principally in the absence of stockings and petticoat; and the gown is only worn occasionally. The children of the Moors are dressed exactly like their parents, the little girls wearing veils, and the boys turbans. Possibly the above admixture of European fashion may be one of the results of the colonization of Algiers by the French. The Jews generally dress like Europeans: their women wear a gilt wire cap, slanting a yard back from their heads, giving them, as Mr. Campbell tells us, "the appearance of dragon flies;" they strain their hair and eyebrows "to the frightful resemblance of a red cow's tail."* Their costume often presents the extremes of poverty and wealth; as a pair of ragged small-clothes, and a crimson-velvet and gold jacket, and embroidered silk sash. The Berebers cover themselves with a black woollen garment like a sack, which is made to last generally a whole life, and is never taken off; and the head-dress is a woollen cap, like a priest's cowl. The women dress much like the men; they tattoo their legs and arms, and stain their hands and nails, but never veil; and they delight in trinkets. Both sexes wear buskins, like those of the ancient Romans; and any one who repairs a cap which is wholly repudiated at Algiers is considered a fop.

The general costume of the Arabs is a large loose shirt and cotton trousers; sandals or red leather half-boots, laced; a red hanging cap, with a blue silk tassel; a woollen wrapper worn round the body, and thrown over the head, and hanging down the back; and the Bornouse mantle. The dress of the females differs but little from that of the men. The poorest class have only the wrapper or scarf, which is passed over the head and fastened at the waist, others have a woollen gown with short sleeves. The young women wear their hair in tresses, decorated with beads, coral, and a silver crescent, and they wear a large blue woollen turban; also silver ear and neck rings, and charms against disorders and misfortunes. All the women tattoo themselves, and stain their hands and nails, but they never dye their hair; they wear red laced boots, like the men. An Arab belle is almost covered with tattooed flowers, open hands, circles, the names of gods, and of her friends; and she often wears two or three pounds' weight of jewelry.

The countries of central Africa, explored by Denham, Clapperton, and Lander, present many interesting portraitures of costume. The principal garment is the tobe, a linen or cotton garment not unlike the surplice of an English clergyman in shape and volume; it hangs loosely over the person, and is suitable to a climate in which any kind of tight garment would be oppressive.

The costume of the negresses of Soudan is very remarkable, in the hair being stretched over a high pad, helmet-shaped, and the head bound with coral and other bead fillets; the neck-laces are of coral and gold, and the ear-rings very large; glass armlets and anklets are worn; and the upper and under shirts are blue and many-coloured stripes; and a whitish dress, braided pink, with blue waist and wristbands, and a yellow close cap, bound with red, make a very effective costume upon the dark negro person.

African Woman—Kingdom of Bornou.

The negroes of the Sheikh of Bornou may be noticed here: they wear coats of mail composed of iron chain, which cover them from the throat to the knees; some have helmets or skull-caps of the same metal, with chin-pieces; and their horses' heads are defended by plates of iron, brass or

* Letters from the South.

silver, with holes for the eyes. This armour, especially the skull-cap, is like that of the Parthians sculptured on the Trajan column, and subsequently adopted in the Roman army, and then introduced into Africa.

Negroes of Western Africa.—The clothing and ornaments of these people have great variety; different tribes, and people of the same tribe, indulging in a diversity. This passion for dress is not surprising, if we recollect that the negroes have all the requisites for beauty, save colour; and that the mineral wealth of their country enables its chiefs to indulge in barbaric magnificence, which is astounding to more civilized nations.

The poor negroes are content with a coarse cloth wrapper; but the rich wear robes of silk, velvet, and Indian chintz. Red mantles, gold and silver lace, ribbons, and veils, are much in request among the women; and bracelets, rings, and anklets, are worn in profusion. The hair, or rather wool, is as carefully dressed with palm-oil as the flowing locks in other countries, and is entwined with gold; and painting the face and tattooing are common. The general dress is a large-sleeved shirt reaching to the knees; and a high pointed cap is much worn. The Kroomen, on the Grain Coast, wear round their waists shawls and blue cloths, which they purchase at Sierra Leone.

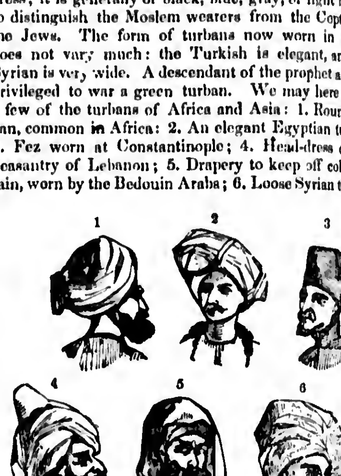
The Ashantees behind the Gold Coast, who are altogether a superior class, dress in barbaric splendour. The Ashantee cloths are of extravagant price, from the costly foreign silks which are unraveled to weave them; they are thrown over the shoulder like the Roman toga; a small silk fillet encircles the temples, and strings of gold beads, coins, and rings are worn round the neck, wrists, arms, and ankles; the sandals are of fine green, red, and white leather. Lumps of rock-gold hang from the left wrist, which are supported on the heads of boys; and wolves' and rams' heads, of cast-gold, as large as life, hang from the sword-handles. The warriors wear caps of eagles' feathers, and of pangolin and leopard skin, the tails hanging down behind; their corselets are of leopard skin, covered with gold cockle-shells, and stuck full of knives sheathed in gold and silver; and their cartouch-boxes, of elephant hide, are similarly ornamented; silk scarfs and horses' tails stream from their arms and waist-cloth; iron chains and collars dignify the most daring; and the sides of their faces and their arms are curiously painted in long white stripes, having the appearance of armour. Even the executioner wears on his breast a massive gold hatchet. The splendour of all Ashantee pageants is enhanced by large umbrellas or canopies of the most showy cloths or silks, crowned with emblems in gold.

Modern Egyptians.—Egypt has long been mainly occupied by Arabs, whose manners and customs are a combination of those which prevail most generally in the towns of Arabia, Syria, Northern Africa, and in a great degree, Turkey, whose characteristics of costume have already been sketched. Nevertheless, the Arab-Egyptians "are to be regarded as not less genuine Arabs than the townspeople of Arabia itself;"* and although their dress has points of resemblance to the costumes of all the countries referred to above, it will be found to possess great originality of character and interest.

The dress of the men of the middle and higher classes has remained almost the same during the lapse of centuries. It consists of a pair of full drawers, of linen or cotton, descending a little below the knees or to the ankles; a full-sleeved shirt of linen, cotton, or silk, over which, in cool weather, is worn a short vest of cloth or striped coloured silk or cotton, and a long vest of the latter materials descending to the ankles, and having full sleeves divided from or a little above the wrist. A coloured shawl or piece of white figured muslin is worn round this vest as a girdle; and the usual outer robe is a long cloth coat with or without sleeves. The turban consists of white muslin, or a Cashmere shawl wound round a close red cloth cap, with a dark blue silk tassel at the crown, beneath which is worn a close cotton cap. The head is shaved, except just at the crown, and mustachios and moderate beards are common. Socks are occasionally worn, but stockings are not in use: the shoes are of red morocco, pointed and turned up at the toes; and sometimes these are worn over yellow morocco shoes. In the girdle is worn a case-knife, a dagger, or a case for ink and pens. The pipe is generally carried; and the tobacco-pouch and handkerchief are crammed into the bosom of the outer vest.

The humbler classes wear drawers, and a full blue linen, cotton, or brown woollen gown, wide sleeved, and open from the neck to the waist, where is sometimes a white or red woollen girdle. The turban is of white, red, or yellow woollen, cotton, or muslin, round a white or brown felt cap. The poorest classes wear only this cap and the brown or blue gown, or merely a few rags. In cold weather, they sometimes wear coarse black or variously-striped woollen cloaks. A blue and white plaid is likewise worn over the shoulders or wrapped about the body. The shoes are of red or yellow morocco, or of sheep-skin.

The turban is the most distinctive article of Egyptian dress; it is generally of black, blue, gray, or light brown, to distinguish the Moslem wearers from the Copts and the Jews. The form of turbans now worn in Egypt does not vary much: the Turkish is elegant, and the Syrian is very wide. A descendant of the prophet alone is privileged to war a green turban. We may here notice a few of the turbans of Africa and Asia: 1. Round turban, common in Africa: 2. An elegant Egyptian turban; 3. Fez worn at Constantinople; 4. Head-dress of the peasantry of Lebanon; 5. Drapery to keep off cold and rain, worn by the Bedouin Arabs; 6. Loose Syrian turban.



Eastern Head-dresses.

The women of the middle and higher orders of Egypt dress elegantly; under their shirt, which is like the men's, they wear very wide trousers of silk, cotton, or muslin, coloured or white; and over them a long vest closely resembling that of the men. A shawl or embroidered handkerchief is put loosely round the waist as a girdle. The outer robe is of cloth, velvet, or silk, embroidered with gold or silk, and generally resembling that of the men; though, instead of this robe, a jacket is often worn. The head-dress consists of an under and upper cap, round which is tightly wound a kerchief of printed or painted muslin or crape, and to it is attached a muslin veil embroidered and spangled, and hanging from the back of the head to the ground. The hair is worn plaited or braided down the back, with attached

* Lane's Account of the Manners and Customs of the Modern Egyptians.

golden ornaments; and two tall locks hang down on each side of the face. Stockings or socks are rarely worn, but inner shoes of red or morocco, and over them yellow slippers, with high pointed toes; or wooden clogs, from four to nine inches in height, richly ornamented. Such is the in-door dress of the Egyptian ladies. When abroad, they wear over this dress a large loose silk gown of pink, rose, or violet colour; a sort of silk robe tied over the head (black for the married, and white for the unmarried), and a long white muslin face-veil, reaching from under the eyes nearly to the feet. Yellow morocco short boots or socks are worn under the yellow slippers. This dress resembles an unsightly disguise, though it displays the eyes, which are always the most beautiful feature of an Egyptian woman.

The poorer class of women wear trousers, a blue shirt, a coarse black face-veil, and a dark blue muslin or linen head veil. A very large blue, white, and red plaid wrapper is also worn by the middle class. The head-dress is a black silk kerchief, bordered red and yellow, and tied diagonally in a knot behind. The shoes are of red morocco, round toed; but in Upper Egypt shoes and the face-veil are rarely seen; and some of the poorest women of Cairo never conceal their faces. But the most common female dress in Egypt is merely a blue shirt and head-veil; and in Upper Egypt, some of the women envelope themselves in a dark brown woollen wrapper and head-veil, which, though dull, is picturesque. Mr. Lane tells us that "the women of Egypt deem it more incumbent upon them to cover the upper and back part of the head than the face, and more requisite to conceal the face than most other parts of the person." He adds, that he has seen in this country women but half covered with miserable rags, and others still nearer a state of nudity.

AMERICAN COSTUMES.

In all those portions of America, including Canada and the United States, which have been long possessed by an English race, the costumes of England and France prevail, any differences which exist being only of minor importance. Peculiarity of costume on the American continent has therefore to be sought for among the native Indian tribes, and among the descendants of Spanish or Portuguese settlers.

North American Indians.—The Indian savages, or red men of the forests and prairies of North America, occupying the vast region to the west of the Missouri, present

North American Indian.

the most interesting specimens of costume in the New World, enthusiastically described as "worthy the pencils of Raphael or Hogarth." The condition of these extraordinary people is, indeed, highly favourable to the distinctions of dress; they are divided into tribes (of whom great numbers are warriors), which are much less broken than the feudalism of those countries of Europe in which costumes are most strongly marked.

The general dress of these tribes consists of a skin shirt, a robe of hide, leggings, and mocassins, and equipments and decorations in great variety. The fashion of long hair is almost universal; but, contrary to European usage, the women are not permitted to indulge in this taste. The length of the hair of a chief (who received his name and office in consequence) is stated to have measured ten feet six inches.

In the costliness and elegance of their costumes the Blackfeet and the Crows are, perhaps, unrivalled. The materials of their dresses are nearly the same; but there is a distinctive mode in each tribe of stitching or ornamenting with porcupine quills, which are the principal decorations of all their fine dresses. The attire of a chief of the Blackfeet consists of a shirt or tunic of deer skins, the seams embroidered with porcupine quills, and fringed with the locks of the hair of victims slain by the chief in battle. The leggings are of the same material and trimming, as are also the mocassins. Over all is worn a robe of young buffalo-skin with the hair on, the inside being garnished with porcupine quills and rude representations of battles. A long pipe, bow and quiver, lance and shield, complete his equipments. He is almost always on his horse's back: and thus armed and equipped, his appearance is very picturesque. A Crow sometimes wears a magnificent crest, or head-dress, made of the quills of the war-eagle and ermine skins; and his horse is covered with a many-coloured net terminating with a crupper, embossed and fringed with beautiful shells and porcupine quills. Necklaces of bears' claws and otter-skin, and ornamented tobacco sacks and belts, are too numerous to describe. The medicine bag is also an important article of costume; it is formed of the skins of animals, of birds, or of reptiles, variously decorated, and always stuffed with grass or moss, and generally without drugs or medicines in them, as they are religiously closed and sealed, and carried as a sort of protection throughout life. The scalps (from the crown or centre of the head) of enemies are preserved as records of a warrior's prowess, and their locks used as trimming. Sometimes a war-knife and buffalo horns are worn upon the head, which is shaven; and the shield and spear are decorated with feathers. In short, nothing can exceed the picturesque variety of these aboriginal costumes, or the vanity of their wearers.

The women wear long loose robes or wrappers of skin, and carry their children strapped to a kind of frame at their backs. The snow-shoe must not be forgotten; it is about three feet long and one foot wide in the broadest part, and its frame is filled with a network of twisted deer-skin, strengthened with sticks placed crosswise; the foot is confined to the shoe by skin strings, though to walk well in these shoes requires as much practice as to navigate a canoe.

Mexicans.—The European dress is common in Mexico, and has long been worn by the higher classes: the people are fond of change; for it is related that a traveller having left a book of London fashions at Xalapa for a few months, on his return found an entire revolution in female dress, founded upon the English model. Still, many picturesque dresses are seen in Mexico, in great measure the introduction of the Spaniards, whose celebrity in the annals of European costume will doubtless be remembered by the reader.

The national riding-dress is of all the most curious, and is enormously expensive. The back and quarters of the horse are covered with stamped and gilt leather, fringed with tags of brass, iron, or silver, which jingle at every step. The saddle, which is large, is superbly embroidered with silk, gold, and silver, and the pummel inlaid with these metals; the bridle has large silver ornaments; and an Arabic bit. The horseman is attired with corresponding richness. His *sombrero*, a low-crowned hat, with a brim six inches wide, is broadly edged with gold or silver lace; his jacket, of cloth or printed calico, is likewise embroidered with gold or silk, or trimmed with fur; his breeches are generally pea-green or azure, open at the knee, and terminating in two points below it, and they are thickly studded down the side with large silver buttons. Next is the riding-cloak, often of velvet, and embroidered with gold. But the boots are the pride of a true Mexican cavalier; they are formed of deer-skin, well tanned and soft, stamped with figures, and bound round the legs with coloured garters below the knees. At the ankle commences the shoe, which, at the top, spreads out six inches, like a scallop-shell. The spurs, of silver, are very heavy, and have rowels three or four inches in diameter, and often a bell attached to the side.

The costume of a muleteer is likewise very striking: the jacket, of embossed russet leather, has silver buttons; the overalls, of the same material, are cut so as to be the length of the foot, and are sustained by a red silk sash above the waist, allowing the shirt to appear between it and the jacket; a pair of huge silver spurs rattle at the heels, and a long straight sword hangs from the waist.

The ladies generally wear black, but on holidays the colours are very gay; shawls are worn over the head like the *mantilla*; and the country ladies wear a profusion of spangles; and they are as proud of a neat shoe and a small foot as the females of Spain. Few ladies appear in public on foot, but in enormous coaches, in full evening costume, smoking cigars. The milliners of Mexico are so many brawny mustachioed men, who may be seen in the shops making flowers and dresses and trimming caps. Next door, women may be seen on their knees grinding chocolate; but in all semi-barbarous nations the hardest labour falls to the women's share.

Colombians.—The Colombian costume is chiefly borrowed from the mother country. The Spanish mantle, or a wide cloak which envelopes the whole person, is the usual attire. But in the streets of Bogota a female may be seen smoking her cigar, and wearing a handsome broad beaver hat, pearl necklace, many rings, and a rich black mantle, ornamented with bugles, but walking without shoes or stockings. The ladies of rank, however, are proud of their pretty feet and small ankles, which are always set off by handsome silk stockings and very neat shoes. Like the women of Spain, they walk with grace and dignity, and are equally coquettish and playful with their fans. A black or blue cloth mantilla, and a small conical black beaver hat, and black silk gown, were formerly the walking dress; but large French bonnets, with artificial flowers and gay silk gowns and neckerchiefs, are now much worn; and the walking evening dress is a pretty straw hat, with artificial flowers; a warm Norwich shawl, and chintz or cotton gowns of British manufacture. Pearls, emeralds (the largest in the world), gold chains, and crosses, and very large pendant gold and pearl-drop ear-rings, are worn in profusion. The women of the middle class generally wear an embroidered scarlet petticoat, a white boddice, with frills and ribbons, and a parti-coloured cotton band; the hair is plaited, and adorned with artificial flowers. The dress of the men is Spanish, with jack-boots and long silver spurs; and a cloak made of rushes, a large straw hat, and bark sandals, are much worn in travelling.

Of the native Indian tribes of this territory, the Carribees are the finest race; the head is shaven, except a tuft on the crown; both sexes paint themselves, and wear only a band or wrapper of blue cloth; they are of a reddish copper colour, and, with their picturesque drapery, resemble bronze statues. The women oat barouary ornament their infants by raising the flesh in alternate stripes from the ankle to the hip. The Chaymans, another tribe, only wear clothes out-of-doors, and then a light cotton gown.

Peruvians.—Peru presents many interesting peculiarities of costume, owing to the various races of its population. The Indians, or native Peruvians, in their male dress, remind Mr. Templeton of the peasantry of Connaught; they wear coarse brown frieze breeches open at the knees, a vest falling in strips round the waist, where it is confined by a cord, and a sort of loose cloak; shirts are seldom worn; the legs are bare, with the exception of low hide sandals; and the hat resembles Don Quixote's helmet, without the niche in it. The women wear a short petticoat, and a scarf round the shoulders, fastened with a large silver pin or a spoon. The Cholas, of Indian and Spanish descent, are very fond of dress and ornament; the girls wear a petticoat containing from twelve to fourteen yards of rich velvet or satin, trimmed with ribbons and gay flowers, a scarf over the shoulders, and a narrow-brimmed black hat, like that of the Welsh women, or a broad hat, with a little lace, silk, or velvet-festooned curtain attached to it. They wear gold and silver ornaments and jewels in profusion.

The women of Lima wear a very unique costume, consisting of a closely-fitting petticoat of velvet, satin, or stuff, with a waistband and buckle; fringe, lace, spangles, or flowers on the lower part, and elegant silk stockings and satin shoes; the *manto*, or hood, of thin crimped silk, is drawn round the waist, and then turned over the back of the head, and enveloping all the upper part of the person except one eye, thus completely disguising the wearer. The ladies of Lima sit on horseback like men; the dress is then European, with a large shawl over the head, and a Manilla grass hat above all, and huge gold or silver spurs on their satin shoes.

The Peruvian ladies are fast adopting the French fashions, and many *marchandes des modes* are established in the large towns; but the Spanish fan is still retained; the mantilla may also be seen, and the long veil falling down the back. The hair is very luxuriant, and universally prized, so that a poor peasant girl has been known to refuse £7 or £8 for her weaving tresses. The shoe of the Indian city dame strongly contrasts with the hide-sandal of the peasant; sometimes a pair costs ten dollars; the heel spreads like a fan, and is adorned with shreds of cloth, spangles, and gold and silver tissue.

The Peruvian male costume has little worth notice; and it would be better for the men of Peru if the women only took the lead in dress. The Tucumano wears trousers, and a large figured shawl over his shirt, with a very broad-brimmed conical-crowned hat tied under the chin. The Indian merchant has embroidered breeches and jacket, a rich fringed mantle over the left shoulder, and a helmet-shaped ornamented cap. But the Peruvian gentlemen mostly dress in the English fashion, and our goods are preferred to either French or German manufactures.

The cloak of the country, or the *poncho*, is an oblong square garment, with a hole in the centre for the head; it is made of cloth or silk and *vicuna* wool of very tasteful colours; it is worn constantly by the men, but only by ladies when on horseback. Mr. Temple* describes a pair of light summer boots made without seam or stitch, of the skin of the hind legs of a horse, and dried ready for wear in a week—"easy as a glove."

Chilians, &c.—Among the changes produced in Chili by free trade, is the general substitution of the English for the Spanish-American costume; and the principal

* Travels in Peru and Potosi.

peculiarities of costume remain among hunters, guachos, and other half-wild denizens of the country.

The equipment of a rich guacho chief at Paraguay is truly magnificent: his Peruvian *poncho* is superbly embroidered on a white ground; his jacket is of fine India cloth; his waistcoat embroidered white satin, with gold buttons; his short collar and front are of fine French cambric, richly tamboured his breeches are of black velvet, with gold buttons, and open at the knees; and from under the knee-bands are seen the fringed and worked extremities of a pair of drawers of fine Paraguay cloth, and ample as a Turkoman's trousers, and just showing a pair of brown *vicuna* wool stockings; while his skin boots fit the feet and ankle as a French glove fits the hand; the tops are turned over like buskins, and to the heels are attached large silver spurs. His large hat is of Peruvian straw, with a black velvet band; and around his waist is a rich crimson silk sash, which serves as riding-belt, braces, and girdle for a huge silver-handled knife in a morocco sheath. His horse is alike gorgeously caparisoned: the saddle, bridle, and reins being silver mounted, and the stirrups elaborately wrought out of at least ten lbs. of virgin silver.* In fine, nothing more splendid than this horse and rider can be found in South America.

At Buenos Ayres and Mendoza, British manufactures are much in request. In the latter town the men wear blue and white round jackets; and the women are only seen in *dishabille* during the day, but in the evening they promenade completely equipped in the costume of London or Paris.

Brazilians.—The vast region of Brazil presents a few traces of its original Indian barbarism, the natives having never been incorporated with the European settlers, but having retired before them into the depths of the forests. Here some of the tribes paint themselves frightfully, and by hanging pieces of wood to their ears, stretch them till they hang down to the shoulders; and the under lip is similarly extended. A scanty portion of clothing has been borrowed from the Portuguese colonists, whose costume was generally adopted in the towns, until, by the free intercourse of Brazil with England, our fashions of dress were assumed by the Brazilians, as well as our furniture and domestic habits. Within two years from their introduction in 1818, English goods made their way, and women might be seen dressed in silks, who, a year previous, would have worn Lisbon printed cottons and thick cloths, and have gone to church stockingless and slipshod. The mineral wealth of Brazil has ensured so ample a supply of clothing from other countries, that manufactures have made less progress here than in any other of the South American colonies; and the only important fabrics are gold and silver articles, which are very beautifully wrought.

Rio Janeiro is almost a European town in dress as well as style of building, though its crowd of half-naked blacks and mulattoes soon destroys the illusion. St. Salvador is a gayer city; and here the French style of dress is much followed, but the official costume is more native. Thus we find the Secretary of State, a half-Indian, mounted on a mule, and dressed in white cotton; his jacket faced with red, and leggings with ponderous spurs; his hat is broad-brimmed and glazed, and has a gold lace-band; his sash is yellow; a gold epaulette graces his right shoulder, and a huge long sword hangs by his side, while his dagger is fastened to his right knee.

In the provinces, sandals with loops and ankle-rings were the Brazilian shoes long after the introduction of English manufactures; and when a native took to wearing a shirt and drawers, a long bed-gown and slippers, he oddly thought himself a gentleman, and entitled to respect accordingly. To this day the arts of life appear to be unknown in some villages, where the natives are bare from the waist upwards, and the children wear no clothes whatever. Even at Rio the extremes of mankind are collected, and the slave population merely wear a waist-cloth.

Brazilian.

At Pernambuco, the benefits of its large cotton-trade are evident; white and coloured muslins alternate with silks and satins; and the men, who formerly wore full-dress suits of black, gold buckles, and cocked hats, now wear Nankin pantaloons, half-boots, and round hats; and even the sedan-chairs and their bearers are improved The costume of the Sertanejos, the graziers of the interior, is partly aboriginal; his pantaloons or leggings, jacket, and hat, are of brown undressed leather; a tanned goat-skin tied over his breast; slippers confined by straps, and iron spurs upon his naked heels. He carries on horseback a change of clothes in a piece of red baize, with tinder, tobacco, and pipe, and a knife in his girdle. The Sertanejos women merely wear a chemise and petticoat within doors, and shoes and a white head-cloth when they leave home. Before the direct trade with England, the coarse cotton cloth of the country was worn by both sexes; and then a dress of English or Portuguese common printed cotton cost from two to three guineas!

The preceding engraving represents a Brazilian sugar-planter. He is well clothed and armed, and his horse is superbly caparisoned; the mountings are silver; and such a saddle as is here represented, when made of morocco leather and green velvet, silver-mounted, sometimes costs one hundred guineas. He travels, with his wife, in rude state, the lady being borne by negroes in an embroidered hammock, and attended by a female on foot.

It may be mentioned, that jewels and gems are worn profusely in Brazil; yet, although it is the land of the diamond, the splendid beetles of the country are worn as brooches. The coronation attire is magnificent. The crown, except the green velvet cap and the band of gold, seems one mass of diamonds; the ruff is of Spanish lace; and the green velvet robe, embroidered with gold, has, in place of the ermine in other regal attire, a dress cape of the bright yellow feathers of the toucan, which was part of the dress of the ancient caciques of the country. The imperial under-dress is of white satin, embroidered with gold, high military boots, gold spurs, and a diamond-hilted sword. At court the nobility wear the costumes of their ancestors centuries since; and in the national museum are preserved the superb feather coronets, dresses, and ornaments of the aboriginal chiefs.*

* Robertson's Letters on Paraguay.

* Stewart's Visit to the South Seas.

AUSTRALASIAN COSTUMES.

The costume of the English settlers in the Australian continent and islands is, as may be supposed, purely European, the London fashions being regularly transmitted thither. The only peculiarity of costume is among the native tribes, who, placed at a low condition in savage life, are dressed in the most primitive and barbarous style.

The clothing of the men of certain tribes consists of a skin cloak worn like a robe over the shoulders, and fastened round the neck, the fur part being turned inside in wet weather. Around the waist is worn a belt, not unlike an officer's sash, made of opossum fur; and attached to it are flaps of opossum skin cut in stripes, and worn before and behind; and a skin purse and tobacco pouch are carried in this belt. The jet-black hair is worn long, and well greased; but some tribes tie it to the top of the head with bunches of reeds and cockatoo feathers; and they wear the beard. The skin is tattooed in stripes, more especially among the natives of the south, which renders them terrific in appearance.

The women also wear opossum skin-cloaks; and they have one or two nets, in which they carry at their back an infant child, and burdens generally. Their hair is shorter and more curly than that of the men, and is occasionally ornamented with kangaroo teeth, affixed to their locks by wax, so as to dangle all round their heads. Both sexes are very fond of ornament, for which purpose they thickly coat their skin with fish-oil, and on high occasions smear their faces with red and white earth; on their bodies are traced the forms of birds and beasts, and the jaw-bones of fish and the tails of dogs are favourite decorations; and through the nose is often worn a feather or piece of bone. They carry spears, clubs, and other weapons, in great variety.

New Zealanders.—The natives of New Zealand, considered by Dr. Laing to be of Asiatic origin, are physically and intellectually superior to the New Hollanders, although they are yet essentially a savage people. Their personal appearance is very fine; their mean complexion is that of a European gipsy; but their faces are much disfigured by tattooing. Their chiefs have fine athletic forms; and their mat cloak tied over the right shoulder, and descending to the ankles, brings to the mind of a classical beholder the Roman toga; whilst their towering stature and perfect symmetry give even more than Roman dignity to the illusion. The young women, too, are graceful, and have expressive eyes and a profusion of long silky hair.

No two persons are tattooed exactly alike; it is generally commenced on the lips, then on the cheeks, and progress is made alike in embellishment and age. Tattooing is no sign of rank, for slaves get marked as much as chiefs; but every tribe has distinctive insignia. It is considered a mark of beauty; and some of the young natives have their bodies marked over with small dots, resembling the blue spots in a Guernsey frock. The most valued article of dress is the *pui*, a sort of cloak formed of the skins of dogs, the furs cut lengthwise, and sewed alternately white, brown, or black, to a strong matting. These garments are sent to the principal chiefs as presents. The common native mat is made of flax, scraped with the mussel-shell. Another mat is made of silken flax, interwoven with blue, red, and green baize, purchased of the Europeans: it is worked with sampler-like borders of elegant design. This is a handsome summer dress; but for warmth and comfort, the English blanket is in universal repute.

The mats are worn over the shoulders, tied across the breast; and around the waist is a similar mat, fastened with a belt. Spear-grass and sedgy cloaks are worn in wet weather. The women affect less handsome apparel than the men, but they are fond of ornament. Red ochre and shark-oil are the cosmetics used from head to foot. Both sexes wear in the ears paroquet-skins, bones, cloth, beads, teeth of friends, enemies, dogs, pigs, &c., and are generally garnished with sealing-wax: armlets, ringlets, necklets, and anklets, and fancy wood combs are worn, and nose ornaments by the men. The hair on gala-days is worn in a topknot, with sea-fowl flowers; and various paints are used.

English female garments are already much in request; and the men may be seen strutting about in a cast-off cloth jacket; and this passion has been indulged by the missionaries and colonists from England. It has been well observed—"True it is, till their European costume shall become complete (and perhaps even then), they will look more noble in their mat-cloaks; but no barbarous country was ever civilized till the people had adopted the costume of their conquerors; and the expensive and complicated dress of refinement and fashion is the taste that will lead the savage to industry and the arts of peace—not the head-dress of plastered hair and the garment made from the cloth-tree."*

New Zealand Family.

The engraving represents a family of New Zealanders, two of whom wear the fine coloured silken flax-mats and the third the blanket robe.

* Murray's Encyclopædia of Geography.

BRITISH COSTUMES.

BRITISH AND ROMAN PERIODS.

The original inhabitants of the British isles were of Celtic descent, and are believed to have brought with them the Thracian custom of *tattooing* their bodies, by squeezing certain coloured juices into figures made with the points of needles. Hence they must have resembled in appearance the tattooed islanders of the South Seas; and although personal distinction may have been the leading object of this species of ornament, it appears to have been generally adopted by barbarous half-clad tribes. Among the Southern or Belgic Britons, at the time when Julius Cæsar landed in the country (55 B. C.), the arts connected with clothing had made some advance; but in the more northern parts, the practice of living half naked, with painted and tattooed bodies, was common, and remained till a much latter period than in the south. Such fanciful decorations are supposed to have given name to the nation of Picts, from the Latin word *picti* (painted); but other authorities refer the term to different origins.

Pict.

The Roman dress does not appear to have been adopted until towards the close of the first century, when the better classes of Southern and Eastern Britain exchanged the *braccæ* for the Roman tunic, reaching to the knee, and the *toga* or mantle.

In the dress of the women there was but little change. They appear in two tunics, the one reaching to the ankles, and the other has short sleeves, and reaches about half-way down the thigh; or they resemble a round gown, or bed-gown and petticoat, though the latter, distinct from body and sleeves, is not considered to be ancient. This tunic was called in British *gwn*, and hence our word *gown*; of which we still see specimens of short dimensions worn by women of the humble classes in England, Scotland, and Wales.

ANGLO-SAXON AND DANISH PERIODS.

Whatever traces of costume may have been left in Britain by the Romans, they disappeared soon after the arrival of the Saxons in 449, who introduced fashions of apparel from northern Germany, which were copied by the Romanized British, and continued with no material change for several centuries.

The common dress of the males of the eighth century consisted, as we find, of linen shirts; tunics, or a kind of surcoat; cloaks fastened on the breast or shoulders with brooches; short drawers, met by hose, over which were worn bands of cloth, linen, or leather, in diagonal crossings. Leather sandals were worn by the early Anglo-Saxons: but afterwards the shoe became common; it was very simple, and well contrived for comfort, being open down the instep, and there, by a thong passed through holes on each side of the slit, drawn tight round the feet like a purse. A felt or woollen cap, called *hæt* (hence our modern word hat), was worn by the higher classes of Anglo-Saxons; but it is generally believed that the serfs or lower orders were without any other covering for the head than what nature had given them.

Although Sir Walter Scott, with the natural modesty of genius, disclaims pretensions to complete accuracy in the costume of the characters in his historical romances, the following portrait of Gurth, the Saxon swineherd, in "Ivanhoe," is nearly correct: "His garment was of the simplest form imaginable, being a close jacket with sleeves, composed of the tanned skin of some animal, in which the hair had been originally left, but which had been worn off in so many places that it would have been difficult to distinguish from the patches that remained to what creature the fur had belonged. This primeval vestment reached from the throat to the knee, and served at once all the purposes of body-clothing.

Gurth.—Saxon.

There was no wider opening at the collar than was necessary to admit the passage of the head, from which it may be inferred that it was put on by slipping it over the head and shoulders in the manner of a modern shirt or ancient hauberk. Sandals, bound with thongs made of boar's hide, protected the feet; and a sort of roll of thin leather was bound artificially round the legs, and, ascending above the calf, left the knees bare, like those of a Scottish Highlander. To make the jacket sit more closely to the body, it was gathered at the middle by a broad leathern belt, secured by a brass buckle, to one side of which was attached a sort of scrip, and to the other a ram's horn, accoutred with a mouth piece for the purpose of blowing. In the same belt was stuck one of those long, broad, sharp-pointed, and two-edged knives which were fabricated in the neighbourhood, and bore even at this early period the name of a Sheffield whittle The man had no covering upon his head, which was only defended by his own thick hair matted and twisted together. One part of his dress only remains, but it is too remarkable to be suppressed; it was a brass ring resembling a dog's collar, but without any opening, and soldered fast around his neck; so loose as to form no impediment to his breathing, yet so tight as to be incapable of being removed, excepting by the use of the file. On this singular gorget was engraved in Saxon characters—'Gurth. the son of Beowulf, is the born thrall of Cedric of Rotherwood.' "

The Anglo-Saxon females wore under-tunics, with sleeves; another inner garment, the linen kirtle; and over these the long full gown, with loose sleeves. The head-dress is a hood or veil, which, falling down before, was wrapped round the neck and breast; and this was the only head-covering of the women when abroad. The hair was carefully dressed, and golden head-bands, half-circles, neck-bands, and bracelets were worn; with ear-rings, necklaces, crosses, and jewelled ornaments too numerous to describe. The hose and shoes resembled those worn by the men. The long sleeves of the gown or the mantle, drawn over the hands, served as gloves, which were not worn before the eleventh century. All classes used on their cheeks a red cosmetic, so that the art of painting the face is not a creature of refinement. The general colours of the dresses were red, blue, and green, sometimes embroidered in patterns; and gold tissue and cloth of gold were worn by princesses and nuns; and the latter embroidered robes, sandals, tunics, vests, cloaks, and veils of enormous cost—for pearls and precious jewels were interwrought with the materials, and sometimes three years were spent in working one garment; and their dresses were often lined with sable, beaver, and fox furs, or the skins of lambs or cats.

The Danes originally wore the dresses of sailors, the general colour of which was black; but when enriched by piracy, they soon became wearers of scarlet, purple, and fine linen, and in England outshone the Saxons; they were effeminately gay in their dress, and the length and beauty of their hair. The Anglo-Danish kings appear principally to have worn a red habit, embroidered with gold, and a purple robe; and their mantles were richly embroidered with gold and pearls. Upon a manuscript of the reign of Canute, he is, however, represented in a Saxon dress, the mantle being richly ornamented with cords or ribbons, and tassels; and he wears shoes and stockings with embroidered tops. His body, when discovered in Winchester Cathedral in the year 1766, was decorated with gold and silver bands, and a richly jewelled ring; bracelets were worn by all persons of rank, and invariably buried with them. Canute's queen wore the tunic, mantle, and long veil. The materials of the Danish dresses were cloths, silks, or velvets, procured either from Spain or the Mediterranean, by plundering the Moors.

From the Danish Invasion to the Norman Conquest there were few changes in costume, if we except the imitation of Norman-French fashions in the reign of the Confessor, by shortening the tunics, clipping the hair, and shaving the beard, but leaving the upper lip unshorn. Tattooing was practised even to this time, although it had been forbidden by a law passed in the eighth century.

ELEVENTH TILL FOURTEENTH CENTURY.

The Norman Conquest introduced a greater degree of taste and splendour into British costume; but the dress of the common order of people remained long of a comparatively rude fashion, partly from the effect of caste and sumptuary laws, which prevented any decided change. As time advanced, the materials of dress improved, but the cut was little different, and, till this day, we have a sample of the Anglo-Saxon tunic in the *smock-frock*, a species of overall linen shirt, very generally worn by the peasantry of England. The *blouse*, a linen shirt of blue instead of white, which is now universally worn by workmen in France, Switzerland, the Low Countries, and part of Germany, had an equally early origin.

In the reign of Rufus many costly changes were made in dress; the tunics were lengthened, and the undergarments even trailed upon the ground. The sleeves were also drawn over the whole hand, although gloves were worn, at least by the higher classes. The cloth mantles were lined with rich furs; and one lined with black sables and white spots cost £100. Extravagantly peaked-toed boots and shoes were worn; and a court coxcomb, who caused the points of his shoes to curl like a ram's horn, received the name of *De Cornibus*, or with the horns. The hair, which had been shorn from the back of the head as well as the face by the Norman-French, was now again worn long; and the courtiers in Stephen's reign even wore artificial hair, so that wigs may date from the twelfth century. The long beard also reappeared in the reign of Henry I.

The monumental effigies of Henry II. and his queen Eleanor, and Richard I. and his queen Berengaria, in the abbey of *Fontevraud*, Normandy, are undoubted examples of the regal costume of the latter half of the twelfth century, inasmuch as they represented the sovereigns sculptured in their habits, as if they still lay in state. The robes of the two kings are two tunics (the upper called a *Dalmatica*), with rich waist-belts, and over them mantles superbly embroidered; that of Henry being fastened by a *fibula* or brooch on the right shoulder, and that of Richard fastened upon the breast. The gloves are jewelled on the back of the hand, and the boots have spurs without rowels; both monarchs wear their crowns, although that of Henry is much mutilated. These royal habits represent also the costume of the nobles at the same period. Henry introduced the fashion of indenting the borders of dresses, and the short cloak of Anjou, whence he was called Court Manteau (curt or short-mantle). A mantle of Richard is also described as nearly covered with solid silver half-moons and orbs.

In the course of the thirteenth century, the sumptuousness of apparel increased; rich silks woven with gold, embroidered and fringed, and French velvets, were much used; and a rich stuff manufactured in the Cyclades was made into a dalmatica or super-tunic, called Cyclas, which was worn by both sexes. The furs of ermines, martens, squirrels, the vair, and the minevair or minever, were added to the list of furs for winter garments.

The general male dress consisted of the cyclas just mentioned; and the tunic open as high as the waist, to show the drawers; with chausses or stockings. The principal novelty is the super-totus, or over-all, worn like the mantle or cloak, and consisting of a kind of large-sleeved shirt, with a capuchon. Long-toed shoes and boots were resumed, with embroidery and colours. The caps or bonnets, and hats, now resemble our modern beaver.

The female costume differed in fashion and name, rather than in form, from those of the twelfth century. The veils were of gold tissue or superbly embroidered silk, and over them was worn a diadem, circlet, or garland, or a cap-like coronet, by persons of rank, and sometimes a round hat. The head-dresses were very numerous: the wimple covered the head and shoulders, and was fastened under the chin; and the hair was worn in a net or caul of gold thread, which continued in fashion for the next two centuries. A very ugly kind of wimple called the gorget, appeared in the thirteenth century; it was a neck-covering, poked up by pins above the ears. The long robe was also worn trailing on the ground; the cloth stockings were embroidered with gold; and trinkets of gold, as buckles, rings, earrings, and chaplets, and jewels, were much worn; and sometimes flowers, fresh from the garden or field, were entwined round the head as a relief to artificial decoration. In this century, too, we first meet with the surcol, which Strutt calls a corset, boddice, or stays, worn over the rest of the dress, which enlarged in the skirt, and spread into a train; it was made high in the neck and had long tight sleeves.

The dress of the working-classes may be supposed to have been improved about this period by the introduction of the worsted manufacture; it is stated to have been brought to the country by a colony of Flemings, who, in the reign of Henry II. settled at *Worsted*, a village in Norfolk, and hence the name of the fabric.*

We now come to the fourteenth century, in which Edward III. and his queen Philippa led the fashion in apparel. As seen from the effigy on his tomb, the costume of Edward is characterized by its dignified simplicity. The dalmatica is low in the neck, falls in straight folds to the feet, and is open in front nearly half its height, being embroidered at the edges of the aperture; the sleeves of the under tunic have at each wrist a row of buttons, a fashion of the reign of Henry III.; the mantle, embroidered at the edges, is worn over the shoulders, and confined by a jewelled band across the breast; the shoes or buskins are also embroidered, and the hair and beard are patriarchal; the crown has been removed or lost.

* See note to Hallam's History of the Middle Ages.

The effigy of Queen Philippa, also at Westminster, is equally distinguished by its simplicity; the skirt is long and full, the boddice closely fitting, the waist-belt jewelled, and the mantle ornamented on the shoulders, and confined by a diagonal band across the breast; and upon the head is a low crown, jewelled, and from it depends a kind of draped ornament half way down the check. The costume of the nobles in this reign was, however, far less simple than that of the sovereign. In place of the long robe and tunic was worn a close-fitting body-garment (jupon) superbly embroidered, reaching to the middle of the thigh, and confined across the hips by a splendid belt; from the sleeves of this garment hung long slips of cloth, called *tirippes* (tippets), and over the whole was occasionally worn a long mantle fastened by buttons upon the right shoulder. This dress was, however, the extreme of foppery. The caps were of various shapes, and among them we find the knight's *chapeau*, nearly in the form now used in heraldry. Beaver hats are also worn; but the greatest novelty was a single feather in the front of the cap. The golden chaplets, by the addition of leaves, now assumed the form of coronets. The gay tournaments of this period led to the introduction of many costly foreign fashions; so that, in 1363, expensive dress, beyond the income or rank of the wearer, was forbidden by law; furs of ermine, and pearl ornaments (except for head-dress), were forbidden to all but the royal family and the wealthiest nobles; cloths of gold and silver were permitted only to the next in fortune; and persons of small income were forbidden to wear silks, embroidery, or trinkets.* But the ladies dressed still more sumptuously, as in the engraving, where the gown fits close in the boddice, and the train is so long in the front as to be held up, and thus display the embroidered under-dress; the sleeveless jacket worn over the gown is also embroidered and trimmed with fur; the hair is worn long, and the cap is low, and resembles a coronet. Tippets from short sleeves, and the jupon, were also worn by ladies as well as by gentlemen; and both sexes wore daggers stuck through pouches in their rich girdles. The particoloured tunics worn by the ladies at tournaments were likewise very striking, and greatly encouraged the fopperies of the time. One of the additions to the military costume of this period was the knight's cap and crest.†

Lady of 14th century.

In this reign mourning habits appear to have been first worn, the colours being black and brown.

The reign of Richard II. must have been the high carnival of coxcombery. The sovereign himself, according to Holinshed, had a coat or robe which cost 30,000 merks. Particoloured dresses were universally worn, and even the hose were of two colours, so as to render the term, *a pair*, inapplicable: the colours of the king and his court were white and red. Men and women alike wore hoods set with jewels; and their tippets were jagged, and reached to the heels; and the long-peaked shoes, called *crackowes* (from Cracow, in Poland), were fastened to the knees with gold and silver chains. The engraving shows a gentleman of this period, with shoes and hose all in one, the mantle cut into the shape of leaves at the edges, a belt and pouch, and a fantastically-turbaned head-covering. Chaucer has left us the costume of several ranks at this period: his squire wears a short gown, "with sleeves long and wide;" his yeoman "a coat and hood of grene;" his merchant many colours, with a forked beard, and a "Flaunderish bever hat," and clasped boots; the reeve or steward a long surcoat and rusty sword, his beard and head shaven and shorn; the miller wore a white coat and blue hood, a sword and buckler, and red cloth holiday-hose; and the hats, caps, and bonnets of all classes were very fantastical. Knives, ornamented with silver, and purses, were worn by most classes in their girdles; and shoulder-belts, with bells, were a mark of rank. Liveries are also now mentioned as worn by substantial artisans as well as by menial servants; but the ploughman appears only in a tabard or sleeveless coat, and the mechanic in a tunic. The hair was worn long and curled, and the beard forked.

Gentleman of 14th Century.

In the female costume of this reign the fantastic particoloured dresses were retained, with the embroidered jupons and kirtles, hip-kirdles, and long tippets from the elbow; and the *surcol* or external corset, faced with fur, and terminating in a train sometimes so long as to be carried over the arm, or shorter, opened up the side, and bordered with ermine. The gowns, mantles, and other garments, were emblazoned with arms, or they bore sentimental mottoes; and the royal badge of a white hart, chained, was much worn at tournaments and jousts. The head-dress continued as in the preceding reign. The attire of the carpenter's wife in the "Canterbury Tales," with a silk girdle and head-fillet, and brooch, indicates the condition of this class of females.

FIFTEENTH CENTURY.

Whatever may have been the foppery of the thirteenth and fourteenth centuries, they appear to have been exceeded by the absurdities of costume in the fifteenth century, when it was difficult by dress to distinguish one sex from the other. These fantasies were mostly borrowed from France, whose fashions now began exclusively to guide the taste of the English, and have continued to do so until the present time.

The effigy of Henry IV. is remarkably splendid, the upper tunic, girdle, and mantle being embroidered at the edges, and the latter connected by a richly-jewelled band across the chest, besides cords and tassels. The beard and mustachios are worn, but the poll is shaven; the

* Few enactments have been more erroneous in principle, or in operation more detrimental to national prosperity, than the sumptuary laws, by which, in the earlier ages of our history, the legislature so vainly, and, it may be added, so unjustly endeavoured to prevent the various ranks of men from enjoying the fruits of their industry or of their patrimonial possessions. "There is hardly," says Mr. M'Culloch, "a single article among those that are now reckoned most indispensable to existence which has not been denounced, at its introduction, as a useless superfluity, or being in some way injurious. Few articles of clothing are at present considered more indispensable than shirts; but there are instances on record of individuals being put in the pillory for presuming to wear so expensive and unnecessary a luxury!" Mr. Hallam observes, that the sumptuary laws, enacted in France and England during the fourteenth century by the governments, to restrain the extravagance of their subjects, may well justify the severe indignation which Adam Smith has poured upon all such interference with private expenditure. "The kings of France and England were undoubtedly more egregious spendthrifts than any others in their dominions, and contributed far more, by their love of pageantry, to excite a taste for dissipation in their people, than by their ordinances to repress it."

† The origin of the "Prince of Wales' Feathers" (a triple ostrich plume) was long referred to the Black Prince adopting them from the helmet of the king of Bohemia; next, they were stated to have been assumed from that monarch's banner; but there is still greater reason to believe the plume to have been but a fanciful badge chosen when feathers were first used as heraldic crests upon helmets.

crown is supposed to be an imitation of the magnificent "Harry Crown," broken up and pawned by Henry V. Early in this reign, too, the sumptuary laws were revived not only as to materials but fashions; so that garments, cut or slashed in devices, were forbidden, but with little effect. In this reign appeared the collar of SS (or Esses), which Meyrick considers to have been taken from the initial letter of Henry's motto, "Souveraine." The annexed engraving represents a gentleman of this reign in shortened tunic, buttoned in front, with girdle, large flapping sleeves, tight hose, peaked shoes, and head-cloth, with long end hanging over the left shoulder, and tucked in the girdle. The next cut shows a labourer of the same period in the ordinary woollen dress, with hood and tippet, hose, and leather boots laced in front. The female costume in this reign differed from that of the preceding principally in a kerchief or veil covering the head-dress, and assuming a square form.


Gentleman of 15th century.


Labourer of 15th century.

In the short reign of Henry V., there were few changes in the civil costume: cloaks of scarlet cloth or camlet, and pieces of fur, are novel outer garments. Feathers were worn in the helmets, and the bascinet took the shape of the head behind: for the jupon or surcoat was substituted a skirt of horizontal steel bands, and large sleeves of cloth or silk were worn over the armour, and the two-handed sword now first appeared.

The confused costume in the reign of Henry VI. baffles classification, more especially the odd-shaped caps, hats, and bonnets, in which a single feather was sometimes worn. The boots or galoches, reaching half way up the thigh, the short boots or buskins, and the high-fronted shoes, had very long toes, which, in the next reign, reached half a foot. The state robes were lined and trimmed with furs or had only caps or collars of ermine, with bars according to the rank of the wearer. The mantle of the Order of the Garter about this period was first made of velvet, and lined with white damask or satin. Silk was worn over armour, and the *salade* or *sallet* head-piece, projecting behind, was introduced; and the armour was richly ornamented. Gowns, with long and heavy trains, continued to be worn by ladies, whose most fantastic change was the heart-shaped head-dress of great size:* turbans of the Turkish form were also worn.

Edward IV. on his seal, wears a tunic, dalmatica, and mantle, deep ermine cape, and high-arched or imperial crown. The civil costume was very absurd; and jackets and doublets were worn so short as to call forth a law in 1463 ordering them to be lengthened behind; the sleeves were slit, so as to show the fine white linen shirt, and the shoulders were padded; the men wore their hair very long, and their bonnets either very high or covering simply the crown; the hose were tight, and the boots and shoes of all patterns and lengths. Gold chains were generally worn; and even boys strutted in velvet, silk, and satin. All this extravagance was attempted to be checked by law, but with little effect. In armour, the principal novelty was the halbert. In the female costume, trains of gowns were partially discontinued for broad fur or velvet borders, and the silk girdles widened, and were more richly ornamented. The boddice, laced in front over a stomacher, now first appeared. But the greatest eccentricity was the lofty steeple head-dress, shown in the annexed portrait; this consisted of a roll of linen covered with fine lawn, which hung to the ground, or was mostly tucked under the arm.* Caps, with large wings or lappets on each side, were also much worn at this period.


Lady of 15th century.

Richard III., according to his wardrober's books, was a right royal fop, for we find him wearing a blue cloth-of-gold doublet and stomacher, "wrought with netts and pyne-apples," and crimson and purple-velvet robes, embroidered and furred, and crimson satin hose, and tissue cloth-of-gold shoes, at his coronation. The nobles in this reign had their hose tied by points to the doublet, which was sometimes worn open, but laced like a boddice; and over it was worn a long or short gown, the former hanging loose, and the latter plaited before and behind, and girded about the waist; and both gown and doublet were slashed. The general head-dress was a closely-fitting cap or *bonet* (bonnet), with a single feather in it; and scarlet hats and hoods were worn. The boots had very long-pointed toes, and reached to the middle of the thigh.

In this reign plate-armour reached its highest perfection; it was elaborately ornamented and inlaid with gold, and, with the arms, it bore religious and other mottoes; and the knee and elbow pieces were fan-shaped, and curiously wrought. Richard wore his crown of ornament in the field of Bosworth, as Henry V. had done at Agincourt. The mode of putting on a suit of armour may be here described: the knight commenced with his feet, and proceeded thus:—"1, His sabatyns, or steel shoes; 2, the greaves, or shin-pieces; 3, the cuisses, or thigh-pieces; 4, the breech of mail; 5, the tuilettes, or overlapping pieces under the waist; 6, the cuirass, or breastplate; 7, the covers for the arms, or vambraces; 8, the rerebraces, or covering for the remaining part of the arm or shoulder; 9, the gauntlets; 10, then the dagger was put on; 11, the short sword; 12, the cloak, which was worn over the armour; 13, the bascinet; 14, the long sword; 15, the pernonbel, held in the left hand; 16, the shield."† The knight was then armed *cap-à-pié*.

In the female costume, the chief novelty is a head-dress of embroidered stuff or gold net, projecting from the back of the head, and a stiffened kerchief over it, spreading out like wings.

Hitherto, the authorities for costume have been illuminated manuscripts, tapestry, and monumental effigies,

* It is related that Isabella of Bavaria, Queen of Charles VI. of France, carried this fashion to such an extent as to have the doorways of the palace of Vincennes altered to admit ladies when in full dress; but we think, with M. Planché, that the above anecdote, if authentic, relates to the steeple head-dress, to be mentioned presently.

* This extraordinary head-dress resembles the *tantoora* worn at the present time in Syria. M. Planché considers that the peasantry of Normandy "to this day wear the identical steeple caps with the butterfly wings, that, 300 years ago, towered upon the heads of the gentle dames of London and Paris."—*History of British Costume*, p. 207.

† Sir Samuel Meyrick.

in which there is often perplexing indistinctness. At this period painting comes to our aid; and the portraits by Holbein are the best illustrations of the costume of the two succeeding reigns, the minute execution of this great painter being well shown in the embroidered dresses of his time. Of Henry VII., however, we find a portrait of earlier date than Holbein's time, from a beautiful painting on vellum, in which the king wears a richly-embroidered doublet, with a jewelled border, low in the neck, beneath a large mantle with a fur cape; the gold neck-chain is massive; the hair is in long ringlets, surmounted by a close cap, with wing-like projections at the sides.* The male costume of the wealthier classes in this reign consisted of a fine shirt of long lawn, embroidered with silk round the collar and wristbands; and such a shirt, that belonged to the eldest born son of Henry VII., is in the possession of M. Gage, F. S. A. The sleeves of the doublet were slashed at the elbow, as in the reign of Edward IV.; or they were in two or more pieces, fastened at the shoulders and elbows with laces or points, through which the shirt protruded. The doublet was laced over a stomacher and petticoat, the male costume thus resembling that of the females in name as well as form. The outer garment was a long coat or gown, with loose hanging sleeves, and a broad turn-over collar of velvet or fur. The long hose were differently coloured in the upper and lower portions, and in the former slashed or puffed; the shoes were absurdly long and broad-toed, and high boots were worn for riding. In the head coverings there was great variety. The hoods were abandoned to official habits, and instead were worn broad felt hats or caps, and bonnets of velvet or fur profusely decked with ostrich feathers; or the large plumed cap was slung at the back, and a smaller cap of velvet or gold net worn on the head. The knave of our playing cards has a cap peculiar to this period: the hair was worn as long as in the reign of Henry I.

At the latter part of this century military costume had reached the highest degree of splendour of which it was capable; and the disuse of the surcoat, and the transfer of its armorial emblazonry, in relief or engraving, to the polished steel, had introduced great variety of decoration. Every visiter to the Tower of London must remember the famous suit of armour which unquestionably belonged to Henry VII.; and nothing can exceed its superb beauty, covered as it is with engraving, and accompanied by a complete harness of steel for the charger on which it is mounted. The puckered skirts appear no longer in cloth or velvet but in steel; *pauldrons* of the same material protect the shoulders; the whole frame is impervious to the lance point; and the plumed helmet completes the panoply: besides the long sword, the thin-bladed dagger of the time hangs sheathed at the girdle, on the right side. The disuse of the surcoat in this reign was doubtless to show the splendid armour, which was not only ribbed and engraved, but fluted. The halberd became the common weapon; and the hand-gun or cannon, by the addition of a rude lock with a cock, borrowed from the cross-bow, became the *arc-a-bouche* or *arquebus*.

In these distracted times party-colours were worn. Thus, the family colours of the House of Lancaster were white and red; those of York, purple and blue; and those of Tudor, white and green. Buttons also bore partizan figures; and in 1833 there were found, in excavating for the New Hungerford Market, in London, two linked cloak-buttons of silver, one bearing a bust with a diadem, and a bandeau of roses, the robe fastened with a rose brooch or jewel, and on each side of the bust a rose springing up; whence these buttons are presumed to have been made and worn in honour of Elizabeth of York, whose union with Henry VII. terminated the Wars of the Roses.

The female costume of the reign of Henry VII. is distinguished by the square cut of the boddice in the neck, and embroidered and jewelled stomachers, belts, and girdles hanging in front nearly to the feet; the sleeves were large and full, and when confined at the wrist, resembled "the bishops' sleeves" imitated in England, from the French, a few years since. These sleeves were slashed, divided, and joined like those of the men. The head-dresses were close caps and cauls, from beneath which the hair hung down to the waist; and several kinds of capuchons were worn. In the dress of the humbler classes we find mentioned a "furred flocket and gray russet rocket," "kirtle bristow red," "blanket hose," "Lincoln green," &c.

At the close of this century the mourning habits had become so sumptuous as to be limited by law; the principle article being a barb or veil, used at funerals, which was tied on above the chin by duchesses and countesses, and lower by all other ranks.

Throughout the above period the principal material of the clothing of the middle classes must have been abundant; for in the reign of Edward III., our woollen manufacture almost rivalled that of the Flemings, and our exports to the continent were very large; there appears however, to have been little or no linen made at this period in England.

SIXTEENTH CENTURY.

Few changes of costume occur in this century until after the accession of Henry VIII., when the petticoat was laid aside; and as fashion delights in extremes, there was substituted the tight hose, or *trouses*, closely resembling the Norman chausses. The costume of Henry and of the noblemen and gentlemen of his time, appears to have been a jacket or doublet, with full skirts, and sleeves to the wrist, with ruffs or ruffles, and over it a short but full coat or cloak, with large hanging sleeves, and a wide fur collar; stockings and broad-toed shoes; and a large-brimmed cap edged with ostrich feather. Henry's wardrobe comprised coats of every length, and among them occurs the *cassock*, of German origin, short in the waist, and reaching to the knee, having sleeves to the elbow, and thence showing the shirt: this garment was ornamented with strips or borders of cloth, silk or velvet, of different colours, or of gold lace or embroidery, and gold buttons. Hall, the chronicler, describes several of Henry's superb dresses, and among them a *frocke*, or coat of velvet, embroidered all over with gold of damask, the sleeves and breest cut and lined with cloth of gold, and tied together "with great buttons of diamonds, rubies, and orient pearls." The cloaks and mantles were of corresponding magnificence. The shirts were pinched or plaited, and embroidered with gold, silver, or silk. The term *hose* continued to be applied to the entire vestment, from the waist to the feet, throughout this century: the material is more distinctly stated, for Henry wore knit silk, as well as cloth hose; the precise period of the separation of the hose into breeches and stockings is not so clear as the derivation of the latter term from the "*stockying* of hose," "that is, adding the lower part that covered the legs and feet to that which was fastened by points to the doublet,"* and was called the *stocks*. The shoes and buskins were of the German fashion, very broad at the toes, and of velvet and satin, slashed and puffed. The hats, caps, and bonnets, were of almost endless forms. We find in Henry's wardrobe accounts hats of green velvet, and caps of orange, yellow, and green; his favourite bonnet, and, indeed, that of the time, is seen in the portraits of Henry, by Holbein. The Milan caps and

* Engraved from "the Sutherland Clarendon," as the frontispiece to M. Planché's "History of British Costume."

* Planché's History of British Costume, p. 256.

bonnets, of cloth or velvet, were worn placed on the side of the head, profusely ornamented with feathers. The bonnet with an embattled border was also worn; but the chaperon or hood was almost confined to official personages. The cardinal's hat may be mentioned here: it was of a red colour, low, circular-crowned, and had a much broader brim than is represented in sculpture.

Henry passed sumptuary laws, directing that cloth of gold and tissue should be used only for dukes and marquisses, and that purple should be kept for the royal family. Earls might use embroidery, and commoners of distinction silks and velvets; and it was even thought necessary to restrict the commonalty and serving-men to cloth of a certain price, and lamb's fur, and to forbid them wearing any ornaments, or even buttons, save the badge of their lord or master. The king likewise forbade his courtiers wearing long hair, according to the general fashion, and made them poll their heads, which led to the introduction of the peruke. This change rendered short hair fashionable; and as the king grew corpulent, the doublet and breeches were puffed out and wadded by his courtiers and attendants, to make them as bulky as himself.

One of the principal events of this reign, illustrative of costume, was the famous Tournament of the Field of Cloth of Gold, at which Henry VIII. and Francis I., and their suites, vied more in splendour of attire than in prowess of arms; and the splendour of their dresses has almost exhausted the descriptive powers of Hall, who has minutely chronicled this "most magnificent spectacle that Europe ever beheld." Its mighty artificer was Wolsey, who was most gorgeously habited, his very shoes gleaming with diamonds, and the crimson velvet saddle-cloth of his horse glittering with burnished gold. The brilliancy of the armour, and the elaborate beauty of the costume of the queens and courtly dames, well became this sunset of chivalry, at which even citizens and city wives disported their richest silks and their heaviest chains.

With the female costume of this reign we are familiarized by the portraits of Henry's queens, who appear to have been sumptuously attired in cloth of gold, brocade, velvet, and other costly materials; and they wore diamonds, gold neck-chains, and girdles, and jewelled ornaments in profusion. The gowns of the nobility were open in front to the waist, so as to show the petticoat; and above was worn a waistcoat similar to that of the men, superbly embroidered. Another novelty was the partlet, covering the neck and throat like a habit shirt. It was made of lawn, embroidered with gold. The ladies' sleeves, like those of the men's dresses, were distinct from the gown or waistcoat, to which they were tagged. They were mostly of satin, quilted and variegated with gold, and had buttons of pearls and gold at the wrist. This fashion must have added greatly to the variety of the costume, for several pairs of sleeves might be worn in turn with the same body-dress. The masques in this reign were very splendid; and in the report of the dresses worn at one of them, are mentioned "demy sleeves, naked down from the elbows," which M. Planché considers to have been "the first appearance of bare arms since the time of the ancient Britons." Gloves were not unknown, for Henry left a pair to one of the executors of his will. They were sometimes finely perfumed, and brought from Spain and Italy as presents. In this and the preceding reign the head-dresses assumed a different character, having long lappets or ear-pieces hanging down below the shoulders, and when made of velvet studded with pearls, jewels, and gold, they were truly superb. Three-cornered caps of minever were also worn throughout the reign; and the close-fitting cap reaching to the ears, and known as "Mary Queen of Scots' cap," was first worn about this period. The ladies' hunting-dress differed but little from the riding-habit of the present day; across it was usually slung, from the right shoulder to the left side, a horn resembling a bugle.

In this reign *pins* were first brought from France, and used by Catherine Howard, before which time the different parts of the dress were kept together by ribbons and loopholes, laces with points and tags, clasps, hooks-and-eyes, and skewers of brass, silver, and gold; but the poorer classes used the natural thorn for the above purpose.

The dress of the middle ranks in this reign may be seen in prints of the time: plain russet coats, and white kersey sloppes, or breeches, with stockings of the same pieces, were the ordinary suit; and the London apprentices wore blue cloaks in summer, and gowns of the same colour in winter, as badges of servitude; for this appears to have been the age of domestic distinctions—the relics of the feudalism of the middle ages. The women wore sheep, russet, or long woollen gowns, worsted kirtles (hereafter called *petticoats*), and white caps and aprons; and milk-white underlinen came into general wear. The engraving shows a man and woman in the ordinary dress of this period.


Man and Woman of 16th century.

The principal novelty of the reigns of Edward VI. and Mary was the flat round bonnet or cap, of plain velvet or cloth, worn on one side of the head, and decorated with a jewel and single ostrich feather. The bonnet itself is preserved in the caps worn at the present day by the boys of Christ's Hospital; and their blue coat and yellow stockings are such as were worn by the London apprentices at the date of the foundation of the hospital by the youthful Edward. The gown of the wealthier classes was furred with sables in front and round the broad sleeves. Philip, on his marriage with Mary, brought into England a richer style of dress for the men, particularly the close ruff; the doublet, which fitted exactly under the chin, and the short Spanish cloak—all of which remained for a considerable time in fashion. The preposterously large stocks, or trunk hose, continued to be worn, but the broad-toed shoes were discarded. The armour continued nearly the same as in the preceding reign. To female costume the chief addition was the *fardingale*, an immense hooped petticoat, introduced from Spain under Queen Mary. The entire dress was worn very close, so as to conceal the person as much as possible.

Queen Elizabeth's fondness for dress is proverbial, and she is stated to have left three thousand different habits in her wardrobe. This great number is explained by the royal affectation of wearing by turns the costume of all the nations of Europe, which may be traced to the use of foreign materials made up by foreigners. Bohun in his character of Elizabeth, tells us that "when she appeared in public she was richly adorned with the most valuable clothes, set off again with much gold and jewels of inestimable value; and on such occasions she ever wore high shoes, that she might seem taller than indeed she was. The first day of the Parliament she would appear in a robe embroidered with pearls." Hentzner gives a less flattering portrait of the queen, in her 65th year: "Her face oblong, fair, but wrinkled. She had in her ears two pearls, with drops; she wore false hair, and that red, and upon her head she had a small crown. She was dressed in white silk, bordered with pearls of the size of beans, and over it a mantle of black silk, shot with silver threads. Her train was very long. Instead of a chain she had an oblong collar of gold and jewels."

But the glory of the Elizabethan era of female costume, as well as its most remarkable characteristic in the sixteenth century, was the *ruff* of plaited linen or cambric, which took the place of the partlet, and rose from the front of the shoulders behind the head nearly to its full height: from the bosom descended a huge stomacher, on each side of which projected the immense fardingale. In this characteristic costume Elizabeth went to St. Paul's Cathedral to return thanks for the defeat of the Spanish Armada; though, besides the magnificent ruff, the queen wore a mantle with a large wing-like collar, her hair intertwined with pearls, large pendant jewels on the neck, and a superb lattice-work of pearls over the entire dress.

But the ruff must be further noticed: no sooner had its material been changed from Holland to lawn or cambric, than a difficulty arose as to starching or stiffening it, instead of the clumsy mode of supporting it by poking-sticks of ivory, wood, or gilt metal. At length the art of starching was brought from Flanders, and taught in London for a fee of four or five pounds. The fashion next lay in the colour of the starch, of which there were five varieties. Stubbs assailed these "spiders' webbs" of ruffs, some of which were "clogged with gold, silver, or silk lace," and "speckled and sparkled with the sun, the moon, and the stars," and either pinned up to the ears, or hanging over the shoulders like flags or windmill sails. The same writer describes the gowns of silk, velvet, *grograin*, taffeta, or fine cloth; of "fashions changing with the moon," with sleeves trailing on the ground, or "cast over the shoulder like cows' tails," or short sleeves tied with "love knots" of ribbon.

Stockings, which we find mentioned as foreign rarities in the wardrobe accounts of Henry VIII. and Edward VI., became common of home manufacture in the reign of Elizabeth. In the third year, a pair of black knit silk stockings made in England was presented to her majesty, who was so pleased with the article that she would never after wear cloth hose. This resolution has been attributed to Elizabeth's desire to encourage English manufactures by her own example, and may be taken as some set-off to her extreme fondness for foreign materials and fashions of dress. Soon after this, a city apprentice having borrowed a pair of knit worsted stockings brought from Mantua, made a pair like them, which he presented to the Earl of Pembroke; and these are the first worsted stockings known to have been knit in England. Mary Queen of Scots, at her execution, wore stockings of blue worsted, clocked and topped with silver, and under them another pair of white; and the stockings of this time generally consisted of silk, jarnsey, worsted, crewel, fine yarn, thread, or cloth, of all colours, and with clocks, open seams, &c. The invention of the stocking-frame, by Lee, at Calverton, near Nottingham, in 1599, must have brought stockings into general use: he or his brother is said to have worked for Queen Elizabeth; but he was driven by the jealousy of the other stocking manufacturers into France, where he died of a broken heart—an end by no means uncommon in the lives of inventors. The garters of this period were very costly, sometimes of gold and silver, and £4 or £5 a pair; they are presumed to have been worn by ladies since the time of Edward II., but they must not be confounded with the leg bandages of an earlier date. The ladies wore "corked shoes, prisnets, pantoffles, or slippers," which raised them two inches or more from the ground: they were made of black, white, green, or yellow velvet, or Spanish and English leather, embroidered with gold, silver or silk, and shaped after the right and left foot, like the Anglo-Saxon sandal. The Elizabethan head-dresses were French hoods, hats, caps, kerchiefs, cauls of net-wire, and lattice caps, the latter, as well as an ermine bonnet, being forbidden by law to all but "gentlewomen born, having arms." In Elizabeth's jewel-box is a long list of wigs, or rather head-dresses, among which are cauls of hair set with seed-pearl and gold buttons. The hair was curled, frizzled, and crisped, and under-propped with pins and wires into the most fantastic forms. The finger-rings, ear-rings, bracelets, and other jewelry, were very splendid: velvet masks and pocket looking-glasses were carried by fashionables, with fans of ostrich feathers set in gold, silver, or ivory handles, the latter introduced from Italy, and used by both sexes.

The male costume in Elizabeth's reign was the large trunk hose, long-waisted doublet, short-cloak, hat, band and feather, shoes with roses, and the large ruff; but the great breeches, "stuffed with hair like woolsacks," after the separation of the hose into this garment and stockings, appear to have been worn throughout the reign: they were made of silk, velvet, satin, and damask. The doublets were still more costly, and quilted and stuffed, "slashed, jagged, pinched, and laced;"* and over these were worn coats and jerkins in as many varieties as there are days in the year. The cloaks were of the Spanish, French, and Dutch cuts, of cloth, silk velvet, and taffeta of all colours, trimmed with gold, silver and silk-lace and glass bugles, inside and outside equally superb. The stockings, shoes, slippers, and ruffs, resembled those of the ladies. Nor must the rapier, or tuck, be forgotten; and some coxcombs, having introduced this long sword with a high ruff, approaching the royal standard, the queen became jealous, and appointed officers to break those rapiers and clip those ruffs which were beyond a certain length and height. Hats first became common in this reign: they were of all shapes, but the most curious was the steeple-crowned; others were flat and broad, like the battlements of a house; and others with round crowns, and bands of all colours, and ornamented with huge feathers, and brooches, clasps, and jewels of great value. These hats were of velvet, taffeta, or sarsenet, beaver hats being then very expensive, and "fetched from beyond sea." Caps of wool were worn not by choice but compulsion, by a law passed "in behalf of the trade of cappers;" and this led to feuds among the wearers of black and blue caps. The numerous fashions of wearing the hair were assailed by Stubbs, who, after saying there are no finer fellows under the sun than barbers, speaks of the French, Spanish, Dutch, and Italian cuts, new and old cuts, gentlemen's, common, court, and country cuts.

Elizabeth's passion for dress was fully imitated by her courtiers, as preserved to us in the pages of historians and on the canvas of painters. The best portrait of the gallant Raleigh represents him in a white satin doublet embroidered with pearls; and his dress in the Tower was a velvet cap, laced, and a rich gown and trunk-hose. His plush cloak is preserved in the well-known anecdote of his throwing it off for the queen to walk on.

In taking leave of the British costume of the sixteenth century, we may observe that its splendour was almost entirely borrowed from France, "that country which has since given laws in dress to nearly all Europe."

SEVENTEENTH CENTURY.

The changes of costume in this century were not so much in forms as in fashions of habits. The male dress continued nearly the same as in the latter portion of

* This doublet formed a point in front, hanging over the girdle; and, allowing for a little caricature, "is to this day," says M. Planché, "the body-dress of our old and inestimable friend Punch, whose wardrobe, of Italian origin, dates as nearly as possible from this identical period."—*History British Costume.*

Elizabeth's reign. Under James I. it was somewhat more decidedly Spanish, and was chiefly worn of black, with large trunk hose, Spanish rapier, a hat with a conical crown, and a band with a jewel, the better to show which feathers seem to have been discarded. The trunk, breeches, and doublets, appear to have been increased in size from the timid disposition of the sovereign, who had his garments additionally quilted for fear of stilettos. James, in his *braveties*, dressed immoderately, though only in keeping with the sumptuous style of the furniture and house-decoration of the period; and in some instances he scarcely left his nobles the means of "keeping up appearances." Henry, Prince of Wales, must have drawn largely from his father's privy purse, for we find his wardrobe purchases in one year to have been thirty-eight suits of velvet and satin, crimson, green, carnation, orange, and watchet, ash and liver-colour, black and tawny, pink, rose, hair, and deer colour, laid over with Naples silk, gold parchment, silver and "gollowne" lace; the cost of all which was considerably above £2000, then no trifling sum: he had also thirteen cloaks, at the rate of £50 each; gloves wrought with gold and silver at £3 a pair; stockings at £3: and every-day garters at £4, 10s. And we find the weak-minded James encouraging his son's prodigality by sending to him at Madrid "the mirroure of France, the fellow of the Portugal dyamont," which the king wished him to wear alone in his hat, with a little black feather. To his favourite, George Villiers, Duke of Buckingham, who accompanied Prince Henry to Spain, James also sent "a faire table dyamont," with a "faire pearle" hung to it. Buckingham was also "imprisoned in jewels," and wore diamonds as a nobleman of the last century did paste buttons; he had also diamond hat-bands, cockades, and ear-rings; and his hat-feather, sword, girdle, and spurs, were set with this precious gem; and one of his court suits was estimated to be worth £80,000. In these times, therefore, the common phrase of "a man's wearing his estate upon his back" could scarcely have been an exaggeration; and there is no poetical license in John Taylor's censure of the prodigals who

> "Wear a farm in shoe-strings edged with gold,
> And spangled garters worth a copyhold;
> A hose and doublet which a lordship cost;
> A gaudy cloak three manors' price almost;
> A beaver band and feather for the head,
> Prized as the church's tythe, the poor man's bread."

Instead of the ruff was now sometimes worn a starched collar or band, plain, and edged with lace. Late in the reign the jackets or doublets were shortened, and the breeches reduced in size, and fastened in large bows at the knees; the well-stockinged leg was admired, and the hat worn low in the crown, and with broad brim, as seen in portraits of the date 1619. Beards and whiskers had become almost universal in the reign of Elizabeth; but in that of James, the former was sometimes worn trimmed to a point, hanging down at the division of the ruff.

In the female costume there was little change. The huge fardingale continued to be worn by the nobility; a strong passion for foreign lace was introduced; pearls were the favourite jewels, and the ruff maintained its sway, so as to be anathematized from the pulpit; and the fancies of female costume were glanced at in a sermon preached before the king at Whitehall in 1607–8, as "her French, her Spanish, and her foolish fashions; her plumes, her fannes, and a silken vizard, with a ruff like a sail, yea, a ruff like a *rainbow*, with a feather in her cap like a flag in her top, to tell which way the wind will blow."

Experience had scarcely convinced the military world of the inefficacy of steel harness to resist the death-shot of the arquebuss and musket, when James I. wittily said he could not but "greatly praise armour, as it not only protected the wearer, but also prevented him from injuring any other person." The warriors of his time, however, began to discover that it lacked the best part of these qualities. They first laid aside the jambes, or steel boots, then the shield, and next the covering for the arms. When the cavalry disused the lance, the cuisses were no longer worn to guard against its thrust; and the stout leathern or buff coat hung down from beneath the body armour to the knees, and supplied the place of the discarded steel. In the portrait of Henry, Prince of Wales, the armour is worn only to the waist, and the trunk is covered with wide loose straps, through which appears the rich silk or velvet.

We now approach the best era of costume in England; for whatever may have been the merits of certain garments worn in previous reigns, the entire dress in that of Charles I. is unrivalled for picturesqueness and elegant taste. At this we shall not be surprised, if we recollect that it was copied from the habit of Spain, the most becoming of all European costumes. Early in this reign, however, the motley fashion of the time of James I. prevailed; and the Savoy neck-chain, the ruff and cuffs of Flanders, the Naples hat with the Roman hatband and Florentine agate, the Milan sword, and the cloak of Geneva set with Brabant buttons, gloves from Madrid, &c., were the characteristics of the beau of 1629. The ruff had almost universally given place to the falling band; and collars of rich point-lace, large and hanging down on the shoulders, held by a cord and tassel at the neck, and called *Vandyke*, from its being the most sriking part of the dress in which Vandyke at this time painted portraits.

The principal habits were vests and cloaks of velvet, or silk damask, short trousered breeches terminating in stuffed rolls and fringes and points, and very rich boots, with large projecting lace tops. A dress of Charles is thus described: a falling band, green doublet (from the arm-pits to the shoulders wide and loose), zig-zag turned-up ruffles, long green breeches (like a Dutchman's) tied below the knee with yellow ribbons, red stockings, green shoe-roses, and a short red cloak lined with blue, with a star on the shoulder; the king sometimes wore a large cravat, and at other times a long falling band with tassels. The cavaliers were genuine successors of Edward's knights, not less in costume than in high chivalrous bearing. Their dress consisted of a doublet of velvet, silk, or satin, with large loose sleeves slashed and embroidered; Vandyke collar and band, and short embroidered cloak worn on one shoulder; the long breeches, fringed and pointed, met the ruffled tops of the boots; the embroidered sword-belt was worn over the right shoulder, and in it was hung a Spanish rapier; and in the flapping beaver hat was worn a plume of feathers confined by a jewel. A buff coat or jerkin was often worn as a better defence than the doublet, which is sometimes covered. The engraving represents a citizen of this period more plainly attired. In this reign the hair was worn long, and the mustachios and pointed beard formed a triangle about the mouth, as was witnessed not many years since upon opening the coffin of Charles I. at Windsor, when the severed head of the king was found with the pointed beard perfect. Charles is painted by Vandyke with a jewel in one ear only; at Bath is preserved the pocket-handkerchief

Citizen in the time of Charles I.

by him at the time of his execution; it is of very fine white cambric, marked with the imperial crown and the initials C. R. Oliver Cromwell is described by an eye-witness, in 1640, as "very ordinarily apparelled" in an ill-made plain cloth suit; his linen plain, and not very clean, and his sword stuck close to his side. At this time the men usually wore long vests and cloaks of dark colours, with plain collars called falling bands or turn-overs.

Charles is believed to have generally used armour; but the helmet was deprived of its visor; and before the middle of the seventeenth century, nothing remained of the ancient harness but the open cap and cuirass; and some regiments of cavalry thus armed were thence called Cuirassiers.

The female costume of this period was rather elegant than splendid. Gowns with close bodies and tight sleeves were worn, though the fardingale was retained; with a gorget ruff standing up about the neck like a fan. French hoods were still worn, though with little distinction as to rank. The hair was worn in small curls, and the hoods, of all colours, fastened under the chin with curious effect. Ear-rings, necklaces, and bracelets, were much worn; but the Puritans forbade the females to wear lace, jewels, or even braided hair; and they retained the close hood and high-crowned hat.

Towards the close of the reign of Charles I., the cumbrous fardingale disappeared, with the yellow starched ruff and band. Yellow starch had, however, become unfashionable since Mrs. Turner, the physician's widow, went to the gallows with a yellow ruff round her neck, to be hung for her share in the poisoning of Sir Thomas Overbury (Mrs. Turner having introduced yellow starch from France). These tasteless fashions having disappeared, the female dress became very elegant, with its rich full skirt and sleeves, and falling collar edged with rich lace, and the hair worn in graceful ringlets; but these vanities were condemned by the Puritan party.

With the restoration of Charles II. came certain tasteless innovations upon the elegant Vandyke costume of the time of Charles I., which were the first resemblance to the coats and waistcoats of the present day. Thus, our most picturesque attire lasted little more than a quarter of a century. Its decline was gradual, its chivalric character soon degenerated into grotesqueness, which in its turn changed to stark meanness. Early in the reign of Charles II. the doublet was much shortened, and worn open in front, where, and at the waistband, the rich shirt was shown; and the loose sleeves and breeches were decked with ribbons and points, and from the knee-bands hung long lace ruffles. At the wrists, too, ruffles were worn; but the lace collar was shorn of its points, designated to this day Vandyke. The cloak was retained upon the left shoulder, and the high-crowned and plumed hat remained for a short time; but the crown of the hat was soon lowered.

The petticoat breeches were another absurdity; although ornamented with ribbons at the sides, the lining strangely appeared below the breeches, and was tied at the knees; to match which, the sleeves of the doublet only reached to the elbows, and from under them bulged the ruffled sleeves of the shirt, both being ornamented with ribbons. Meanwhile, the skirt of the doublet had been lengthened from above the waist nearly to the knees, and had buttons and button-holes in its entire length, thus becoming a coat, and so named in an inventory of 1679; wherein, also, are the items of waistcoat, breeches, pantaloons, drawers, and trousers, being the earliest mention of these articles. Stockings of various kinds were common, and "the lower ends of stockings are understood as socks. Instead of the lace collar was worn the long square-ended cravat, of the same material, from Brussels and Flanders.

The female costume, as if to compensate for the tasteless additions to that of the men, retained much of its elegance in Charles's reign; indeed, from this time, "the stronger sex" appear to have left the art of dress to the ladies. The portraits of the beauties of the court of Charles II., in Windsor Castle and Hampton Court Palace, are familiar illustrations, in which we see only a pearl necklace upon the bosom, and the hair falling in luxuriant ringlets from beneath a string of pearls. The gowns are of the richest satin, low in the bosom, and have long trains, so that the wearers could not "stir to the next room without a page or two to hold them up." The annexed engraving shows a citizen's wife performing this office herself.


Citizen's wife in the time of Charles II.

In the gossiping diary of Pepys (from 1659 to 1669) we obt[illegible]veral glimpses of the costume of the early part of [illegible] Pepys venerated the fine clothes of either sex [illegible] perhaps inherited from his father's shop-bo[illegible]etches Charles's queen looking "mighty pretty [illegible]te laced waistcoate and a crimson short pettico[illegible]air dressed *a la negligence;*" Lady Castlema[illegible]ellow plume in her hat; and Mrs. Stewart "[illegible]t cocked, and a red plume and excellent taille." He tells us, too, of his wife's jewels, "increased by the ring she hath made lately as my valentine's gift this year; a Turkey stone set with diamonds; and with this and what she had, she reckons that she hath above £150 worth of jewels of one kind or other." His catalogue of coats, cloaks, breeches, and stockings, is curious to the antiquary. In 1660–61, casting his roundhead, he appeared for the first time in the dress of a cavalier, with coat and sword; then a new lace-band; a new scallop, very fine; "shaggy purple gown, with gold buttons and loop-line; a black cloth suit, with white linings under all, to appear under the breeches;" and a fine camlet cloak. Upon launching his coach, he gave his servants a serge livery of green, lined with red: his wife was "extraordinary fine, with her flowered tabby gown that she had made two years ago, now laced exceeding pretty; and indeed was fine all over." He put on his new suit, and so anon they went through the town, with their "new liveries of serge, and the horses' manes and tails tied with red ribbons, and the standards then gilt with varnish, and all clean, and green reines, that people did look mightily upon us." Elsewhere, we find him thus generous to a relative: "I did give my wife's brother 10s. and a coat that I had by me, a close-bodied, light-coloured cloth coat, with a gold edging in each seam, that was the lace of my wife's best pettycoat that she had when I married. He is going into Holland to seek his fortune." Then he chronicles a shepherd's "woollen knit stockings, of two colours mixed," and the king's having no "handkerchers, and but three bands to his neck," the grooms of the bedchamber having taken all the royal linen for their quarter's fees. But a more important note is his minute account of the plan of Charles II. to introduce *a national dress never to be altered*, and which was taken from that of Poland; and it was worn experimentally by the king and his courtiers, and consisted of "a long cassocke close to the body, of black cloth, and pinked with white silk under it, and a coat over it, and the legs ruffled with black riband like a pigeon's leg." Pepys thought this "a very fine and handsome garment; but the king laid aside the pinking, as it made the wearers look too much like magpies." Dryden says these long vests "did become our English gravity;" but they soon gave way before doublets, and hose, and other importations of the Duke of Grammont. Then the diarist describes a new play, in which the

queens Elizabeth and Mary appear dressed in the costumes of the age. He gives us some curious accounts of "young pretty ladies dressed like men, in velvet coats, caps (hats), and ribbons, with laced bands * * * the ladies of honour dressed in their riding garbs, with coats, and doublets, and deep skirts, just for all the world like mine; and doublets buttoned up the breast, with periwigs and with hats; so that only for a long petticoat dragging under their men's coats, nobody would take them for women." Evelyn also mentions "the queene in her cavalier riding-habit, hat and feather, and horseman's coat." Evelyn, too, tells us that our modern paper folding fans, much less picturesque than the feathered fans of earlier date, were introduced by the Jesuits from Japan and China. Trifling as these notes may appear, they illustrate manners and customs, minute information on which will fruitlessly be sought in the broad path of history.

Passing to the reigns of James II. and William III., we find few noticeable novelties in costume. The coats were often of velvet, without collars, with large hanging sleeves, and button-holes of gold embroidery. The petticoat breeches were exchanged for the close-fitting garments tied below the knee, and therefore called knee-breeches; the broad-brimmed hats were turned up on two sides, and edged with feathers or ribbons; the fashion lay in the rich long lace cravat and embroidered waistcoat, the band was now narrowed, so as to resemble that worn at the present time by clergymen. The periwig was worn still longer than hitherto, hanging down in front, or flowing upon the shoulders, though the colour was altered from black to suit the complexion; and combing these wigs was a piece of gallantry, for which purpose a comb was carried, whence the origin of our present pocket-comb: and at court, in the walks of Kensington, the Mall of St. James's, or the boxes of the theatre, the beaux turned their wig curls over their fingers whilst in conversation; the effect of these wigs flowing over the cuirass will be seen in the portrait of the great Duke of Marlborough.

The female costume was unchanged in the reign of James II.; but it became less luxuriant and more formal in the time of William and Mary, in accordance with Dutch taste. The waists were much lengthened with velvet stomachers, covered with jewels, so as to conceal the bosom, hitherto unsparingly exposed; the sleeve was made tight, and trimmed with lace lappets or ruffles, and long gloves were worn, so as entirely to cover the arm; but the skirts were worn long, full, and flounced; the hair, instead of flowing in ringlets, was gathered up, and strained over a toupee of silk or cotton wool, carried up so high as to be called a tower, covered with a lace scarf or veil that hung in front below the bosom; but this head-dress gradually shrunk into a caul with two lappets, known as a "mob." False locks and curls, set on wires to make them stand out, were also worn. Before the Revolution, the citizens' wives dressed with becoming plainness, and gentlewomen wore serge gowns, which, after 1788, were rejected by chambermaids. The increase of rich clothes and jewels was great, and there were one hundred coaches to one kept formerly, all denoting the improving wealth of the country.

A few of the fashions and peculiarities of this century may be summed up in conclusion. From the reign of James I., the ladies appear to have dressed their hair in better taste than previously, in curls on each side of the face, and braided in a knot at the back of the head, where it was often ornamented with jewels or pearls, or a single feather. It was next worn in long locks flowing below the shoulders; and the love-lock, ornamented with ribbon and twisted pearls, was worn on one side. From the reign of Charles II. to that of Queen Anne, long hair was much prized, and was often sold by women of inferior fortune to be made into periwigs. About this time the *fontange* or top-knot, so called from Mademoiselle de Fontange, who first wore it, was driven out of fashion by the fanatical spirit of the time. Hair powder was also introduced from France in this century: it was worn of various colours, an absurdity only discontinued at the close of the last century. Of the fashion of hats we shall afterwards speak.

Under the house of Stuart, the shoe-rose yielded to the shoe-string, the beaux wearing them of silk tagged with silver, and the humbler classes wore laces of plain silk, or even leather thongs—the latter still to be met with in rural life. Shoe-buckles, in size and shape resembling the horse-bean, were introduced at the Revolution; flimsy Spanish leather boots, with spurs, were also fashionable, and beaux went in them to balls.

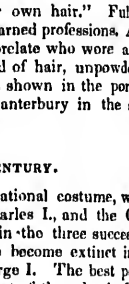
Ostrich and peacock feathers were variously worn in hats, and twigs of yew for mourning. Before the reign of Charles I., the high-crowned hat began to be less worn; and that monarch, in his escape, is described as disguised, and wearing "a very greasy old gray steeple-crowned hat, with the brim turned up, without lining or hat-band." The brim of the hat, however, continued to be worn broad, and when much worn, was called "slouched." It was worn till the end of the century, but with first one flap turned up before or behind, then two flaps; and the third flap being turned up, the cocked hat was complete.

Towards the close of the century, wigs became fashionable, together with false hair, "a custom contrary to our forefathers, who wore their own hair." Full-bottomed wigs were worn by the learned professions. Archbishop Tillotson was the first prelate who wore a wig, which resembled a natural head of hair, unpowdered: the changes in clerical wigs are shown in the portraits of successive archbishops of Canterbury in the state-dining room of Lambeth Palace.

EIGHTEENTH CENTURY.

The picturesqueness of our national costume, which was perfect in the reign of Charles I., and the Commonwealth, gradually declined in the three succeeding reigns, and may be said to have become extinct in the reigns of Queen Anne and George I. The best period of our costume was, therefore, that of the school of portrait painting in England, led by Vandyke, when the fine arts were highly esteemed in the English court, and a good taste began to prevail in the nation.

It has already been seen how a fanciful fashion of attire began to dwindle into the tameness of modern costume in the reign of Charles II., a change which the efforts of that gay monarch could not avert. The alterations were of French origin. Louis XIV., whose general taste was unimpeachable, introduced a new and far from elegant fashion of dress, which the celebrity of his court and other circumstances caused to be extensively copied in foreign countries. About the reign of Queen Anne, this new French fashion had been embraced by courtiers, physicians, and other professional persons in England, also the higher order of gentry; and in the following reigns of George I. and II., it became universal.


Gentleman of 1750.

This dress of the old English gentleman, as it afterwards came to be called, consisted at first, during Queen Anne's reign, of a periwig in formal curls, partly contained in a silk bag on the shoulder; a small cocked hat, full bottomed coat, short breeches, blue or scarlet stockings drawn over the knee and square-toed shoes, with small buckles and high red heels. And this formal costume, relieved only by lace cuffs, ruffles, and neckcloth, and gold or silver clocks in the stockings, remained unmodified through three quarters of the century. The engraving shews a gentleman of the year 1750, and reminds us that the snuff-box, first carried in the reign of James II., continued indispensable for the fine gentleman.

The origin of the cocked-hat has been explained. In the middle of the century it was considered a mark of gentility, and a distinction from the humbler orders, who wore round hats. But the varieties of the native cocked-hat being exhausted, a larger one, named Kevenhuller, was imported from Germany; and early in the reign of George III. (1762), hats were worn, upon an average, six inches and three-fifths broad in the brim, and cocked between Quaker and Kevenhuller. Some had their hats open before like a church-spout or a tin flour-scale; some wore them rather sharper, like the nose of a greyhound; and an account states—"We can distinguish by the taste of the hat the mode of the wearer's mind. There is the military cock and the mercantile cock; and while the beaux of St. James's wear their hats under their arms, the beaux of Moorfields wear theirs diagonally over their left or right eye; sailors wear the sides of their hats uniformly tucked down to the crown, and look as if they carried a triangular apple pasty upon their heads. Some wear their hats with the corners, which should come over their foreheads in a direct line, pointed into the air; those are the Gawkies. Others do not above half cover their heads, which is owing to the shallowness of their crowns."* Cocked-hats, richly trimmed with gold-lace and ostrich-feathers, occur in Hogarth's pictures, which, indeed, will furnish a better idea of the entire costume from 1727 to 1760 than many pages of description; and the portraits by Sir Joshua Reynolds will supply the dress of the next forty years.

The fashions of wigs were as various as those of hats. A peruke and a plaited and tied tail were called a Ramillies, from the famous battle of that name. The tie-wig became the fashion, from the celebrated Lord Bolingbroke going to court with his wig tied up, upon which Queen Mary observed that he would "soon come to court in his night cap," a royal rebuke which established a fashion. In 1764, wigs went out of wear, and the wig-makers of London petitioned George III. to compel gentlemen to wear wigs by law, for the benefit of their trade! The fashion of wearing powder in the hair, however, came to the wig-makers' relief; and the wig decreased in size as the century rolled onward. In the present day, formal wigs are almost confined to the heads of prelates and law officers; and the latter, to get rid of the powder nuisance, wear wigs made of other materials than hair, as the metal platina. Wigs are, however, much worn, from the greater prevalence of baldness than formerly; but their perfection now consists in bearing so close a resemblance to the natural or living hair as to avoid detection. The side curls were originally worn by postilions, to maintain their resemblance to boys.

Towards the middle of the reign of George III., the male dress took the form of the court suit worn at the present day; the breeches having, from the year 1760, been worn over the knees, fastened by buckles or strings. The coats of the eighteenth century were of velvet, silk, or satin, as well as broadcloth, and their colours very fanciful. Hogarth's favourite colour was sky-blue; Reynolds's, deep crimson and violet; and Goldsmith rejoiced in plum-colour. About 1790, cloth became the general wear; the waistcoat being of the costlier materials, and embroidered, and sometimes the breeches. The court dresses were of velvet or satin, with steel, jewel, or paste-buttons; the wig had a silk bag; and the jewelled or steel-cut hilted sword has been retained through the mutations of the last hundred and forty years.* Buckles were worn at the knees and in the shoes till the close of the last century; and the large square plaited buckle was the *ton* until 1791, when shoe-strings became general; though the Prince of Wales and his household endeavoured, by wearing buckles, to retain the fashion.

Lady in the time of George II.

The female costume of the eighteenth century was as formal and tasteless as that of the men. The most odious piece of attire introduced in the early part of the century was the large whalebone petticoat, which degenerated into the hoop petticoat, and made a lady to appear as if standing in an inverted tub. In the reigns of George I. and II., loose gowns, called *sacques*, and hooded silk cloaks, were worn, and a very small muff, such as have been lately revived. This costume is shown in the annexed portrait of a lady of George II.'s time. Ornamental aprons were also worn, as at the present day, with the watch, necklace, and the fan, which was sometimes from twelve to eighteen inches in length, and beautifully made. Gay sings:

> "The fan shall flutter in all female hands,
> And various fashions learn from various lands.
> For this shall elephants their ivory shed.
> And polish'd sticks the waving engines spread:
> His clouded mail the tortoise shall resign,
> And round the rivet pearly circles shine.
> On this shall Indians all their art employ,
> And with bright colours stain the gaudy toy;
> Their pains shall here in wildest fancies flow;
> Their dress, their customs, their religion show.
> * * *
> Gay France shall make the fan her artists' care,
> And with the costly trinket arm the fair."

Spanish broadcloth, trimmed with gold-lace, was used for ladies' dresses in the reign of George I.; and furbelowed scarfs were worn from the duchess to the peasant.

The flowing coif, or rather veil, of the finest linen, fastened on the head, and falling behind, prevailed under Queen Anne, until the towering head-dress was restored; and this being again disused, the hair was worn in curls down the back. Hoods of all colours and fashions on horseback and at the opera, were worn; the projecting fontange again appears, pointed like a steeple, with long crape streamers, their feathers piled up with flowers in stages; and even figures of four-wheeled carriages were head ornaments. Periwigs were also worn by the ladies; and the head was sometimes made up of pins, paste, and pomatum, so as to *keep* for a month. Queen Ann had the good sense not to disfigure her chestnut locks with powder; but it was generally worn till 1793, when Queen Charlotte and the princesses discarded it.

Caps may next be noticed: they were at first small frilled or puffed; then the French night-cap covering the cheeks; the Ranelagh mob-cap, copied from the head-kerchiefs of market-women; the Mary Queen of Scots' cap, of black gauze, edged with French beads; the fly-cap, like a butterfly, edged with garnets, topazes, or brilliants; and Goldsmith's "Cousin Hannah's cap," a few bits of cambric and flowers of painted paper stuck on one side of the head. Calashes, like the head of a cabriolet, were next appended to the head-dress. A flat straw or silk hat, of small size, and trimmed with ribbons,

* London Chronicle, quoted in M. Repton's paper on Hats, in the Archæologia.

* The Marquis of Westminster occasionally wears a court-sword, on the hilt of which is, we believe, set the celebrated Nassuck diamond, sold, in 1837, for £7200, though originally valued at £30,000.

was worn upon the crown of the head; and a large round gipsy straw hat fastened by ribbons under the chin. The bonnet, in early times generally made of velvet, cloth, and silk, was in the eighteenth century changed to straw. Gay mentions a new straw hat lined with green, about 1724, but it was then comparatively rare; for the simple art of plaiting straws together to make bonnets was only practised to any considerable extent about sixty years since; it now employs upwards of 200,000 females in England—Dunstable, in Bedfordshire producing the best plait. In our time English straw has been superseded by Leghorn plait, which having declined in fashion, our own straw, silk, and velvet, have been substituted as materials for bonnets; and our home manufactures must have been materially benefited by the change.

NINETEENTH CENTURY.

The formalities of the eighteenth century received a terrible blow at the French Revolution; and in the ten years from 1790 to 1800 a more complete change was effected in dress by the spontaneous action of the people than had taken place at any previous period in a century. The change began in France, partly to mark a contempt for old court usages, and partly in imitation of certain classes of persons in England, whose costume the French mistook for that of the nation generally. This new French dress was introduced by the party who were styled the Sans Culottes. It consisted of a round hat, a short coat, a light waistcoat, and pantaloons; a handkerchief was tied loosely round the neck, with the ends long and hanging down, and showing the shirt collar above; the hair was cut short, without powder, *à la Titus*, and the shoes were tied with strings.

The comparatively simple form of dress of the Sans Culottes found many admirers in England, and soon became common among young men; the change from antique fashions was also greatly helped by the imposition of a tax on the use of hair-powder, which was henceforth generally abandoned. Pantaloons which fitted closely to the leg remained in very common use by those persons who had adopted them, till about the year 1814, when the wearing of trousers, already introduced into the army, became fashionable. Still, many elderly persons held out in knee-breeches against all innovations, and till the present day (1842) an aged gentleman may occasionally be seen clinging to this eighteenth-century piece of dress. The general use of white neckcloths continued, notwithstanding the introduction of the standing collar, till the reign of George IV., when this monarch's taste for wearing a black silk kerchief or stock, and also the use of black stocks in the army, caused a remarkably quick abandonment of white neckcloths, and the adoption of black instead. The year 1825, or thereabouts, was the era of this signal improvement in costume.

While these leading changes were effecting, other alterations of a less conspicuous nature were from time to time taking place. The disbanding of the army after the piece of 1815 led to various transformations besides those we have mentioned. While pantaloons were the fashionable dress, it became customary to wear Hessian boots; these, which had originated among the Hessian troops, were without tops, and were worn with small silk tassels dangling from a cut in front; being drawn over the lower part of the pantaloons, they had a neat appearance, but the keeping of them clean formed a torment that prevented their universal use. When trousers were introduced from the practice of the army, the use of Wellington boots to go beneath them also became common.*

Referring to the era of 1815 to 1825, as that in which trousers, Wellington boots, and black neckcloths or stocks came into vogue, we may place the introduction of the surtout in the same period of history. From the time when the collarless and broad-skirted coat had disappeared about the commencement of the century, the fashion of coats had changed in various ways, till the above-named era, when the loose frock-coat or surtout was added to the list of garments. We remember of seeing French military officers, when in undress, wearing frock-coats as early as 1811; it is probable, therefore, that the modern surtout is only a variety of the loose military great-coat brought from the continent by the British army; however it originated, it may be allowed to be one of the greatest improvements in the style of dress which has yet occurred in the nineteenth century.

WELSH COSTUME.

The Welsh, as a relic of an ancient Celtic people, possess remarkably few external traits of their original. They have, like the Irish, become Anglicised in costume, and we should in vain search amongst them for the *breacan* or checkered clothing of their Scythian ancestry. The general material of dress is home-made, or at least a common kind of woollen cloth, and flannel. Blue is the general colour of attire. The women wear close-fitting jackets, and dark brown or striped linsey-woolsey petticoats. The most remarkable part of the Welsh costume is the hat worn by the women. All females, in parts of the country not modernized, wear round black hats, like those of men; and this fashion is supported to a small extent by ladies of the higher rank. This use of the hat is not Celtic: the fashion is derived from England, and is only two or three centuries old.

IRISH COSTUME

The Irish at an early period wore the same Celtic fashion of attire as was preserved till recent times in the Scottish Highlands; but, as in Wales, every thing of the kind disappeared as the country became Anglicised. The primitive species of attire, including coloured mantles, kirtles, and other fanciful garments, remained in use till the sixteenth century, when laws were passed by Henry VIII. enjoining the use of caps, cloaks, coats, doublets, and hose, of English cut, but of Irish or any other materials.

The general dress in Ireland, at the present day, rarely varies from that in England. There are, however, some interesting peculiarities of costume amongst the peasantry of the southern and western counties. In Kerry, says Mr. Crofton Croker, "the inhabitants of one barony are easily distinguished by their peculiar dress from those of another; the greatcoat is there worn in the fashion of a mantle, fastened by one button under the chin, and the sleeves hanging down unoccupied by the arms." In the county of Limerick the men's dress is invariably grey, produced by a mixture of black and white wool, without dyeing. In the eastern parts of the county of Cork, light blue is predominant; in the western parts, and in the county of Kerry, light or powder blue; and nearly the same peculiarity extends to female dress. In the eastern baronies of the county of Cork and county of Limerick, cloaks of the brightest red are seen. In the west of Kerry and Cork, dark blue and gray prevail.

A brown stuff gown and green petticoat is the popular female costume, with stockings of the brightest blue; stockings are seldom seen, and shoes are scarcely ever worn except on the Sabbath and other holidays. Silver buckles and cloak clasps are much prized, and are handed down from mother to daughter. Bonnets are quite unknown; but the high-cauled mob cap is sometimes worn under the hood. The *fadakeen*, or little hood, is also a favourite head-dress, and is formed by a kerchief

* It is proper to mention that trousers had, for the previous fifteen or twenty years, been used by boys, and were perhaps from them adopted by the army. Previous to the French Revolution, the dress of boys was almost the same as that of men.

ully folded round the head, and tied in a knot under the chin.

The general costume of the male peasantry is well known for its oddity. A round black hat or *caubeen*, round which perhaps is bound a rope of straw; the rough short coat; the corduroy small clothes, open at the knees, the buttons and strings enjoying a sinecure "for convayience;" the gray stockings most likely hanging loose on the legs; and the short black pipe stuck in the side of the mouth, which is ever ready for a joke. Such is Pat in ordinary costume; but frequently he may be seen with a freeze greatcoat over all—and this cumbrous garment, like the mantle worn by females, seems to be used when there is no plea for its use on the score of weather. Mr. and Mrs. Hall, in their beautiful work on Ireland, thus speaks of the female cloak:—

"The Irish cloak forms very graceful drapery; the material falls well and folds well. It is usually large enough to envelop the whole person; and the hood is frequently drawn forward to shield the face of the wearer from sun, rain, or wind. Yet we would fain see its general use dispensed with. A female in the lower ranks of life cares but little for the other portions of her dress if she has 'a good cloak;' and certainly her ordinary appearance would be more thought of, if the huge 'cover-slut' were not always at hand to hide dilapidations in her other garments. 'Oh, then, I'm not fit to be seen; wouldn't I better tidy myself a bit?—but aisy! sure when I throw on my cloak no one will know what I am,' is a so frequent observation; and away they go, shrouded from head to foot in this woollen hide-all. It is true that the climate is damp, that it is cold, and that the cloak commonly performs a double office, being used as a blanket by night as well as a covering by day. But woollen retains the damp; and this fact, together with the certainty that it imbibes and retains all unwholesome infections, and is seldom or never washed, are serious arguments against it, picturesque though it is. The peasant Irish have so few comforts, that we would far rather add to than take from their small store; but we conceive the 'cost of a cloak' could be more advantageously laid out."

The materials of the dress of the Irish peasantry are chiefly the native wool, worked rudely up into frieze or linsey, druggets, and flannels, for they seldom can afford to wear the linen they fabricate. Unfortunately, the bulk of the Irish have little idea of tidiness either in households or attire. Taking things too easily, as respects exterior marks of decency, they allow their clothing to fall into disrepair, and finally ruin; consequently, their dress is generally more picturesque than neat, and it often seems a problem how they get into it. We are glad to observe, however, that this heedlessness is in course of removal, and that the dress is everywhere improving.

SCOTTISH COSTUMES.

At the present day, Scotland cannot be said to possess any national costume which distinguishes the bulk of the people from their fellow-subjects in South Britain; and however much the fact may surprise the artists and dramatists of England, it is very certain that the inhabitants of Edinburgh, Glasgow, and other cities and towns in Scotland, are dressed in precisely the same fashion of garments as is now seen in the streets of London, Paris, Brussels, or the capital of any other civilized country.

This general resemblance of Scottish costume to that of England has existed since about the reign of James I., when foreign manners and fashions were introduced among the higher classes of society, and thence forced their way into ranks of professional men, traders, and ultimately the people at large. Previous to the era we mention, the dress of the Scotch, both those of the Highlands and Lowlands, was distinguished by parti-colours, woven in checks, according to taste or ancient usage. By the Celtic race in the Highlands, this species of variegating cloth with colours was called *Breacan*, which signifies spotted, and by the Teutonic population of the Lowlands it received the name of *Tartan*, a word whose origin has defied the researches of etymologists, but which it is not unlikely may have been derived from the ancient Tartar races, who used a similar kind of colouring in their attire. Whatever be the origin of the term, all doubt as to the antiquity and almost universal use of the thing meant is at an end.

"When the soldiers of Catherine [Empress of Russia] opened the vast tumuli which are scattered over the great desert between the Tobal and the Irtish, among other memorials of a high antiquity they discovered a small bronze figure of a mounted Tartar, apparently an image of one of those tutelary deities still in common use among the Calmucs and Mongols. The head was represented in the small conical bonnet once universally worn from Thibet to St. Kilda, *still* continued in China and Albania, and not extinct among the Highlanders until the beginning of the eighteenth century. The body was covered by a *checkered tunic*, engraved in cross lines, evidently indicating a parti-coloured garment; and the whole figure might have passed unnoticed among the earliest Highland grave-stones, or the remote Islesmen in the year 1715. By the traditions of the surrounding tribes, the tumuli where the bronze was found are said to cover the remains of Tartars killed in the battles between Tamerlane and the Calmucs, whose descendants at this day wear vestments checkered in various colours, resembling the character of tartan. The Turks, another race of the same stock, are still attached to the same habit; and hence the wandering Turkish pedlars in England frequently wear a gown of *Highland tartan*, from its conformity to their ancient taste. But not only among the Calmucs and Walgusians remains this remnant of an earlier period, separated by distance and by language; it is found lingering in various quarters of the world, and various degrees of civilization. Among the Tuscans, the Neapolitans, the Albanians, and the Basques, broad striped stuffs and silks retain the common elements of its colouring. In Wales, the petticoat of the women still preserves a tradition of their ancient *breacan;* and that of the Malo-Russians and Don-Cossacks exhibit unequivocal tartan. It is of checkered cloth, in various colours, *both of the warp and the woof*, generally red, green, and black, and so exactly resembling the Scottish patterns that it might be mistaken for the manufacture of a Scottish loom. These coincidences are strong evidence of an ancient universality, once prevalent through a large portion of mankind, and of which the tartan of Scotland is only one of the last remnants, preserved by the remote solitude and the tenacious habits of an aboriginal people, secluded from the revolutions of the world and the modifications of society."*

We do not find that tartan cloth, or indeed cloth of any kind, had been worn by the Lowlanders of Saxon or Teutonic origin in the shape of philibegs or kilts, that ancient fashion of attire being for ages previously confined to the Highland clans. That tartan, however, was at one time as much in use for other garments in the Lowlands as Highlands, is distinctly proved by the following extract from the "Vestiarium Scoticum" (1560–1570), already quoted. We slightly modernize the orthography, to render the language intelligible to English readers:—

* "Vestiarium Scoticum:" from the manuscript formerly in the Library of the Scots College at Douay, with an Introduction and Notes, by John Sobieski Stuart. Edinburgh: William Tait. 1842. The above extract is from the learned introduction of Mr Stuart.

"For sameikle as in thir present tymes been seen dyvers uncuthe chaunges in the auld Scottysh fassoun, and men do now effect foreign and straunge fantasies, radder nor sic holsom use and order as cumeth of their ain native guise, and has been usit be our forbeirs in the auld tyme, for nowe all do tak pryd to buske them in heich crounit hattis, Frenche cloukis, Englishe hudes, lang pyket schune, and udder sic lyk uncuthe braveries, the whilk was unknawen till our ancestors of gude femen, wha was contentit to gang with ane bonnet of Kelshewblew, and ane mantel or plaid lyk as affore tym was usit be ther faderis begone; with ane pair of rouch rowlyns [buskins] or hemands of hartshyd, as was much usit be our umquhile lorde and soverine King James of nobil memorye; for he had ever besydes thae of his awin colouris, twa or three plaidis of divers kyndes in his wardrobe, whilk he usit in his jornayes when that he wald not be knawen openlye."

Tartan, for clothing, disappeared in the Lowlands in the course of the seventeeth century; but even as late as the beginning of the eighteenth century, parti-coloured plaids were pretty generally worn; and young women were in the habit of using a "tartan screen," that is, a small plaid of variegated colours. In the fine old Scottish song, "Wat ye wha I met yestreen,' the *screen* of tartan is alluded to in the following characteristic manner:—

"Wat ye wha I met yestreen,
Coming doun the street, my joe,
My mistress in her *tartan screen*,
Sae bonnie, blythe, and sweet, my joe."

The tartan screen, which was worn in the fashion of a covering for the head and shoulders, so as to combine in some measure the properties of a modern bonnet and shawl, was formed of costly materials; the ladies of the higher classes employing silk, and those of inferior station fine worsted, the colours in each case being remarkably brilliant. Being often employed with a degree of real or affected modesty to conceal a part of the features, it may be said to have performed the office of a veil to Scottish maidens; and hence its appellation of *screen*. Against such "vanities" the pulpit in these times often railed, and, as we suppose, with the usual results. The plaids of the men were of coarser materials, and were used only as mantles as a defence against the weather; yet, if we are to believe Ramsay, they were not untasteful in their colouring: in the "Gentle Shepherd," he makes one of his shepherds speak of

"A *tartan plaid* spun o' gude haslock woo,
Scarlet and green the sets, the borders blue,
Wi' spraings like gowd and silver cross'd wi' black."

Whatever may have been the character of the tartan employed for the plaids of the Lowlanders, and the general garments, including the philibeg of the Highlanders, towards the middle of the eighteenth century, it was very much obliterated in the year 1747, when all kinds of tartan, and also the ancient costume of the Highlanders, were, with a view to break the spirit of the clans, formally proscribed by law. The following is the provision in the act of Parliament on the subject:—

"That from and after the 1st day of August, 1747, no man nor boy, within that part of Great Britain called Scotland, other than such as shall be employed as officers and soldiers in his majesty's forces, shall, on any pretence whatever, wear or put on the clothes commonly called Highland clothes; that is to say, the plaid, philibeg, or little kilt, trowse, shoulder belts, or any part whatsoever of what peculiarly belongs to the Highland garb; and that no tartan or parti-coloured plaid or stuff shall be used for great-coats or for upper coats; and if any such person shall presume, after the said first day, to wear or put on the aforesaid garments, or any part of them, every such person offending, being convicted by the oath of one or more credible witnesses before any court of justiciary, 'shall suffer imprisonment, without bail, during the space of six months;' and being convicted for a second offence, shall be transported to any of his majesty's plantations beyond seas, there to remain the space of seven years."

This contemptible law was repealed in the year 1782; but before that time the tartan and the "garb of old Gaul" had been generally abandoned, except among Highland regiments, and it is chiefly copies from their attire that have guided modern attempts at reviving the costume.

Highland Costume.—Originally the costume of the Highlanders resembled that of other Celtic tribes, and consisted of little else than a woollen garment of variegated colours wrapped round the body and loins, with a portion hanging down to cover the upper part of the legs. In progress of time this rude fashion was superseded by a distinct piece of cloth forming a philibeg or kilt, while another piece was thrown loosely as a mantle or plaid over the body and shoulders. In either case the cloth was variegated in conformity with the prescribed *breacan* or symbol of the clan; and hence the tartan was sometimes called *cath-dath*, or battle colours, in token of forming a distinction of clans in the field of battle.

According to the author of the "Vestiarium Scoticum," the following, in the reign of James VI., was the list of chief and subordinate clans, each possessing its own tartan; among these clans, it will be observed, are included certain Lowland families or houses, who had also adopted the same kind of cognisance.

Clan Stewart—six colours, chiefly red, checked with green, purple, black, white, and yellow.
Prince of Rothsay—three colours, checked with green and white.
Royal Stewart—chiefly white, checked with green, red, purple, and black.
Macdonald of the Isles—chiefly green, checked with black, purple, red, and white.
Ranald—chiefly green, checked with black, purple, red and white.
Macgregor—chiefly red, checked with green and white.
Ross—chiefly red, checked with green and purple.
Macduff—chiefly red, checked with green, black, and purple.
Macpherson—equal portions of black and white, with small lines of red and yellow.
Graht—chiefly red, with checks of green and purple.
Monro—chiefly red, checked with black and white.
Macleod—chiefly yellow, checked with black and red.
Campbell—chiefly green, checked with black, purple, yellow, and white.
Sutherland—chiefly green, with black, purple, red, and white.
Cameron—chiefly red, checked with green and yellow.
Macneil—chiefly green, with purple, black, white, and red.
Macfarlane—very dark, being chiefly black checked with white.
Maclachlan—chiefly yellow, with checks of brown.
Gillean or Maclean—chiefly green, checked with black and white.
Mackenzie—nearly equal portions of green and purple, checked with black, white, and red.
Fraser—chiefly red, checked with purple, green, and white.
Menzies—equal portions of red and white.
Chisholm—chiefly red, checked with purple, green, and white.
Buchanan—chiefly red and white, with small black stripes.
Lamont—chiefly green, checked with black, purple, and white.

Macdougall—chiefly red, checked with black, purple, and green.
Mackintyre—chiefly green, checked with purple, red, and white.
Robertson—chiefly red, checked with purple and green.
Macnab—chiefly red, checked with crimson, green, and black.
Mackinnon—chiefly red, checked with green, black, and white.
Mackintosh—chiefly red, checked with green, black, and white.
Farquharson—chiefly green, with purple, black, red, and yellow.
Gun—chiefly green, checked with black and red.
Macarthur—chiefly green, checked with black and yellow.
Mackay—chiefly a bluish purple, with black and red checks.
Macqueen—nearly equal portions of red and black, with yellow.
Bruce—chiefly red, with green, yellow, and white.
Douglas—very dark, being equal checks of black and slate colour.
Crawford—equal portions of red and green, with white.
Ruthven—chiefly red, with purple and green.
Montgomery—chiefly light green, checked with purple.
Hamilton—chiefly red, with purple and white.
Wemyss—chiefly red, checked with black, white, and green.
Comyn—chiefly red, with green, black, and white.
Sinclair—chiefly green, checked with black, purple, red, and white.
Dunbar—chiefly red, checked with green and black.
Leslie—chiefly red, checked with purple, black, and yellow.
Lauder—chiefly green, with purple, black, and red.
Cunningham—chiefly red, with black, purple, and white.
Lindsay—chiefly red, with purple and green.
Hay—chiefly red, with green, yellow, white, and black.
Dundas—chiefly green, with purple, black, and red.
Ogilvie—chiefly green, beautifully checked with purple, black, yellow, and red.
Oliphant—equal portions of green and purple, with black and white.
Seton—chiefly red, with small lines of green, black, purple, and white.
Ramsay—chiefly red, with black squares checkered with white.
Erskine—red and green.
Wallace—red and black, checkered with yellow.
Brodie—chiefly red, with black and yellow.
Barclay—chiefly light green and purple, checkered with red.
Murray—chiefly green, checkered with black, purple, and red.
Urquhart—chiefly green, with black, purple, white, and red.
Rose—chiefly red, with small checks of purple, green and white.
Colquhoun—green, purple, black, red, and white.
Drummond—chiefly red, with green and dark red.
Forbes—chiefly green, with black, red, and yellow.
Scott—chiefly red, with green, red, and black.
Armstrong—chiefly green, with black, purple, and red.
Gordon—chiefly green, with purple, black, and yellow.
Cranstoun—yellowish-green, with purple and red.
Graham—chiefly green, with black checks.
Maxwell—chiefly red, with green and black.
Home—dark purple, with black, red, and green.
Johnston—chiefly green, with purple, black, and yellow.
Ker—chiefly red, with black and green.

To this list the names of other Scottish families who have adopted a peculiar set of tartan as a cognisance would be added, and probably the entire number of tartans now fabricated for indiscriminate sale is not fewer than a hundred. One of the most commonly used patterns of tartan is that adopted by the 42d regiment—dark-green, checkered with purple. Some of what are called fancy tartans are gaudy, but not in good harmony or contrast of colour.

As modernized and improved by the Highland regiments, the "belted plaid," worn as the philibeg or small kilt, with a separate drapery depending from the shoulder in imitation of the ancient garb, is one of the most picturesque and graceful costumes to be seen in any part of the world; and although it leaves the leg bare at and a short way above the knee, we are assured that it is by no means too meagre an attire for cold weather. A gentleman in Edinburgh informs us that he never catches cold when dressed in the kilt and hunting among his native Highland hills; but that he is always unwell after returning to town and donning the dress of the Lowlanders. Anciently, the Gael wore no shoes or garments for the legs. The feet were only on occasions covered with pieces of hide, tied with a thong, called *brogs*, which, though slender, were very lasting, and were well suited for walking or running on heathy mountains. The introduction of shoes, and also hose, formed from the same tartan cloth as the kilt, is comparatively modern. The hose of the common men in the Highland regiments are still not knitted or wove like stockings, but cut from the web and sewed.

It appears that even in ancient times the Celtic tribes did not always wear the loose garments we have described; but that they also, or at least some of them, wore the *triughas* or *trius*, a species of vestment "formed of tartan cloth, nicely fitted to the shape, and fringed down the leg. They were sometimes merely striped, and were fastened by a belt around the loins, with a square piece of cloth hanging down before. It required considerable skill to make the trius. The measure was a stick, in length one cubit, divided into one finger and a half. There is preserved a Gaelic saying respecting this garment, by which we are given to understand that there were two full nails to the small of the leg, eleven from the haunch to the heel, and three to the breech, a measure inapplicable to few well made men."*

The coat in which the upper part of the body and arms of the Highlanders are now invested, is of course quite modern, having come into use when the old form of the plaid dress was laid aside. Made, as it usually is, with short skirts and small round buttons, it cannot be considered in harmony with the rest of the attire; but it is nevertheless convenient, and could not well be improved.

The bonnet has for ages been a part of the Highland costume, as it was formerly also of the Lowlanders, and, we may add, the English previous to the introduction of felt hats. The *haet* of the Anglo-Saxons must have been little else than a thick woollen cap or bonnet. "In England, it was ordained, in 1571, that every person above seven years of age should wear, on Sundays and holidays, a cap of wool knit, thickened and dressed in the country by cappers, under the penalty of 3s. 4d. for every day's neglect; lords, knights, gentlemen of twenty marks' lands, such as have borne offices of worship, gentlewomen, ladies, and wards being excepted."†

The English gave up bonnets sooner than the Scotch; and ultimately the cry that "the blue bonnets had come over the border," was equivalent to saying that a party of Scotch marauders had entered England on one of their usual hostile excursions. The Highlanders, with whom the bonnet has remained longest as a part of ordi-

* "The Scottish Gael." By James Logan. 2 vols. London 1831.
† Logan's "Scottish Gael."

nary dress, have adopted very many shapes and modes of ornamenting their head-gear. The heavy plume of black feathers used in the army is quite modern, and in exceedingly bad taste, besides being totally unconformable to the idea of a primitive and light costume. The true bonnet of the Highlands is small, either round or peaked in front, dark blue or gray in colour, and without any tartan or checkering. In fancy dress, as for example in the adjoining cut, the bonnet is somewhat larger, and occasionally has a band of tartan. Highland chiefs were distinguished by three pinion feathers of the native eagle stuck in the bonnet; and those who enjoyed the rank of gentlemen were entitled to wear a single feather. It was customary also for the members of each clan to wear in the bonnet a peculiar badge formed of some native shrub. Authorities differ as to the precise shrubs worn for this purpose. According to Logan, the Buchanans used a sprig of bilberry; the Camerons, crowberry; the Campbells, fir-clubmoss; the Forbses, broom; Frasers, yew; Macleods, juniper; Robertsons, fine-leaved heath, &c.

The full dress of Highland chiefs and gentlemen has always been liberally ornamented with sword, baldrick, dirk, large brooches, buckles, shot pouch, and purse. The purse or sporan is a most important part of the costume: it is formed of the skin of a wild animal with the hair on, and tied to the waist by a band, hangs down in front, so as to fall easily upon the lap, and not incommode the legs in walking. It is usually ornamented with silver tags or tassels, and a flap covering the mouth of the purse is sometimes decorated with the vizard of a fox. "In many cases," says Logan, "the purse is composed of leather, like a modern reticule. It is formed into several distinct pockets, in which the Gael carried their money, watch, &c., and sometimes also their shot; but anciently they bore a similar wallet or builg at the right side, for the shot, or for a quantity of meal or other provision. This was termed *dorlach*, and was the knapsack of the Highland soldier; and small as that of the present military is, among the Gael it was still more portable. 'Those of the English who visited our camp,' says an author quoted by Jameson, 'did gaze with admiration upon those supple fellows, the Highlanders, with their plaids, targets [shields], and dorlachs.' The purse admits of much ornament, but according to my taste, when too large, it hides the beauty of the kilt."

After a period of indifference to the preservation of this beautiful national costume, there has latterly sprung up a better tone of feeling on the subject, both among Lowlanders and Highlanders. Encouraged by prizes liberally awarded by the Caledonian Society of London, a public exhibition takes place triennially at Edinburgh, at which there is a competition of skill in playing the Highland bagpipes, dancing, &c., and taste in dressing in proper holiday costume. A hundred or more men generally attend from all parts of the Highlands in their respective clan tartans; and the exhibition as a surviving relic of manners and customs the most ancient in the world, is one of the most interesting which can be witnessed. The last exhibition was in the summer of 1841.

In conclusion, with respect to the ancient Highland dress, it is proper to mention that it is upon the who[le] little worn in the present day in the Highlands, in[to] which the modern garb of jackets and trousers of pla[in] woollen cloth has been generally introduced, and [is] worn on all ordinary occasions. In short, except as [a] fancy costume, it is seldom seen anywhere in Scotlan[d].

Lowland Costume.—As already observed, the costu[me] of the Lowland Scotch is at the present day the same [as] that which has for ages been common in England an[d] France. Among the peasantry, however, in unsophisti[-]cated districts of the country, there remains a few trai[ts] of a past state of things. The Lowland small far[mer] of eighty years since was dressed in strong woolle[n] clothing, perhaps home-made of a gray or light-blue colour, the legs below the knee being enveloped in coarse gray stockings. The Anglo-Saxon smock shirt does not appear ever to have been used in Scotland, where the garments both of men and women were for the most part of woollen or plaiden. The hat eighty years since was rare. The class of peasants we allude to still wore the blue bonnet, which differed, however, from the Highland bonnet in shape; it was flat like a bannock, drooping on the neck or projecting over the countenance, and was ornamented o[n] the top with a small tuft or cherry of red worsted. I[f] to this humble attire we add a gray woollen plaid, wor[n] when the weather or old age required such a means o[f] protection, and place in the hand a snuff-*mull*, or box i[n] the form of a crooked horn, we have a complete pictu[re] of the Lowland Scot in full costume, as he existed abo[ut] the year 1760. As late as thirty years since, we remem[-]ber of seeing many such; and even yet they have n[ot] entirely disappeared.

While the flat blue bonnet has generally given way [to] the modern hat, or only survived in the degenerate for[m] of a small round Kilmarnock bonnet worn pretty gene[-]rally by carters, ploughmen, and boys of the humbl[er] rank, the gray checked plaid has withstood all innova[-]tions. This garment, which is still universally wor[n] by shepherds and other persons in rural districts of t[he] country, may be viewed as the only relic of the ancie[nt] variegated attire of the Lowland Scotch. The checke[r-]ing is very simple, consisting only of small cro[ss] bars of white and black, and the general effect [is] gray. The plaid is made longer than broad, to enab[le] the wearer to wrap one end round his body and shou[l-]ders, and allow the other to hang gracefully down th[e] back. The right arm is generally left disengaged. Th[e] very general use of this simple kind of plaid has led [to] frequent reference in the lyrical pieces of the Scotti[sh] bards; thus Burns, in his usually descriptive languag[e] says in one of his songs:—

> "I'll tak my *plaid* and out I'll steal,
> And ower the hills to Nannie O."

The only other variety of costume worthy of noti[ce] in connection with the Lowlands of Scotland, is that of [a] remarkable community of fishers on the coast of the Fi[rth] of Forth, near Edinburgh. At Newhaven, a villa[ge] westward from Leith, and at Fisherrow, a suburb [of] Musselburgh, these fishers have from time immemori[al] possessed a monopoly of supplying the metropolit[an] market with their perishable wares, procured often at [no] small personal risk on the bosom of the adjacent fi[rth]. The dress of the males differs little from that of [...]

women generally, and the peculiarities we have to mention are confined entirely to the women, married and unmarried, whose exclusive and cheerfully performed duty it is to sell the fish in the markets and streets of Edinburgh. These *fishwives*, as they are termed, are of an exceedingly robust frame and constitution, and usually carry loads of from one to two hundred weight upon their backs, in creels or willow baskets, and evince a masculine degree of strength which is not unaccompanied by manners equally masculine. These singular Amazons dress themselves in a style which, if coarse, must also not be uncostly. They are unable to wear any head-dress, excepting a plain muslin cap or *mutch*, and on the front of this is loosely placed a coloured kerchief, to lessen the pressure of a broad belt which crosses the forehead and must be slipped over the head every time they set down their merchandise. They usually wear a voluminous mass of petticoats, with a jerkin of blue cloth, and several fine napkins enclosing the neck and bosom. Their numerous petticoats are of different qualities and colours, but generally striped red, or yellow, or blue; and it is customary while two or three hang down to the calf of the leg, to have as many more bundled up over the haunches, so as to give a singularly bulky and sturdy appearance to the figure. Thirty or forty years ago, they wore no shoes or stockings, but cannot now be impeached with that defect, so often imputed to Scottish women by travellers. The *cries* of the fishwives are well known to visiters of Edinburgh as being musical, and far from unpleasing. It has been conjectured that the fisher community to which they belong, and which admits of no mixture from other departments of the population, is descended from a colony of settlers from the coast of the Netherlands; but of this there is no evidence, and their names and language do not materially differ from what are common in other parts of Mid-Lothian

TIME—CHRONOLOGY—TIME MEASURERS.

SPACES OF TIME.

Time is the general relation of events and successive existences to each other—a thing of duration, involving the past, the present, and the future. It is very obvious that for the measurement of time we can have no standard of the same tangible nature with a pound, a yard, or a pint measure. We must have recourse to the lapse of time involved in some continued or reiterated *motion*, as to which we have all the proof possible in the nature of the thing, that, on the whole, it requires the same period of time for its recurrence on one occasion as on every other. Such motions, as the measure of periods or portions of time not less in duration than a single day, are those of the rotation of the earth on its axis, the revolution of the moon round the earth, and that of the earth and moon round the sun. Of such as shall constitute the measure of periods less in duration than a single day, or day and night, there are no explicit natural standards; and hence the utility and necessity of mechanism of human invention, the motions of which, mathematically adjusted and numbered, shall measure and record such briefer and more arbitrary periods of time as those we term seconds, minutes, and hours.

In accordance, therefore, with what is the common practice of mankind in applying such a scale of time to the general routine and purposes of life, especially in its more civilized condition, we propose to treat here, briefly, of the measurement of time by days, months, years, and cycles, considered with special reference to their respective natural and artificial subdivisions and accumulations.

DAYS AND HOURS.

The day is that portion of time which elapses while the earth turns once completely round on its axis—each half of its circumference passing, alternately, through the light of the sun on the one hand, and through the darkness of the starry heavens on the other—thus producing, to those carried around with it, the succession of day and night, and the apparent phenomenon of a diurnal revolution of the sun from one point in the illuminated atmosphere back again to the same point, or nearly so.

The succession of day and night would undoubtedly constitute the first great natural period reckoned by the human race—involving, as it does, not only the most familiar and most strikingly contrasted phenomena within the bounds of man's experience, but phenomena peculiarly adapted to the great necessities of his nature—those of vigilance and sleep. Yet the precise point at which the day should be held to begin and terminate must have been a matter much less easily settled; and accordingly we find, that while amongst ancient nations—the Babylonians, Persians, Syrians, Greeks, and almost all the nations of Asia—the day began at sunrise, and was held to last throughout the whole of the ensuing daylight and darkness (an arrangement better adapted to countries near the tropics than elsewhere, as the sun there rises more nearly about the same time throughout the year); the Jews, Turks, Austrians, and others, with some of the Italians and Germans, have begun their day about sunset; the Arabians theirs at noon, as do astronomers and navigators of all nations; the ancient Egyptians, and most of the modern Europeans and Americans, on the other hand, as well as the modern Chinese, beginning theirs at midnight, which is evidently the most convenient plan, since it throws all the waking and active part of the day under one date.

The subdivision of the day into morning, forenoon, mid-day, afternoon, evening, and night, is natural, though somewhat indefinite, and may be conceived to have always been more or less marked by man, even in his rudest state, and at all events the ancient Chaldeans, Syrians, Persians, Indians, Jews, and Romans, divided the day and the night into four parts; but there is nothing obvious in the natural changes or motions of the sun, moon, earth, or stars, which could point out the division of days into hours, hours into minutes, or minutes into seconds. These divisions are entirely artificial and arbitrary, unless, indeed, we conceive the second to represent that minutest portion of time which, to the human mind, constitutes its natural unit or rudiment, as particles constitute the units of a mass; but even seconds have been subdivided into thirds, and still it is evident that, after all, these are no more the minutest elements of time than are what our chemists term molecules the minutest elements of masses.

In the civilized part of the world, it is now customary to divide the day, and reckon the minuter portions of time, by instruments to be afterwards described, in seconds, sixty of which constitute a minute; in minutes, sixty of which constitute an hour; and in hours, twenty-four of which constitute a day. Most nations have these instruments marked for only twelve hours, the computation being twofold, like the day itself; but the Italians, Bohemians, and Poles, run them on from the first to the twenty-fourth—from one o'clock to twenty-four o'clock. The Chinese, on the other hand, divide the day into twelve hours only, each being, therefore, twice the length of ours. In the decimal system adopted by the French, the day was divided into ten hours.

The length of time which elapses while any given point on the earth's surface passes from a similar point in the starry firmament and returns to the same point, is called the sidereal day, and is found, when measured by the motions of the ordinary instruments invented for the purpose of pointing out its subdivisions—namely, time-keepers—to consist of, or be equal to, 23 hours, 56 minutes, 3 seconds, and (to be still more exact, as astronomers require to be) 4 thirds—a third being the sixtieth part of a second. But although the distance of any fixed star in the firmament is so immense that the whole orbit of the earth is but as it were a point itself in comparison, and the motion of the earth in that orbit therefore cannot alter or affect the length of the sidereal day to any appreciable extent, it is otherwise with the solar or natural day, which is that portion of time elapsing between the arrival of the sun at the meridian, or mid-day, on two consecutive days. The main length of this period of time is 24 hours, nearly 3 minutes 56 seconds on the average being required, in consequence of the earth's motion in its orbit, to bring the sun up to the same meridian on every successive day. The present inclination of the plane of the earth's equator to the plane of its orbit, however, which is diminishing, though with extreme slowness, and the unequal rapidity of the motion of the earth in its orbit, which is also diminishing as slowly, with the diminution of the eccentricity of the orbit, really cause the solar or natural days to be of unequal length: so that, though averaging 24 hours each, they sometimes fall short and sometimes exceed that average. It is the former of these causes, too, which gives rise to the difference in the relative length of night and day, according to the seasons of the year.

MONTHS AND WEEKS.

After the day, the next distinct natural measure or division of time marked out by the heavenly bodies, in their time-keeping revolutions, is the month. The lunar month is a period during which the moon revolves once round the earth, and is equal to 29 days, 12 hours, 44 minutes, 3 seconds. The solar month is the period during which the sun appears to pass through a twelfth part of his annual course, or through one of the twelve arbitrary signs of the zodiac, and is equal to 30 days, 10 hours, 30 minutes: it is not so distinctly pointed out by nature as the lunar month. The month came ultimately to be disconnected from the lunar and terrestrial revolutions, as will be afterwards more particularly noticed, and civil or calendar months, accommodated to the year, were substituted; these also, as well as the names given to them in their annual order, will fall to be noticed while treating of the year itself and its subdivisions.

The subdivision of the month into weeks of seven days is very ancient, having, from the most remote period of history, been in use among the Hindoos and other nations in the East, including the Chaldeans and Jews. According to an early practice, the days of the week in various countries received names from planets with which they were imagined to be connected, or from certain deities reverenced by Pagan nations. Thus the French, at the present day, following the practice of the Romans, name the days from Mercury, Jupiter, Venus, &c., while the English adopt Saxon appellations derived from the deities of northern Europe, and from the Sun and Moon. Hence our term Sunday is from the Sun; Monday, the Moon; Tuesday, Tuesco; Wednesday, Woden; Thursday, Thor; Friday, Friga; and Saturday, Seater. (See article SUPERSTITIONS.)

YEARS AND SEASONS.

The year, properly so called, or the solar or astronomical year, is that portion of time which elapses while the sun passes through the twelve signs of the zodiac, or rather while the earth revolves once completely round the sun in its orbit; and while, from the parallelism of the axis of the earth's rotation to itself, combined with its inclination to the axis of the orbit, each hemisphere is turned alternately, once toward and once from the sun; thus constituting, at least in the extra-tropical regions, the distinction between summer and winter.

It would undoubtedly be this marked alternating distinction which would first lead the attention of every rude but progressing nation not inhabiting tropical countries to calculate their time by years, for in these would even the most savage nation feel an interest analogous to that with which they had come to contemplate the alternating distinction between day and night. The spring and autumn, too, would soon be stamped with the impress of their sensibilities as natural periods, respectively, of hope and fruition. But it is rather remarkable that the only distinctions in the seasons made by the most ancient nations known were those of summer and winter, as if these had been so extreme as to absorb all other distinctions.

The distinction of the seasons would soon be found to depend upon the alternate approach and departure, or elevation and depression, of the sun in the heavens at stated and regularly recurring intervals; but the exact division of time into solar years could not have been effected till astronomy had made some progress; when it would immediately appear, in the endeavours at length made to measure the year by revolutions of the moon, that as an exact number of days, or times of the earth's rotation, is not contained in "a moon," or lunar month, so an exact number of moons, or even of days, is not contained in a year, or revolution of the seasons. Such observations as these led to methods of accumulating the one period to the other; or, in other words, to the

ADJUSTMENT OF THE CALENDAR.

The Chaldeans, Egyptians, and Indians, and indeed almost all the nations of antiquity, originally estimated the year, or the periodical return of summer and winter, by 12 lunations; a period equal to 354 days, 8 hours, 48 minutes, 36 seconds. But the solar year is equal to 365 days, 5 hours, 48 minutes, 49 seconds; or 10 days, 21 hours, 13 seconds longer than the lunar year, an excess named the *epact:* and accordingly the seasons were found rapidly to deviate from the particular months to which they at first correspond; so that, in 34 years, the summer months would have become the winter ones, had not this enormous aberration been corrected by the addition or intercalation of a few odd days at certain intervals. Thus was the calendar first adjusted, and the solar year estimated to consist of 12 months, comprehending 365 days. But no account was taken of the odd hours, until their accumulation forced them into notice; and a nearer approximation to the exact measurement of a year was made about 45 years before the birth of Christ, when Julius Cæsar, being led by Sosigenes, an astronomer of his time, to believe the error to consist of exactly 6 hours in the year, ordained that these should be set aside, and accumulated for four years, when, of course, they would amount to a day of 24 hours, to be accordingly added to every fourth year. This was done by doubling or repeating the 24th of February; and, in order to commence aright, he ordained the first to be a "year of confusion," made up of 15 months, so as to cover the 90 days which had been then lost. The "Julian style" and the "Julian era" were then commenced; and so practically useful and comparatively perfect was this mode of time-reckoning, that it prevailed generally amongst Christian nations, and remained undisturbed till the renewed accumulation of the remaining error, of 11 minutes or so, had amounted, in 1582 years after the birth of Christ, to 10 complete days; the vernal equinox falling on the 11th instead of the 21st of March, as it did at the time of the council of Nice, 325 years after the birth of Christ. This shifting of days had caused great disturbances, by unfixing the times of the celebration of Easter, and hence of all the other movable feasts. And, accordingly, Pope Gregory XIII., after deep study and calculation, ordained that 10 days should be deducted from the year 1582, by calling what, according to the old calendar, would have been reckoned the 5th of October, the 15th of October, 1582. In Spain, Portugal, and part of Italy, the pope was exactly obeyed. In France the change took place in the same year, by calling the 10th the 20th of December. In the Low Countries the change was from the 15th December to the 25th, but was resisted by the Protestant part of the community till the year 1700. The Catholic nations in general adopted the *style* ordained by their sovereign pontiff, but the Protestants were then too much inflamed against Catholicism in all its relations to receive even a purely scientific improvement from such hands. The Lutherans of Germany, Switzerland, and, as already mentioned, of the Low Countries, at length gave way in 1700, when it had become necessary to omit *eleven* instead of ten days. A bill to this effect had been brought before the Parliament of England in 1585, but does not appear to have gone beyond a second reading in the House of Lords. It was not till 1751, and after great inconvenience had been experienced for nearly two centuries, from the difference of the reckoning, that an act was passed (24 Geo. II., 1751) for equalizing the style in Great Britain and Ireland with that used in other countries of Europe. It was enacted, in the first place, that eleven days should be omitted after the 2d of September, 1752, so that the ensuing day should be the 14th; and, in order to counteract a certain minute overplus of time, that "the years 1800, 1900, 2100, 2200, 2300, or any other hundredth year of our Lord which shall happen in time to come, except only every fourth hundredth year of our Lord whereof the year 2000 shall be the first, shall not be considered as leap years." A similar change was about the same time made in Sweden and Tuscany; and Russia is now the only country which adheres to the *old style*; an adherence which renders it necessary, when a letter is thence addressed to a person in another country, that the date should be given thus:—April $\frac{1}{13}$ or $\frac{\text{June 26}}{\text{July 9}}$; for it will be observed, the year 1800 not being considered by us as leap-year, has interjected another (or twelfth) day between old and new style.

The twelve calendar or civil months were so arranged by Julius Cæsar, while reforming the calendar, that the odd months—the first, third, fifth, and so on, should contain 31 days, and the even numbers 30 days, except in the case of February, which was to have 30 only in what has been improperly termed leap-year, while on other years it was assigned 29 days only; a number which it retained till Augustus Cæsar deprived it of another day.

The commencement of the year, till a comparatively very recent period was the subject of no general rule The Athenians commenced it in June, the Macedonians in September, the Romans first in March, and afterwards in January, the Persians on 11th August, the Mexicans on 23d February, the Mohammedans in July, and astronomers at the vernal equinox. Amongst Christians, Christmas day, the day of the Circumcision, the 1st of January, the day of the Conception, the 15th of March, and Easter day, have all been used at various times, and by various nations as the initial day of the year. Christmas day was the ecclesiastical beginning of the year till Pope Gregory XIII., on reforming the calendar, ordered it, in 1582, to begin thenceforward on the 1st of January. In France and England the same practice commenced about the same time; but, in the latter country, it was not till 1752 that legal writs and instruments ceased to consider the 25th of March, as the beginning of the year. In Scotland, New Year's day was altered both for historical and legal purposes, from the 25th of March to the 1st of January, by a proclamation of King James VI., in the year 1600. The English plan was found exceedingly inconvenient; for when it was necessary to express a date between the 1st of January, which was the commencement of the historical year, and the 25th of March, which opened the legal one, error and confusion were sure to occur, unless it were given in the following awkward fashion—January 30, 1648-9, or 164$\frac{8}{9}$. Even this was apt to lead to mistakes; and it is perhaps, even to this day, a matter of doubt with some intelligent persons whether the execution of Charles I., of which the above is the usual appearance of the date, occurred in the year 1648 or 1649; it in reality occurred in the year which, by our present uniform mode of reckoning, would be called 1649.

The present mode of reckoning time has experienced no interruption, in its leading features, for many years, except under the French republic. In September, 1793, the French nation having resolved that the foundation of their new system of government should form their era, instead of the birth of Christ, whose religion they had in a great measure shaken off, resolved also that a calendar should be adopted on what were termed philosophical principles. The Convention, therefore, having decreed, on the 24th November, 1793, that the common era should be abolished in all civil affairs, and that the new French era should commence from the foundation of the republic, namely, on the 22d September, 1792, on the day of the true autumnal equinox, ordained that each year henceforth should begin at the midnight of the day on which the true autumnal equinox falls. This year they divided into twelve months of thirty days each, to which they give descriptive names, as follow:—from the 22d of September to the 21st of October was Vendémiaire (Vintage Month); to the 20th November was Brumaire (Foggy Month): to the 20th December was Frimaire (Sleety Month;) this completed the autumn quarter; to the 19th January was Nivose (Snowy Month); to the 18th February was Pluviose (Rainy Month); to the 20th March was Ventose (Windy Month); which completed the winter quarter; to the 19th April was Germinal (Budding Month), to the 19th May was Floreal (Flowery Month); to the 18th June was Prairial (Pasture Month); here ended the spring quarter; to the 18th July was Messidor (Harvest Month); to the 17th August was Fervidor or Thermidor (Hot Month); to the 16th of September was Fructidor (Fruit Month), which terminated the period of summer. In ordinary years there are five extra days, namely, from the 17th to the 21st of our September, inclusive; these the French called *Jours Complementaires*, or *Sanscullotides*, and held as festivals; the first being dedicated to Virtue, the second to Genius, the third to Labour, the fourth to Opinion, and the fifth to Rewards. At the end of every four years, forming what they called a Franciade, occurred a leap-year, which gave a sixth complementary day, styled *La Jour de la Revolution*, and employed in renewing the national oath to live free or die. The *week*, though not exclusively a Christian or Jewish period of time, they also abjured. The thirty days of the month were divided into three parts of ten days each, called *Decades*; of which the first nine (called Primidi, Duodi, Tridi, Quartidi, Quintidi, Sextidi, Septidi, Octidi, Nonidi) were working or common days, while the tenth, styled Decadi, was observed as a kind of Sabbath, though not exactly in the Jewish sense of the word. The French, however, in indicating any particular day, either by word or writing, generally mentioned only the number of the day of the month. The Republican Calendar was first used on the 26th of November, 1793, and was discontinued on the 31st of December, 1805, when the calendar used throughout the rest of Europe was resumed.

CYCLES.

A cycle is a perpetual round or circulating period of time, on the completion of which certain phenomena return in the same order, the end being thus, as it were, brought back to the beginning. Under such a definition, the common practice of accumulating years into centuries has, of course, no title to be classed; it is merely an arithmetical computation, like the equally common mode of counting by tens—forming, indeed, part of the same system.

The *Solar Cycle* is a period of 28 years, during which the day of the month, in every succeeding year, falls on a different day of the week from the first, till the cycle is completed; when the days of the month and week meet as at first, one cycle corresponding to another. By this cycle, which has no relation to the sun's course, we find "the Dominical letters," or those letters among the first seven in the alphabet (used to represent the days of the week) which point out the days of the month on which the Sundays fall during each year of the cycle. If there were 364 days in the year, the Sundays would happen every year on the same days of the month; if 365 exactly, every 7th year; but because the additional fractional period contained in the year makes an alteration of a day in every 4th year, the cycle extends to four times seven, or 28 years.

The first solar cycle in the Christian era having begun 9 years before the commencement of that era, to discover what year of the cycle the year 1842 forms, we must add 9, and divide the sum 1851 by 28, the period of the cycle, and the quotient 66 is the number of solar cycles that have passed during that era, the remaining 3 being the year of the cycle corresponding to 1842.

The *Lunar Cycle*, also called the "Golden Number," from its having been written in letters of gold by the Greeks, and the "Metonic Cycle," from its having been discovered by Meton, an Athenian astronomer, is a period of 19 years, at the end of which the phases of the moon occur on the same days of the civil month as in a previous lunar cycle, and within an hour and a half of the same precise moment of time.

The first lunar cycle in the Christian era having begun one year before the commencement of that era, to discover what year of the cycle 1842 forms, we must add 1, and divide the sum 1843 by 19, the period of the cycle, and the quotient 97 is the number of lunar cycles that have passed during that era: there being no remainder, the golden number is completed in 1842; or that year forms the last in the cycle.

The *Dionysian Period* is a combination of the solar and lunar cycles, forming, by the multiplication of 28 by 19, a period of 532 years, at the expiration of which it is again new moon on the same days of the week and month as before: chronological events are compared and tested by such a calculation.

The *Indiction* may here also be noticed; though, were it not for severing it from the other cycles with which it is connected in the Julian period, it might perhaps more properly appear under the head of epochs and eras. This was a Roman period of 15 years, the first of which commenced in the year 312 after the birth of Christ. It was appointed merely for the regulation of certain payments by the subjects of the empire; but it came to be observed by the Greek church and the Venetian senate, as well as the court of Rome.

The *Julian Period* is a combination of the solar and lunar cycles with the Indiction; the respective periods of 28, 19, and 15 years being multiplied by each other, and the product 7980 years, being what is called the Julian Period, during which there cannot be two years having the same numbers for the three cycles; but at the termination of this period they return in the former order.

The year 1842 is the 6555th of the Julian period; hence it began about 700 years previous to the date vulgarly assigned to the creation of the world, and has been used instead of that era, to obviate the disputes of chronologers, and to reconcile their systems; for all agree as to the year in which the Julian period began.

The *Precession of the Equinoxes*, on the supposition that the motion on which it depends is uniform, is a cycle of 25,920 years, during which the points whereat the sun crosses the equator at the equinoxes retrograde along the whole circle of the ecliptic, and return to their former position. The present rate of this motion, which depends on the solar and lunar attraction of the quantity of matter heaped up along the region of the equator, is 50 seconds of a degree yearly, or a whole degree in 76 years.

Sir Isaac Newton endeavoured to fix the period of the Argonautic expedition by this cycle, and it has given rise to some curious and interesting speculations regarding the period when the signs of the zodiac were invented.

The *Ecliptical Cycle* is an unknown period of time during which the angle between the ecliptic and the equator, or the obliquity of the ecliptic, has completed all its changes. The present rate of the diminution of the obliquity is estimated at about 48 seconds of a degree every century. The extent of this change on either hand, like the length of the period in which it is accomplished, is at present unknown, though astronomers, founding on elements with regard to which there admittedly exists "great uncertainty," suppose the extent of the "oscillation" to be very limited. The degrees of ecliptical obliquity at present existing in the *different* planets, however, so far as known, vary from a state in which it almost vanishes in the entire coincidence of the ecliptic with the equator, as in Jupiter, to one in which it is almost "wide as the poles asunder," as in Uranus. The ascertainment of the extent of this movement, in the case of the earth, is of great practical importance, especially in geological chronology. The changes of the seasons are occasioned by the obliquity of the ecliptic, being more or less extreme according to the greater or less degree or extent of that obliquity; and, from certain recent discoveries in geology, which seem to imply the former increase of these extremes, coincidently with the former increase of the obliquity of the ecliptic, it appears highly probable that the hiththe hopeless problem of a *geological chronology*, in its most comprehensive sense, by a "conversion of astronomical into geological periods"—a problem proposed a few years since as the subject of a prize essay by the Royal Society of London—will receive its complete solution from the movements of this great ecliptical pendulum.

CHRONOLOGY.

The subject to which we have here found it advantageous to limit the use of the term Chronology, as more or less involving the occurrence of events in the world's history, may be divided into the two following branches:—

EPOCHS AND ERAS.

The principal difficulty which must have presented itself to nations desirous of preserving the memory of events, as they might occur, in their annals, from day to day, from month to month, and from year to year, and for long periods of years, would be to obtain a starting point from which to number these days, months, years, and periods of years; and as no very marked astronomical event (unless, perhaps, eclipses) could render one of these starting points preferable to another, such starting points came practically and generally to consist, in early times, when nations had little mutual intercourse, of some event, important or known, perhaps, only to the nation dating from it. This event would form *an epoch*, so named from a Greek word signifying to stop. The enumeration and series of years computed from an epoch is called an *era*; and accordingly of epochs and eras there have been almost as many as there have been of nations. As the eras of ancient nations, however, have become obsolete, it would be useless, as it is here impossible, to enumerate all that we know of, or even any great number of them. But we shall notice a few of the most important in the mean time, reserving the names of all the other principal eras to be afterwards presented together in a tabular form.

The *Era of the Olympiads* is the first on record, and it also became the most celebrated of the ancient methods of computing lengthened periods of time. It took its rise among the Greeks, 776 years before the birth of Christ. Public games had been instituted at Olympia, a city in Elis, which took place every fifth year, at the recurrence of the full moon after the summer solstice, namely, about the beginning of our July. As this festival made a great impression on the public mind, the people began to reckon by Olympiads, or recurrences of the Olympic games, an Olympiad comprising four years. The computation by Olympiads ceased after the 364th Olympiad in the 440th year after the birth of Christ, as usually computed, though the epoch of the birth of Christ is not a point of time exactly fixed. The Greeks lately adopted a new era, called

The *Era of Seleucus*, or the *Seleucidæ*, sometimes also called the era of Alexandria. This era commenced twelve years after the death of Alexander the Great, at the first conquest, by Seleucus Nicator, of that part of the west which afterwards formed the immense empire of Syria. This era has also prevailed, and still exists, amongst the people inhabiting the Levant. The Jews reckoned by it till the 15th century of the Christian era, when they substituted the supposed era of the Creation, to be afterwards noticed; and they still begin their year according to it, in the months of September or October.

The *Roman Era* was reckoned by the Romans from the epoch of the foundation of their famous city Rome, an epoch now precisely ascertained to have corresponded to the 753d year before the birth of Christ. The computation of time by the Roman era ceased in the sixth century of the Christian era.

The *Christian Era*, of which we now live in the eighteen hundred and forty-second year, was not adopted as a mode of time-reckoning immediately after the commencement of Christianity. That religion existed long in a very obscure way; and the date of the birth of its founder did not, for several centuries, become a sufficiently important event in the eyes of enlightened nations to cause them to make it an era. The era of the Olympiads, the Roman era, the era of Seleucus, and the dates of ecclesiastical councils, and other events then considered of importance, were the common modes of reckoning, and continued partially to be so till a period less remote than many people suppose. Even in Italy and its celebrated capital, Rome, which became the chief seat of Christianity at a very early period, this era was not used till the sixth century. It was introduced into France in the seventh, but not fully established till the eighth. In Spain, though occasionally adopted in the eleventh, it was not uniformly used in public instruments till after the middle of the fourteenth, nor in Portugal till about the year 1415. Now, however, all nations professing Christianity have abandoned other eras, and confined themselves to this; using the Latin words *Anno Domini*, "the year of our Lord," or their initial letters, A. D., to distinguish it; while for all dates previous to the generally received epoch of the era, the words *Anno ante Christum*, "the year before Christ," their abbreviation, A. A. C., or even more usually the letters B. C., signifying "before Christ," are used.

The *Era of the Hegira* commences at the epoch of the flight of Mohammed from Mecca to Medina, which took place on the 16th day of July, A. D. 622. The Mohammedan year is regulated by this event, and hence it is used by the Turks, Arabs, and other Mohammedans, comprising a large portion of the modern population of the world.

The *Mundane Era*, or era of the creation of the world, has been the subject of much controversy. No less than 300 different opinions, according to Kennedy, in his "Scriptural Chronology," have been entertained regarding the period which elapsed between the creation and the incarnation. Some have made it 3616 years; others 6484. From the creation to the deluge, the computation of the Hebrew text makes a lapse of 1656 years; the Samaritan version only 1307; the Septuagint 2262. No ancient chronologist attempted to fix the epoch of the creation: some conceived it impious to do so. In modern times, the impiety has been supposed to lie all the other way. But some enlightened commentators have been bold enough to return to the ancient orthodox idea, so far, at least, as to maintain that the Scriptural epoch of the creation is indefinite, being merely cursorily alluded to in the words, "In the beginning God created the heavens and the earth." Geologists, in general, also adopt this wide interpretation. In the authorized version of the Bible, however, the chronology usually given places the epoch of the creation in the year 4004, B. C. Thus, A. D. 1 is A. M. 4004; the letters A. M. being used as an abbreviation of *Anno Mundi*—"year of the world."

Years of Principal Eras Correspondent to 1812.

		YEARS.	ABBREV.
Era of Creation (Constantinopolitan account),	- - - -	7350	A. M. Const.
Era of Creation (Alexandrian account).		7334	A. M. Alex.
Era of Creation (Jewish account), 7th Thebet.	- - - -	5602	A. M.
Julian period.	- - - -	6555	Jn. Per.
Caliyug (Hindoo),	Poos or Margaly,	4943	Cal.
Era of Abraham.	4th month of	3857	Ær. Abr.
Olympiads.	7th month 1st year of	654	Olymp.
Era of Rome.	- - - -	2594	A. U. C.
Era of Nabonassar,	8th month of	2590	Ære Nab
Egyptian era.	- - 24th Cohiac.	2588	A. Æg.
Era of Death of Alexander,	3d month.	2165	A. Mort. Alex.
Spanish, or era of the Cæsars.	-	1880	A. Cæs.
Dioclesian, or era of Martyrs.	24th Cohiac.	1558	Æ. Diocl.
Hegira.	- - - 7th Regeb.	1257	A. H.
Chinese year,	39th year of 71st cycle of 60 years		

TABULAR CHRONOLOGY.

Under this head the leading events, phenomena, or facts, recorded in history, are arranged in the order of time in which they have occurred—that is, in chronological order.

BEFORE CHRIST.

Twilight of history previous to B. C. 3000. But fabulous or doubtful till about 1200, or the period of the Trojan war. Homer lived at about 1000 B. C. Fall of Assyrian empire, 900.

800.—Chaldeans in Mesopotamia—Reckoning by Olympiads, 777. New Assyrian empire—Rome founded, 753 (according to Newton, 627). Æthiopians in Egypt—Syracuse—End of kingdom of Israel—Babylonian Assyrian empire—Epoch of era of Nabonassar, 747. Grecian colonies in Italy.

700.—Draco in Athens—Nebuchadnezzar—Invasion of Upper Asia by Scythians, 635. Zoroaster in Persia.

600.—Babylonish Captivity, 588. Cyrus, king of Persia, conquered the Medians, 546. Pythagoras flourished, 539. Cyrus took Babylon, 538. Return of Jews, 536. Pindar, 518. Parmenides—Heraclitus—Anaxagoras, 500.

500.—Sophocles, 495. Tribunes and Ædiles at Rome, 493. Herodotus born, 484. Euripides, 480. Thucydides, 471. Athenian ascendancy, 477. Socrates born, 468. Zeno, 464. Xenophon born, 444. Isocrates born, 436. Metonic cycle began, 432. Peloponnesian war began—Hippocrates flourished, 431. Plato born, 429. Aristophanes flourished, 427. Diogenes born, 413. Athens taken, 404. Retreat of 10,000 Greeks, 401.

400.—Aristotle born, 384. Demosthenes, 382. Lacedæmonians expelled from Thebes, 379. Epaminondas—Thebans in Greece (till 362), 371. Prætors at Rome, 365. Alexander the Great born—Dionysius expelled from Syracuse by Dion—Theopompus flourished, 356. Menander born, 342. Epicurus, 341. Macedonian ascendancy, 338. Thebes destroyed by Alexander, 335. Persia invaded, 334. Syria and Egypt conquered, 332. Death of Alexander—His empire divided, 323. Ptolemy carried 100,000 Jews into Egypt, 320. Alexis flourished, 310. Restoration of Thebes, 315. Seleucus in Babylon—Era of Seleucus began, 312. Sun-dials in Rome—Time divided into hours, 308. Athenian democracy restored, 307. Ptolemy took Lybia, Egypt, and Palestine; Cassander took Macedonia; Lysimachus took Thrace and Bithynia; and Seleucus took Syria with most of Upper Asia, all about this period.

300.—Chrysippus born, 280. Gauls driven out of invaded Greece into Asia—Zeno of Citium, Strato, and Epicurus flourished, 278. Silver first coined at Rome, 269. First Punic war, 265. Regulus put to death, 250. Antiochus the Great, king of Syria—Second Punic war—Hannibal passed the Alps, 218. He defeated the Romans at Thrasymene, 217; at Cannæ, 216. Archimedes's screw invented—Archimedes killed, 212. Polybius born, 206. Plautus flourished, 204. Hannibal defeated by Scipio at Zama, 202. First Macedonian war, 201.

200.—Second Macedonian war, 172. Macedonia a Roman province, 168. Jews delivered from Syrians, 166. Water clocks or clepsydræ used in Rome, 158. Third Punic war, 149. Carthage destroyed—Corinth destroyed—Greece a Roman province, 146. Lucilius flourished, 121. Romans defeated by Cimbri and Teutones; 80,000 Romans killed, 104. Teutones defeated by Marius; 200,000 killed and 80,000 taken prisoners, 102. Cimbri defeated by Marius and Catullus; 120,000 killed and 60,000 taken prisoners—Julius Cæsar born, 100.

100.—Livy born, 93. Mithridatic war, 88. Marius took Rome, 87. Sallust born, 86. Sylla, Roman dictator, 82. Lucretius flourished, 67. Conspiracy of Cataline—Palestine conquered, 63. First triumvirate, 60. Cæsar's wars in Gaul began, 58. His expedition to Britain, 55, 54. Rome contained 320,000 citizens, 50. Cæsar's war with Pompey began, 49. Cæsar declared Father of his Country, Emperor, and Perpetual Dictator—Adjusted the Calendar, 45. Was assassinated—Diodorus Siculus flourished, 44. Second triumvirate, 43. Death of Brutus and Cassius, 42. Herod, king of Jews, 40. Death of Antony and Cleopatra, 30. Cæsar Augustus declared Emperor—Virgil, Horace, Ovid, Gallus, Pollio, Varius, Tibullus, Propertius, and Phædrus flourished, 27. Cornelius Nepos died—Coin first used in Britain, 25. Victories of Drusus in Gaul, 12. Seneca born, 8. Dionysius of Halicarnassus flourished, 4. Jesus Christ born, 0; sometimes held to be four years sooner.

ANNO DOMINI (YEAR OF OUR LORD).

1.—Death of Augustus, 16. Crucifixion, 33. Conversion of Saul, 36. Tiberius died, 37. Name of Christians given at Antioch, 40. Caligula assassinated, 41. London built or improved by Romans, 50. Claudius died, and Nero succeeded him, 54. Christianity introduced into Britain, 60. Boadicea defeated the Romans, and was defeated by them, 61. Pliny died, 66. Jerusalem destroyed, 70. England conquered by Agricola, 78. Herculaneum and Pompeii destroyed by an eruption of Vesuvius, 79; and not rediscovered till 1730. Valerius Flaccus flourished—Agricola defeated the Caledonians or Scots, 84. Epictetus the Stoic and Juvenal flourished, 90. Persecution of Christians under Domitian, 91. Tacitus and Pliny the Younger flourished, 96. Suetonius—Plutarch.

100.—Adrian entered Britain—Roman empire extended to Euphrates in Asia, 117. Jerusalem destroyed, 118. Temple of Jupiter erected at Jerusalem by Adrian, 130. Ptolemy, Claudian, Arrian, and Antoninus Pius flourished, 138. Apuleius, Marcus Aurelius, Galen, and Appian, 161. Goths in Dacia, 180. Pertinax, Septimus Severus, and Didius Julianus, 193.

200.—Tertullian, Philostratus, Emelius, and Papinian flourished, 202. Wall of Severus built in Britain, 209. First notice of Germans, Upper Rhine, 213. Heliogabalus, 218. Julius Africanus, chronologer, 220. Origen, Dion Cassius, Herodian, 2[illegible]. Artaxerxes, king of New Persian empire, 236. First notice of Franks, Lower Rhine, 250. Goths in Thessaly, 251. Vandals—Germans in Ravenna, 260. Franks in Gaul, 263. Goths repelled by Odenatus, king of Palmyra, 264. Scythians and Goths defeated by Romans, 267. Silk manufactures first brought from India into Europe, 274 (according to other authorities, 551). Visigoths and Ortrogoths in Dacia, 275. Germans expelled from Gaul by Probus—Franks also defeated, 277. Epoch of Dioclesian era, 284.

300.—Constantine the Great embraced Christianity, 306. Lactantius flourished, 311. Sunday appointed to be observed by Christians, 321. Western and eastern provinces united, 323. Council of Nice, 325. Seat of empire transferred from Rome to Constantinople, 330. Jamblicus, 342. Franks in Gaul, 350. In Greece and Asia, 150 cities destroyed by an earthquake, 358. Julian the Apostate killed, 363. Roman law against magicians, 364. Theodosius subdued Britain, 368.

400.—Germans in Helvetia, 407. Vandals in Spain, 409. Alaric plundered Rome, 410. Honorius relinquished Britain, 412. Vandals in Africa, 429. Atilla in Upper Italy—Foundation of Venice, 452. Hengist, the Saxon, founded the kingdom of Kent, 457. Romans expelled from Spain by Visigoths, 468. Hebrew points invented, 475. Western Roman empire overthrown, 476. Visigoths paramount in Gaul, 477. Ælla founded the kingdom of Sussex, 490. Ostrogoths conquered Italy, 493. Silk-worms brought into Europe—Clovis baptized, 496.

500.—Visigoths subdued, and Franks established in Gaul (now France) by Clovis, 508. Heptarchy in England, 559. Columbus propagated Christianity amongst the Picts, 565. Lombardy a kingdom, 568. Mahomet proclaimed Islamism, 569. Latin ceased to be spoken in Italy about 581. Leovigold, the Visigoth, victorious in Spain, 585. St. Augustine in England, 597.

600.—Supremacy of Pope first obtained, 607. Jerusalem taken by Persians, who killed 90,000 persons, 614. The Hegira, 622. Parishes in England first laid out, 640. Saracens in Persia, 651. Glass first in England, 663. Britons retreated before Saxons into Wales and Cornwall, 685. Money first coined by Arabians, 695. Saracens in Carthage—Doges in Venice, 698.

700.—Arabs in Spain, 714. Pepin, king of France, 752. Temporal dominion of the Popes began, 755. Franks in Lombardy, 774; and in Saxony, 785. Haroun al Raschid, 786. Danes landed in England, 787.

800.—Charlemagne crowned Roman emperor—Leo III.—Scholastic philosophy—Arabs advanced in science—Clocks made to strike by the Arabs, and introduced into Europe from the East, 801. Charlemagne conquered the Saxons, 803; and the Sorbes and Vandals, 806; died, 814. Ecclesiastics exempted from military service, 817. Egbert, king of England, 827. Schism of Greek Church, 853. Navarre founded, 855. Feudal system introduced into France by Charles the Bald, 877. Aldermen first appointed, 882. Alfred expelled the Danes from England, and divided it into counties, 890–93. First land-tax in England, 891. Rome taken by Arnolph of Germany, 896.

900.—France ravaged by the Normans, 903. War with the Danes in England for 12 years, 910. Saracens defeated in Spain, 70,000 killed, 910. Hungarians defeated in Germany, 933. Bible translated into German, 939. Arithmetical figures introduced into Europe by the Arabians, 941 (or 991). Italy united to Germany by Otho the Great, 964. Bohemia subdued by Otho II., 977. Capet family ascended the throne of France, 987. Invasion of England by the Normans, 990; and by the Danes, 994. Empire of Germany declared elective by Otho III., 996.

1000.—Canute, king of Denmark, on throne of England, 1014. Moors in Spain, 1038. Edward the Confessor, 1042. Battle of Hastings—William of Normandy conquered England—Probable beginning of tournaments, 1066. Henry IV. deposed by Pope Gregory VII. (Hildebrande), 1076. Domesday-Book begun, 1080; finished, 1086. William the Conqueror invaded France. Origin of Crusades, 1095. First Crusade, 1096. Capture of Jerusalem—Institution of Knights of St. John, 1099.

1100.—Coins first made round in England, 1101. Surnames introduced, 1102. Henry I. united Normandy to England, 1106. Louis VI. of France fostered corporations as a security against feudal lords, 1108. Order of Knights Templars instituted, 1119. Second Crusade, 1147. Plantagenets ascended English throne, 1154. Henry II. conquers Ireland, 1172. Glass windows first used in England for houses, 1180. Kingdom of Jerusalem destroyed by Saladin, 1187. Third council under Richard Cœur de Lion, Frederick I., and Philip II., 1189. Knights of Teutonic order instituted, 1090. First mention of mariner's compass (except in China)—Universities established—Chimneys first used in England, 1200.

1200—Towns and cities first incorporated, 1201. Fourth Crusaders; under Boniface, took Constantinople, 1203. Inquisition originated at Languedoc, 1204. Gengis Khan—Mogul empire—Paris university, 1206. Roger Bacon, 1214. Fifth Crusade, 1217. Magna Charta, basis of English constitution obtained, 1215. First Parliament in England, 1216. Switzerland a province of the German empire, 1218. Astronomy and geography introduced by the Moors into Europe, 1220. Hungarian constitution—States Parliament of France—University of Salamanca, 1222. Thomas Aquinas, 1224. Sixth Crusade, 1228. Coals discovered at Newcastle, 1234. Moguls took Moscow, 1236. Guelphs and Gibellines desolated Italy about 1239. Mogul empire—Seventh Crusade, 1248. Magic lantern invented by Roger Bacon, 1252. Alphonso, King of Castile, constructed his celebrated astronomical tables—Linen first made in England, 1253. Caliph of Bagdad destroyed by Moguls, 1258. Magnifying-glasses invented by Roger Bacon, 1260. Dante born, 1265 (died 1321). China subdued by Moguls, 1279. Coals first dug at Newcastle under charter of Henry III., 1280. Sicilian vespers—10,000 French massacred, 1282. Candles of tallow first used instead of splinters of wood, about 1290 (wax candles about 1300). End of Crusades, 1291. Edward of England overran Scotland, 1296. Spectacles invented, 1299.

1300.—Raymond Lully—Princes Royal of England, eldest sons, created Princes of Wales, 1301. Cambridge University founded, 1302. Bills of exchange first used in England, 1307. William Tell—Helvetic confederation, 1308. Rhodes taken by Knights of St. John, 1310. Templars suppressed, 1312. Battle of Bannockburn, 1314. Paper made from linen rags, 1319. Robert Bruce—Scotland independent, 1328. Gunpowder made by Schwartz, a German, 1330. Cloth weaving introduced into York by two Brabant weavers, 1331. Blankets first made in England, 1340. Petrarch, 1341. Gunpowder in France—Fire-arms—Cannons—Canary isles discovered by Genoese, 1345. Order of Garter founded, 1349. Tamerlane in Persia, 1350. Turks in Europe, 1361. Cities and boroughs first represented in Parliament in England, 1366. John Wickliffe, reformer in England, 1369. Stewarts on Scottish throne, 1371. Invasion of England by French, 1377. Schism of double Popes, which lasted 38 years, 1378. Wat Tyler's insurrection, 1381. Geoffrey Chaucer died, 1396.

1400.—John Huss, Wickliffe's disciple, in Bohemia—Death of Tamerlane, 1405. Oil painting invented by John Van Eyck, 1410. Gunpowder made in England, 1413. Council of Constance, 1414. John Huss burnt—French defeated by English at Agincourt, 1415. Gipsies or Bohemians in Europe, 1417. Madeira discovered, 1418. Metal engraving and rolling-press printing invented, 1423. Maid of Orleans burnt, 1430. Azores discovered by Portuguese, 1432. PRINTING IN BLOCKS INVENTED BY FAUST, 1440; AND IN TYPES, BY JOHN GUTTENBERG, 1444. Slave-trade begun, 1442. Cape de Verd islands discovered, 1444. First standing army in modern ages established in France—Wars of the Roses, 1445. Inundations at Dort: 100,000 persons drowned, 1446. English evacuated France, 1453. Great earthquake at Naples, 1456. Glass first manufactured in England, 1457. First printed book, Vulgate edition of the Bible, 1462. First almanac, 1470. Printing in England by Caxton, a mercer in London, 1471. Lorenzo de Medici, 1472. Watches made at Nuremberg—Violins invented, 1477. Inquisition established in Spain, 1478. Union of Castile and Arragon, 1479. Fall of Tartar dynasty in Russia, 1481. Tudors ascend the English throne—York and Lancaster united, 1485. Cape of Good Hope discovered, 1486. Maps and sea-charts first made in England—Diamonds polished at Bruges, 1489. COLUMBUS DISCOVERED AMERICA, 11TH OCTOBER, 1492. Diet of Worms, 1495. Cabot discovered Newfoundland, 1496. Americus Vespucius landed on North America, 1497. The Portuguese reached the East Indies by sea, 1498. Moors expelled from Castile, 1499. Cabot discovered Florida, 1500.

1500.—Shillings first coined in England—Distaff spinning introduced from Italy, 1505. Brazils discovered—Spaniards in Cuba, Jamaica, Porto Rico, 1508. Battle of Flodden, 1513. Luther flourished (born 1483, died 1546)—Turks in Syria and Egypt, 1517. First voyage round the world by Magellan, 1518–1519. Conquest of Mexico, 1521. Conquest of Chili, 1523; of Peru, 1528. Death of Ariosto, 1533. Henry VIII. head of Church of England—Bible translated into English by Tindal and Coverdale, 1534: by king's authority, 1536. Death of Erasmus, 1536. Suppression of religious houses in England and Wales, 1539. John Calvin—Reformation at Geneva—Variation of the compass observed by Cabot. Mortars and iron cannon first made, and iron first cast in England—Death of Copernicus (born 1473), 1543. Council of Trent—Needles first made in England, 1545. Orange trees introduced from China into Portugal, 1547. Telescopes invented, 1549.

1550.—Crowns and half-crowns first coined, 1551. Books on astronomy and geometry destroyed in England as magical, 1552. Death of Melancthon (born 1497)—Knox—Scottish Reformation, 1560. Knives first made in England—Potatoes introduced from America, 1563. Belgic refugees establish manufactures in England, 1567. Massacre of Bartholomew, 1572. Portugal and Spain united—Drake sailed round the world—Parochial registers established in England—Coaches first used there, 1580. Declaration of independence by united provinces—Gregorian calendar, 1581. Tobacco brought to England, 1583. Turks in Crimea, 1584. Greenland discovered, 1585. Potatoes introduced into Ireland, 1586. Mary Queen of Scots put to death, 1587. Spanish Armada destroyed—First newspaper published in England, titled "English Mercury," and now in British Museum (dated 28th July), 1588. Edict of Nantz—Mauritius discovered, 1598. East India Company established, 1600.

1600.—Dutch East India Company established, 1602. Union of English and Scottish crowns, 1603. Gunpowder plot, 1605. Protestant German states united—Satellites of Jupiter and Saturn and spots on sun discovered, 1608–10. Moors, 900,000 banished out of Spain, 1610. Baronetcies instituted, 1611. Napier—Logarithms invented, 1614. A steam-engine invented by Savary, 1618. Thermometers invented, 1620. English in Barbadoes, Bermuda, Antigua, Providence, Anguilla, and West Indies, 1625. Bacon (born 1560) died 1626. Saturn's ring discovered, 1634. Galileo condemned by inquisition, 1634. Utrecht University founded, 1636. Portugal and Spain dismited—Braganza—Long Parliament in England opened, 1640. Coffee first used in England, 1641. Toricelli's barometer invented, 1643. Tartar revolution in China, 1644. Air-guns invented, 1646. Charles I. beheaded—Cromwell—Commonwealth, 1649.

1650.—Quakers in England, 1651. Cromwell Protector—Milton (born 1608, died 1674), 1653. Air-pump invented, 1654. Independence of Prussia—Huygens—Saturn's 4th satellite discovered by him, 1655. Royal Society of London established, 1663. English in Bombay—Fire-engines invented, 1663. Great plague in London, 1665. Great fire in London, 13,200 houses in 400 streets burned, 1666. Bayonets invented at Bayonne—Cabinet council first instituted, 1670 (first in England, 1693). Halfpence and farthings first coined by government in England, 1672. Spinosa died, 1677. Habeas Corpus Act passed, 1678. Penny Post in London, 1681. Philadelphia founded by William Penn, 1682. Lord Russel beheaded, 1683. Saturn's 1st and 2d satellites discovered by Cassini, 1684. Revocation of Edict of Nantz—Massacre—50,000 reformed quit France, 1685. Newtonian philosophy published, 1686. Telegraphs invented, 1687. Revolution in England—William III., Prince of Orange, landed there—Flight of James II.—Smyrna destroyed by an earthquake, 1688. Toleration act passed—Episcopacy in Scotland abolished, 1689. White paper first made in England—English in Calcutta—Battle of Boyne, 1690. Termination of war in Ireland, 1691. Massacre of Glencoe—Earthquake in England and Jamaica, 1692. Bank of England established and incorporated, 1693.

1700.—Prussia a kingdom, 1701. Petersburg founded, 1703. English in Gibraltar—Marlborough—Battle of Blenheim, 1704. Parliaments of England and Scotland united—Battle of Ramillies, 1706. Stereotype printing in Leyden, 1709. St. Paul's rebuilt—Peace of Utrecht, 1713. George I., Elector of Hanover, ascended the throne of Great Britain—Guelph dynasty, 1714. First Septennial Parliament in England opened—Inoculation at Oxford—Rebellion in Scotland—Battles of Sheriffmuir and Preston—Fahrenheit's mercurial thermometer invented, 1715. Triple alliance; Britain, France, and Holland—Law's Mississippi scheme—Great Earthquake in China—South Sea Scheme, 1720. Peter the Great took the title of Emperor of all the Russias, 1721.

1725.—Academy at Petersburg founded—Coffee trees carried to the West Indies, 1726. Aberration of fixed stars discovered by Bradley, 1727. Gold and diamond mines of Brazil discovered—Thermometer improved by Reaumur, 1730. Porteous mob in Edinburgh, 1736. Herculaneum and Pompeii re-discovered, 1738. Nadir Schah—Fall of Moguls, 1739. (War of Austrian succession till 1748). Stereotype practised at Edinburgh by William Ged, goldsmith, 1740. Behring's voyage, 1741. Anson's voyage round the world, 1744. Battle of Fontenoy—Prince Charles Edward landed in Scotland; is victorious at Prestonpans; and enters England, 1745. Defeat of Prince Charles at Culloden—Electric shock discovered at Leyden—Lima destroyed by an earthquake, 1746. Peace of Aix la-Chapelle, 1748. Thermometer improved by Fahrenheit, 1749.

1750.—Artificial magnets invented in England, 1751. Lightning rods—Franklin—Identity of electricity with lightning—new style adopted in Britain, 1752. British Museum established, 1753. Powerful eruption of Ætna—Lisbon and Quito destroyed by earthquakes—English in Bengal, 1755. (Pitt (Chatham) Prime Minister of England till 1761). Black Hole at Calcutta, 1756. British empire in India firmly established by capture of Surat—Quebec and Guadaloupe taken—Death of Wolfe, 1759. Jesuits expelled from France—Platina discovered—Diving-bell improved—Hyder Ali, 1760. Peace of Paris—France ceded to Britain Canada, Cape Breton, St. Vincent, St. Domingo, Tobago, and the coast of Senegal—Pottery improved by Wedgewood, 1763. Longitude calculated by Harrison's time-piece, 1764. Taxes increased in British America—Opposition, 1764–74. Napoleon Bonaparte born at Ajaccio in Corsica, 15th August, 1768. Steam-engine improved by Watt, at Glasgow, 1770. Cook's first voyage round the world, 1771. First partition of Poland, 1772. Congress of 12 British provinces at Philadelphia—Boulton and Watt's steam-engines, 1774.

1775.—War of American independence—Washington leader, 1775. United States declared independent (4th July), 1776. France allied to the United States—Siege of Gibraltar, when red hot bullets were first used, 1778. Eruption of Mount Vesuvius, 1779. Discovery of Uranus by Herschel, 1781. Independence of the United States acknowledged by Britain, 30th November, 1782. Montgolfier's balloon—Lunardi's balloon in England—Convicts first sent to Botany Bay—German League—Financial distress in France at its height—Discovery of 2d and 4th satellites of Uranus by Herschel, 1787. Massacre of 10,000 Chinese in Formosa, 1788. FRENCH REVOLUTION—Discovery of 6th and 7th satellites of Saturn, by Herschel, 1789. Suppression of nobility, religious orders, monasteries, &c., and destruction of Bastile—Mirabeau—Issue of 600,000,000 assignats, 1790. At Constantinople 32,000 houses destroyed by an earthquake; shock at Lisbon and in Scotland—First census of United States, 3,929,536 inhabitants, 1791. French Republic, 1792. Louis XVI. of France beheaded—Reign of Terror—Robespierre—Great Britain and the German empire, Prussia, Holland, Portugal, Spain, Sardinia, the two Sicilies, and the Pope, all against France—Napoleon Bonaparte then a lieutenant of artillery—Marie Antoinette beheaded—New French era established, 1793. French victorious by land; British by sea—Reign of Terror continued—Robespierre dictator, until revolution of 9th Thermidor (July 27th); put to death July 28th—Moderates in power in France—Revolution in Poland—Kosciusko—Conquest of Netherlands—Punishment of Muir, Palmer, Skirving, Gerrold, and Margarot in England for reform agitation, 1794. Suppression of Stadtholdership in Low Countries—General Bonaparte victorious in Italy—French in Holland and Stadtholder in England, 1795. National Institute of Paris founded—Bonaparte crossed the Alps—Attempt of French to land in Ireland—Battle of Lodi, &c., 1796. Jenner; vaccination introduced—Rebellion in Ireland—Mutiny at the Nore—Bonaparte victorious over three Austrian armies—Revolution of 18th Fructidor—Bonaparte received by Directory with great distinction—Battle of St. Vincent—Suspension of specie payments in Bank of England without serious consequences, 1797. French seizure of British merchandise—Forced French loan of 80,000,000 francs for descent on Britain—Roman republic—Bonaparte in Egypt—Battle of Nile—Batavian, Helvetic, and other republics, 1798. Revolution of 30th Prairial—Fourth constitution—Bonaparte First Consul—Acre—Seringapatam taken—British and Russians quit Holland—Income tax imposed by Pitt, 1799.

1800.—Royal Institution of London founded—Campaign of the Rhine—Bonaparte victorious at Marengo—Moreau at Hohenlinden—Attempt to assassinate first consul by an infernal machine, 1800. Planet Ceres discovered—Egypt evacuated—Nelson at Copenhagen—Peace of Luneville—Legislative union of Ireland with Britain—Paul I. strangled—Alexander I. autocrat of Russia, 1801. Peace of Amiens—Bonaparte consul for life—Planet Pallas discovered—Life-boats invented, 1802. New war between Britain and France—Louisiana purchased by United States for 15,000,000 dollars—Victories of British in India, 1803. Napoleon emperor of France—Pitt minister of England—Van Diemen's Land colonized—Planet Juno discovered, 1804. Napoleon king of Italy—Third Coalition against France—Battle of Trafalgar—Death of Nelson, 1805.—Confederation of the Rhine—Continental system—Dissolution of German empire—Joseph Napoleon king of Naples—Louis Napoleon king of Holland—Pitt and Fox died—English slave trade abolished—Braganza family fled to Brazil—Code Napoleon—Bonaparte declared Britain in a state of blockade, 1807. Bourbons of Spain dethroned by Napoleon—Joseph Bonaparte king of Spain—Joachim Murat king of Naples, 1808. War of France with Austria—Peace of Vienna—Napoleon arbitrator of Europe—Swedish revolution—Gustavus IV. and his heirs excluded—Battle of Corunna—Retreat and death of Sir John Moore—Battle of Talavera, 1809.

1810.—Wellington British commander in Portugal—Napoleon repudiated Josephine, and married Maria Louisa of Austria—Holland and north-west of Germany incorporated with France—Bernadotte made Swedish crown prince—Revolutions in Mexico, Peru, &c., 1810. Prince of Wales British regent—Napoleon's son, king of Rome, born—Mahommed Ali pasha of Egypt, 1811. Napoleon at Moscow with 500,000 men—Moscow burnt 7th September—French retreat—Saddler crossed the Irish Channel in his balloon—War between Great Britain and United States—Battle of Salamanca, 1812. Europe in arms to recover its independence—Many battles: Leipsic, &c.—Wellington victorious in Spain—French evacuated Spain and Germany—Holland conquered—Stadtholder recalled—Quadruple alliance—Allies entered Paris, 31st March—Napoleon abdicated, 11th April, and retired to Elba—Bourbons restored—London visited by allied monarchs—Congress at Vienna—Napoleon suddenly returned from Elba, and entered Paris in triumph, 20th March—War against Napoleon—Waterloo 18th June—Napoleon exiled by British to St. Helena, 12th August—Holy Alliance between Russia, Austria, and Prussia, 26th September, 1815. Algiers bombarded by Lord Exmouth—Indiana added to United States, 1816. Abolition of slave trade by France, Spain, and Holland—Mississippi received into Union—Death of Princess Charlotte, 1817. Congress of Holy Alliance at Aix-la-Chapelle, 1818. Castlereagh's "six acts" passed, 1819.

1820.—George III. died—Trial of Queen Caroline—Maine added to United States. Napoleon died at St. Helena, 5th May—Coronation of George IV.—Death of Queen Caroline—George IV. visited Dublin and Hanover—Florida ceded to United States—Missouri admitted into Union—Mexico declared its independence, 1823. Lord Byron in Greece; died 19th April—Louis XVIII. died; Charles X. succeeded, 1824.

1825.—Treaties of Britain with Rio de la Plata, Columbia, and Mexico. East Indian ports of the Netherlands opened to all nations. Greece sought protection from Britain. Treaty between Portugal and Brazil—Bolivian republic of Upper Peru declared.

1826.—Burmese paid East India Company £1,000,000, and surrendered a great extent of territory, 24th February. Heroic defence of Missolonghi: taken by Turks 23d April. Greece distracted by factions. Don Pedro gave a charter to Portugal, and (2d May) abdicated in favour of his daughter Donna Maria de Gloria, a child seven years of age. Insurrection of Janissaries (14th and 15th June) at Constantinople, and fresh organization of Ottoman army in consequence. Burmans subdued by the British.

1827.—Duke of York died, 5th January. French fleet sent to Algiers. Canning died 8th August. Captain Parry returned from North Pole unsuccessful. Persians defeated by Russians. The Greeks implored aid of European powers. Goderich administration. Battle of Navarino, 20th October, when Egyptian fleet was destroyed by British, Russian, and French.

1828.—Test and Corporation acts abolished. Wellington administration. National Assembly of Greece convoked by senate, 2d February. War declared by Russia against Turkey. Convention between Viceroy of Egypt and Sir Edward Codrington for evacuation of Morea by Egyptian troops, 6th August. Donna Maria received by British in London as Queen of Portugal, 6th October.

1829.—York Minster injured by fire, 2d February. Pope Leo XII. died, 10th February, and was succeeded by Pius VIII. Duel between the Duke of Wellington and Earl Winchelsea. Protocol of Britain, France, and Russia, arranging government, boundaries, &c., of Greece. Catholic emancipation bill carried in House of Lords, 10th April.

1830.—French expedition against Algiers set sail 25th April (city taken 5th July). George IV. died, and William IV. proclaimed, 26th June. The three fatal ordinances issued at Paris to overthrow the charter, 25th July. A coup d'etat violently demanded by the ultras. Stern resistance of the Parisians during three days, 28th, 29th, and 30th July. Flight of Charles X.; abdicated in favour of Duke de Bourdeaux, 2d August. Louis Philippe, Duke of Orleans, declared by Chamber of Deputies king, 7th August. Liverpool and Manchester railway opened, 15th September. National guards re-established. Revolution in Belgium; Dutch rule overthrown and Belgium declared independent, 4th October. Grey ministry formed, 22d November. Polish revolution began at Warsaw, 29th November. Recognition of Belgic independence by allied powers. Polignac and other French ministers tried; the ministers condemned to perpetual imprisonment, and Polignac to civil death.

1831.—Cholera appeared at St. Petersburg, 12th January. Gregory XVI. Pope, 9th February. Reform bill introduced into British Parliament by Lord John Russell, 1st March; frustrated in committee. Parliament dissolved. Carried in new House of Commons, 22d September; rejected by the Peers, 7th October. Riots at Bristol. Great meetings of reformers. Leopold accepted the crown of Belgium. Warsaw surrendered to the Russians. Cholera appeared in England, [illegible] ember.

1832.—Cholera in Edinburgh, 6th February [illegible] ondon, 16th. British reform bill again frustrated in House of Lords. Resignation of ministers, 7th May. Duke of Wellington attempted to form an administration; failed. Earl Grey recalled, 18th May. Reform bill passed. Otho of Bavaria king of Greece. Insurrection at Paris. Don Pedro landed at Oporto 9th July. Civil war for possession of Portugal. Cheap periodical publications of a respectable character began this year: Chambers's Edinburgh Journal, Feb. 4; Penny Magazine, March 31.

1833.—First reformed British Parliament. Bill passed in British Parliament for abolition of slavery in West Indies. Lisbon surrendered to Don Pedro. Opening of China trade in Britain. Donna Maria recognised as queen of Portugal by Britain. Death of Ferdinand VII., king of Spain. Return of Captain Ross from North Seas, after an absence of four years.

1834.—Hostilities in Spain between the adherents of Don Carlos and those of the Queen. Earl Grey resigned, 10th July, and was succeeded by Lord Melbourne. Great dinner to Earl Grey at Edinburgh. Lord Melbourne dismissed by William IV., after being five months in office, and Sir Robert Peel called to the premiership. Dissolution of British Parliament.

1835.—New election and meeting of British Parliament. British ministers defeated on question of Speakership, 19th February. Resignation of Sir Robert Peel. Lord Melbourne recalled, 18th April. English municipal reform act passed, 7th September. Captain Back's return from Arctic land expedition. First election of English town councils under reform, 25th December.

1836.—Ferdinand Augustus, Duke of Saxe Coburg, married by proxy to Donna Maria, queen of Portugal, 1st January. Madame Maria Lætitia Bonaparte, mother of Napoleon, died at Rome, 2d February (born 24th August, 1750). Revolution at Lisbon; constitution of 1820 accepted by Donna Maria. Parliament of Lower Canada opened by Earl Gosford, and dissolved as refractory. Charles X. died at Goritz, in Hungary, 6th November. Balloon voyage from London to Nassau on the continent, in 18 hours, 7th November. Prince Polignac released and exiled, 23d November.

1837.—General Espartero successful in Spain. Princess Victoria, on the 24th May, attained the age of 18, the period of majority by act of Parliament. All the American banks suspended specie payments; very extensive failures. William IV. died, aged 72, after a memorable reign of 7 years. Queen Victoria proclaimed, 22d June. Duke of Cumberland entered Hanover (27th June) as king by salique law, in place of William IV. Grand Junction railway from Birmingham to Liverpool and Manchester railway, opened in July. Railway from Paris to St. Germain, opened 26th August. Riots at Montreal. Carolina American steamer attacked and burnt by Canadians on United States territory, 20th December.

1838.—Sir Francis Head repelled Canadian insurgents under Dr. Mackenzie at Toronto, 5th January. Royal Exchange, London, burnt 10th January. Earl of Durham sent to Canada as Governor-General and High Commissioner, 16th January. Prince Talleyrand, the celebrated French diplomatist, died 17th May. The "Great Western" steamer, the first that ever crossed the Atlantic, arrived at New York from Bristol in fifteen days, on 17th June. Coronation of Queen Victoria, 28th June. Spain still distracted by civil war. The number of newspapers put into the London Post-office on 2d July for provincial circulation was 175,000. Slavery abolished in East Indies. Railway from Ghent to Ostend, opened 2d September—from Paris to St. Cloud, 6th September. Emperor of Austria crowned with iron crown of Lombardy, 6th September. London and Birmingham railway opened throughout, 17th September. Railway from Potsdam to Berlin, opened 29th October. Disturbances in Canada suppressed, 17th November. British troops entered Affghanistan, as auxiliaries of the legitimate king of Cabool, Shah Soojah, against the usurping chief, Dost Mahomed.

1839.—Melbourne ministry resigned, 7th May. Railway from London to Croydon, opened 1st June. Hostilities between Ibrahim Pasha for Mehemet Ali, viceroy of Egypt, and the Sultan, 10th June. Railway from London into the eastern counties opened to Romford, 18th June. Sultan Mahmoud II. died, and his son Abdul Medjid proclaimed, 27th June. The five powers interfered between the Porte and Mehemet Ali, 16th July. Ghiznee taken by the British in India—Dost Mahomed defeated, and Shah Soojah enthroned in Cabool, 20th July. Railway from Paris to Versailles, opened 2d August. Flight of Don Carlos—Peace in Spain, 25th August. Chartist attack on Newport; Frost, an ex-magistrate, and others, apprehended, 4th November. Queen Victoria announced to the Privy-Council her intention to marry Prince Albert of Saxe-Cobourg Gotha, 23d November. Frost and others found guilty of high treason; sentence commuted to transportation for life, 31st December.

1840.—The Chinese emperor issued an edict prohibiting all commerce with the British "barbarians." Penny postage, 10th January. Treaty of commerce between Turkey and Sweden, 23d January. Marriage of Queen Victoria to Prince Albert solemnized, 10th February. Insurrection of Syrian mountaineers against Pasha of Egypt, 7th June. Oxford, a pot-boy attempted to shoot Queen Victoria, 10th June. Prince Louis

Napoleon landed at Boulogne in a steamer with 40 or 50 followers to overturn the French government, and was arrested, 6th August. Convention between Turkey, Austria, Prussia, Russia, and England, for settlement of Eastern question, ratified 15th August. Fortification of Paris by walls, &c., ordered by government, 20th August. Louis Napoleon sentenced to perpetual imprisonment, 6th October. Voluntary abdication of king of Holland, who retired into private life, 7th October. Abdication of Queen Regent of Spain, 12th October; Espartero made Regent. Blockade of all Egyptian and Syrian sea-ports announced in London Gazette, 13th October; suspended till 20th November. Another unsuccessful attempt to assassinate Louis Philippe, 15th October. Capture of Sidon and Acre by allied troops, November 5 and 6. Princess Royal born 21st November. Mehemet Ali agreed to terms of allies; namely, to evacuate Syria, restore Turkish fleet, and receive Egypt as hereditary fief of the Porte, 27th November. Total abstainers from spirituous liquors, or tee-totallers in Ireland, estimated by Father Mathew at 3,300,000. Remains of Napoleon Bonaparte deposited with great pomp in Hotel des Invalides, Paris, 15th December.

1841.—Union of Canadas proclaimed at Montreal, 10th Feb. General Harrison, President of United States, died 4th April, and succeeded 5th, by Mr. Tyler, Vice-President. President, Atlantic steamer, missing, 11th April, and never since heard of. Espartero declared, by Spanish chambers, regent during minority of queen, 12th April. Sir Henry Pottinger sent out to China. Canton taken, but ransomed by Chinese for $6,000,000. Great Western railway from London to Bristol opened throughout, 30th June; cost £5,000,000. Statue of Napoleon placed on column of Grande Armée at Boulogne: fêtes in celebration of the event, 13th to 18th August. Conference of clergy at Manchester for repeal of corn-laws: 650 ministers present. Parliament re-assembled, 19th August. Dreadful destitution in Paisley. Melbourne ministry resigned, 30th August. Railway from Cologne to Aix-la-Chapelle, and other continental lines, opened. Attempt to assassinate a son of Louis Philippe, 13th September. London and Brighton railway opened, 21st September. Dublin, 25th October, Daniel O'Connell was elected Lord Mayor. Birth of Prince of Wales, 9th November.

TIME-KEEPERS.

Reference has already been made to article Astronomy, for an account of the most primitive and natural, as well as the most perfect time-keepers. Our attention here, therefore, must be confined to those artificial machines which have been invented chiefly for the purpose of adding to the convenience of these, by dividing the unit of astronomical time-keeping, namely, the day, into fractional parts, termed hours, minutes, and seconds; there being no such convenient and desirable measurement obvious in nature. Yet long before the invention of any artificial machine, the interval between sunrise and sunset was really divided, with no little accuracy, even among the rudest nations, simply by the shortening, turning, and lengthening of the shadows of trees, rocks and mountains; and it was this primitive mode of dividing the day which no doubt naturally suggested the first idea of

SUN-DIALS.

The most ancient artificial time-keeper of which we have any historical notice is the sun-dial of king Ahaz, who lived about 742 years before the birth of Christ. The first sun-dial constructed on mathematical principles, however, was probably one placed near the temple of Quirinus at Rome, B. C. 293. The Romans, at this time, were not aware that a dial made for Rome is not suited to other places. The ancients used hemispherical dial-plates, and placed the radius which throws the shade in the direction of the north polar star. The dial-plates now in use are flat, with the style or gnomon, the edge of the shadow of which determines the hour-line, running in the plane of the meridian, and hence, also, due north and south; while its sloping edge forms an angle with the horizon equal to the latitude of the place in which the dial is situated, and hence parallel to the earth's axis. Although a sun-dial may certainly be adjusted so as to point out the time of day within a few minutes, it is needless here to dwell farther on the details of an instrument now of little use. The most perfect of sun-dials being only available in sunshine, and not at all through the night (in which, by the way, moon-dials are sometimes used), they were partly superseded, even at a very remote period, by

CLEPSYDRÆ AND SAND-GLASSES.

It has been thought that the regular motion of the dropping of water, and the simpler forms of clepsydræ, or water-clocks, were used for the measurement of time even previous to the invention of sun-dials. They certainly were known in very remote antiquity, and were used in various parts of Asia and Europe; in China, India, Chaldea, Egypt, Italy, and Greece; into the last of which countries they were introduced by Plato. Julius Cæsar found them even in Britain. It was by them that he discovered some of the nights to be shorter or longer in this country than in Italy, which is nearer the equator, or line of equal days and nights. The Romans themselves had clepsydræ 100 years before Cæsar's invasion; and it is supposed that the Phœnicians had introduced them into Britain through Cornwall, where they traded for tin. The clepsydra, invented by Ctesibius of Alexandria, B. C. 145, consisted of a jar containing water, which slowly escaped by a hole at the bottom, while the oar of a miniature boat on the surface, as it sank with the fall of the water, pointed out the hours, which were marked on the side of the jar. It is even alleged that toothed wheels were applied to clepsydræ by Ctesibius. Such instruments, however, though brought to great perfection in the ninth and tenth centuries, and, indeed, still used in India, have never been made to measure time with great accuracy, the water always dropping more slowly as its quantity and weight diminish.

The running of sand through a tube was another obvious species of regular motion, very analogous to the running or dropping of water; and accordingly the hour glass, still in use in this and other countries, was also a very early invention. It was known, if not first made, in Alexandria, B. C. 140.

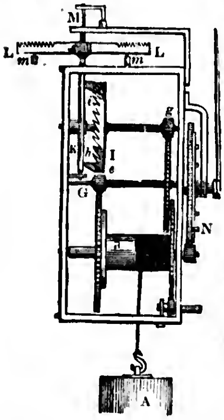
PLANETARIUMS OR ORRERIES.

It is rather a curious circumstance, that, long before the invention of clocks or watches, artificial machines, imitative of the motions of the sun, moon, and planets, the natural time-keepers, were constructed by the ancients.

Of the planetariums of modern times, the first in England was one made for Lord Orrery, whose name has since been given to such machines. The talented and self-taught astronomer, Ferguson, who was originally a poor Scottish herd-boy, made several orreries, and used chronometers to keep them in motion. But though the accuracy with which wheels and pinions can be made to represent different revolutions is beautifully illustrated by the best of these machines, they can give no just conception of the relative size, distance, or velocity of the planets, or hence of the periods of their revolution; and in this respect, therefore, they are mere philosophical toys, as will be at once perceived by reference to article Astronomy, in which an accurate representation of one is given, together with a method, first suggested by the celebrated astronomer, Sir John Herschel, of pointing out the actual sizes, distances, &c., of the various bodies in the solar system in relation to each other

CLOCKS.

The strong hold which the planetary motions appear to have taken on the minds of our forefathers, as the great antitypes of all true time-keepers, is also curiously manifested in the fact, that even when a more detailed measurement of time became necessary, in the intellectual progress of nations, these motions still continued to be represented, so that the very first clock of which we have any perfectly authentic account—that, namely, invented by Wallingford, Abbot of St. Albans, in 1326 not only showed the hours, but the apparent motion of the sun, the changes of the moon, the ebb and flow of the tides, &c. This, however, was by no means the first clock ever constructed; instruments with weights, wheels, pinions, and a balance, for the measurement of time, having been long previously known, though by whom invented appears to be a subject of much controversy. Doubtless they required more than the intellect of a single mind. Be this as it may, the most ancient clock of which we have any description, is that of Henry Vic or De Wyck, a German, erected in the tower of the palace of Charles V., king of France, in 1379; and rude and imperfect as it was, the analogy of modern invention, especially in watches, would lead us to think that it must have been the fruit of several centuries of thought and improvement.



A portrait of this parent of modern time-keepers may be interesting to our readers; and from its comparative simplicity, will be well adapted as a ground-work for further explanation of the mechanism of clocks and watches in their more complex and intricate forms. It will, moreover, show the general mode of construction adopted in the fourteenth century, including the balance with weights instead of a pendulum, by which the motion was then regulated.

General Movement and Regulation of Clock-work.

Without requiring to enter into any very minute detail of the manner in which motion in a clock or watch is successfully communicated from one toothed wheel G or I, or pinion *e* or *g*, to another, which, indeed, would in some instances only tend to perplex the mind of the general reader, it will be readily understood that the weight A below the clock-work, wound up by a cord on the cylinder B, in its constant tendency to fall to the ground, will cause the cylinder to turn round on its axis as it falls, and as the cord uncoils; and thus one toothed wheel or pinion will set another in motion, till the movement be communicated to the crown wheel, escapement wheel, or wheel of rencounter, I, the teeth of which so act on the two small levers or pallets, *ih*, projecting from and forming part of the suspended upright spindle or vertical axis, KM, on which is fixed the regulator or balance, LL, that an alternating or vibratory instead of a circular motion of the balance itself will be the result. The rotatory motion of the wheel-work, in short, will be converted into a vibratory motion by the alternate catching of the levers by the teeth of the crown or escapement wheel, and their alternate escape or 'scapement from them: this, or something always similar, is the cause of the constant ticking of a clock or watch.

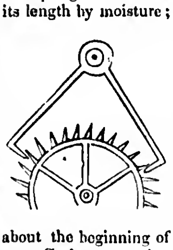
Now, it will at once appear manifest that a heavy weight, such as that here represented, operating on a few wheels thus arranged, unless it have some counteractive weight or other check to modify and balance its operation, will rapidly run down even to the ground, if the height of the clock-work and the length of the cord attached to the cylinder permit it, causing the wheels to rotate, the balance to vibrate, and the hands to revolve on the face of the clock, with similar rapidity, increasing every moment till the weight be fairly run down. It is this rapid motion of the wheel-work which begins in a *modern* clock whenever the *pendulum* is taken away while the weights are still attached to the cylinders; and the rapid ticking then heard is the uncounteracted operation of the crown wheel, moved by the falling weight upon a piece of mechanism similar in purpose to the levers and spindle in the above figure. To prevent this rapid unwinding of the clock-work, then, and to adjust it to the more deliberate measurement of time, we have, in De Wyck's clock, the balance, *loaded with two weights*, *m m*; and the farther these are removed from the axis or spindle, KM, the more heavily will they resist and counteract the escapement of the levers and the rapidity of the rotation of the escapement wheel, till the clock be brought to go neither too quick nor too slow; when, of course, it would be improper to remove them further towards the ends of the balance, as the clock would then go too slow for correct time-keeping.

Pendulum and Escapement.

What the balance and the weights attached to it in De Wyck's clock were to clocks of an ancient date, the pendulum is, in general, to modern clocks; the oscillations of the pendulum, and the vibrations of the balance, being completely analogous in purpose and effect, both being kept up or sustained by the "escapement," while both require, or, as it were, demand, by the law of gravity, a certain time for their performance; and thus, by reaction, check and equalize the exercise of those very powers and movements by which they are kept in play. The measurement of time being thus regulated by the oscillations of the balance or the pendulum, this part of the mechanism of a clock, including the escapement, is of primary interest and importance; and we shall find this also to be the case in the numerous contrivances, chiefly by English artists, to effect the same object to the best advantage in the still more delicate and ingenious mechanism of watches. We may here also remark, that, so invaluable is the principle of *regulation*, whether by oscillation or rotation, and so generally and extensively useful in other respects, that, from the smoke-jack to the steam-engine, has it, in one form or other, been called into practical operation.

Galileo, the great astronomer, when a student at Pisa, happened to discover, while engaged in the cathedral there—not in meditating on the imposing ceremonial of the Catholic church, which was then in progress, but in what, to many a good Catholic, would undoubtedly have seemed the vacant, idle, and profane contemplation of the lamps which swung from the roof—that the oscillations of a pendulum, whether great or small, are performed in equal times in each pendulum—an important fact, the truth of which he tested, not by the beats of his watch (for no such instrument then existed), but by the beats of a natural time-keeper to which we have not yet alluded—namely, the pulse. He afterwards discovered, what was ultimately demonstrated by Newton, that "the shorter the pendulum the less is the time of its vibration;" or, in other words, that the number of oscillations performed by a pendulum in a given time depends on its length, four times the length producing twice the number of oscillations. A pendulum, the length of which, from the point of suspension to the centre of the weight attached to its lower extremity, is 39 inches and 2 tenths, will oscillate once precisely every second in the latitude of London; not in any other latitude, however, as has been found by experience; the number of oscillations with the same length of pendulum diminishing towards the equator, where oscillations equal in length to 2 minutes 15 seconds a day will be lost; while, on the other hand, they will increase towards the poles, where a proportional number of oscillations will be gained. Thus the pendulum of a clock, made and adjusted to time in London, requires to be lengthened if taken nearer to the poles, or shortened if taken towards the equator.*

The first use which Galileo, then a medical student, made of his valuable discovery was to ascertain the rate and variations of the pulse; and its application to clock-work was an afterthought. It is even denied that he did more than suggest such an application; or, as has been also alleged, that at all events his son put his suggestion into execution; and accordingly the merit of the invention of pendulum clocks is very generally attributed to Huygens, a learned Dutchman, about 1657. This celebrated philosopher, in adapting the pendulum to the mechanism previously invented, had little more to do than simply to add a new wheel to the movement, so as to enable him to place the crown wheel and spindle in a horizontal instead of a perpendicular position, that the lower arm of the balance—then, of course, perpendicular, instead of horizontal, as in De Wyck's clock—might be extended, as it were, downwards, and thus, in fact, be converted into a pendulum. The principle thus adopted, however, from the peculiar action of the levers and spindle, required a light pendulum and great arcs of oscillation; and the consequence was, as Mr. Thompson, a recent popular author, tritely remarks, that "Huygens' clock governed the pendulum, whereas the pendulum ought to govern the clock." About ten years afterwards, the celebrated Dr. Hook invented a better method, which was introduced by Clement, a London clockmaker, in 1680, and enabled a less maintaining power to carry a heavier pendulum, which, also making smaller swings or arcs, was less resisted by the air, and therefore performed its motion with greater regularity. This was called the anchor escapement, and it is still in use, together with the practice to which it gave rise of suspending the pendulum by a thin flexible spring instead of a cord, which was liable to change its length by moisture; an evil, however, perhaps fully equalled by the variation of the elasticity of the spring by heat and cold. The seconds pendulum, with the anchor escapement, was called the *royal* pendulum. As this plan, however, was found to cause a reaction or retrograde movement of the wheels, and has hence been called the *recoil* escapement, a further improvement was made about the beginning of the eighteenth century by George Graham, another English artist, who invented the repose or dead escapement.



The wheels are kept by this escapement in a state of repose or rest during the whole oscillation of the pendulum, except at the moment when it receives its impulse from the crown-wheel. Requiring smaller arcs, too, even than before, the oscillations are made in more equal times. A still more perfect modification of the escapement is the free or detached, but it is more difficult to execute. The half-dead escapement, also, has been introduced as a mean between the dead escapement, an increase of power with which causes a clock to lose time, and the recoil escapement, with which a similar increase of power causes one to gain. For the purposes of ordinary clocks, this mode of escapement has been found to answer very well.

Compensation Pendulums.

Pendulum rods, which are usually made of metal, though sometimes of wood, especially in church clocks, were next found to vary in length by variations of temperature, according to that law of nature by which every body increases in volume or in actual size by heat, and diminishes or contracts by cold. The inevitable consequence of the influence of such variations on the length of the pendulum will at once be seen, from what has been already said, to be an increase of the number of its oscillations in a given time while in cold temperatures, and hence shorter than its mean length, as in winter, or even at night or in cold situations; and a diminution of them while in warm temperatures, and hence longer, as in summer, or even during the day, or in warm situations: and a pendulum with a metal rod will cause a clock to vary several seconds in a day from such changes alone. To insure, therefore, a still greater accuracy and uniformity in the measurement of time than had previously been obtained, various ingenious but simple devices have been put into practice, wherein the very cause of the inaccuracy has been made subservient to the end desired. And here the talent of the artist Graham again displayed itself, and led the way to every other modification of the primitive *idea*, however dissimilar in detail, and whether applicable to pendulums or balances, to clocks or watches. Indeed, the first method of "compensation" adopted for pendulums has, with some little improvement, ultimately superseded all its more recent modifications. This method Graham called "the mercurial compensation," and it consists simply of a tube or cylindrical glass jar containing quicksilver or mercury, and attached to the lower end of a steel rod in the arc of its oscillation. As the steel rod lengthens by heat, the mercury expands in volume and rises in the tube; while, as the rod shortens by cold, it contracts, and sinks or falls. Thus the arc of oscillation remains ever at the same distance from the point of suspension or upper extremity of the pendulum; or, in other words, the pendulum, in fact, remains ever of the same length. Graham also conceived the notion of another compound pendulum, composed of different metals so arranged as to compensate each other by their *difference* of expansion or contraction. This modification of the idea of a compensating pendulum was more fully developed by John Harrison, another celebrated artist, who in 1726 invented the gridiron pendulum, composed of five rods of steel and four of brass, so arranged that the rods which expand the most raise the weight at the bottom of the pendulum, as much as the rods which expand the least depress it. Unfortunately, however, this compensation changes, as all metals do, not continuously and gradually, under the influence of heat or cold, but by jerks. The mercurial pendulum, therefore, under certain improvements by Thomas Reid, a talented Edinburgh artist, and by others, has of late been frequently resumed; and it has been found that time-keepers provided with this pendulum and a dead escapement do not vary, on the average, more than a quarter of a second daily—a degree of accuracy wonderful, indeed, when contrasted with the fact, that down to the middle of the sixteenth century clocks were incapable of going nearer to accurate time than about 40 minutes within the 24 hours, and were nevertheless held

* The discovery of this fact, when cleared of the effects of difference of temperature on the length of the pendulum, served to *demonstrate* that the earth is in rotation on an axis passing through the poles; and that its form is that which must result to a fluid or molten mass from precisely such a line and measure of rotation: namely, not a perfect sphere or circular globe, but a spheroid or orange-shaped mass, flattened at the poles and protuberant at the equator. This it did on the natural law of centripetal and centrifugal forces, or forces tending to and from a centre; whence it follows, that bodies are attracted more and more, or become heavier, as they approach the centre of attraction, and that they are repelled more and more, or become positively lighter, not only as they recede from that centre, but also as they approach and enter into the vortex of rotation, or the centrifugal force, which must of course be in the region of the equator. The surface of the earth towards the poles, therefore, was thus proved to be nearer the centre, or, in other words, flatter, the pendulum descending with more weight and rapidity of oscillation there than elsewhere; and a surplus difference remained to be accounted for by the centrifugal force, strongest towards the equator.

to be precision itself compared with all other methods of measuring time then known.*

Other Improvements.

While improvements were effecting in the escapement and pendulum of clocks, the ingenuity of artists was not confined to these alone. Till the beginning of the 16th century clocks were of great bulk, and only fit for turrets or large buildings; and although after this period they were made small enough to be introduced into apartments, there could be no such thing as a really portable clock, far less a watch, till weights and pendulums were got rid of altogether. The substitution of a main-spring for a weight, therefore, constituted a great era in horology, or the science of time-keeping; and this took place about the middle of the sixteenth century, and was shortly afterwards followed by the invention of the fusee, a very necessary appendage to the main-spring. But as these inventions completely altered the form and principles of horological machines, and, together with that of the spiral escapement spring and other improvements, which soon followed that of the pendulum, rather constitute peculiar features of the watch than of the clock (although they were mostly applied at first only to portable time-pieces of the nature of clocks, in which they are, indeed, still used), we shall reserve the explanation of these ingenious pieces of mechanism till we come to treat of watches. Meantime, there is another part of the works of a clock which requires to be here noticed.

Mechanism for Striking the Hours.

It is not known when the alarm or when the striking mechanism of the clock was first applied. The alarm was adopted for the use of the Romish priesthood, to arouse them to their morning devotions. The first striking clock probably announced the hour by a single blow, as they still do, to avoid noise, in most if not all of the Scottish churches. In De Wyck's clock, the wheel N, with its projecting pins, served to discharge the striking part, which it has not been thought necessary to illustrate. Like other old clocks, it locked against an interrupted hoop, fixed on what was called the hoop-wheel; and the 11 notches on the edge of the plate-wheel determined the hours, or particular number of blows which the hammer should give. During the seventeenth century, there existed a great taste for striking clocks, and hence a great variety of them. Several of Tompion's not only struck the quarters on 8 bells, but also the hour after each quarter; at 12 o'clock, 44 blows were struck; and between 12 and 1, no less than 113! Many struck the hour twice, like that of St. Clement Danes, in the Strand, London, first on a large bell and then on a small one. Others, again, were invented so as to tell the hours with the least possible noise, also by the aid of two bells, each blow on the small one indicating 5 hours.

The striking part of a clock is rather a peculiar and intricate piece of mechanism. In ordinary clocks the impelling power is a weight similar to that which moves the time-measuring mechanism itself; but the pressure of this weight on the striking machinery is only permitted to come into play at the stated periods, in course of the workings of the time-keeping apparatus, namely, at the completion of every hour; when the minute-wheel, which revolves once in an hour, and carries the minute-hand of the clock along with it, brings it into action by the temporary release of a catch or detent, permitting the weight wound up on the cylinder of the striking apparatus to run down for a little, in doing which the hammer is forced into action, so as to strike the bell. Whether the strokes shall be one or many, is determined principally by two pieces of mechanism, one called a *snail*, from its form or outline, with 12 steps, and the other a *rack*, with 12 teeth; but the intricate action of the whole it would be in vain here to attempt to explain. Suffice it to say, that the time during which the striking weight is *allowed* to descend varies according to the turning of the 12 steps of the snail on its axis, and the position of the 12 teeth of the rack, at different hours of the day, being sometimes only long enough to permit one blow to be given by the hammer on the bell, and at another time long enough for 12 such blows. The lifting piece of the rack-hook, in some clocks, may be raised by pulling a string attached to a small additional piece of mechanism, and thus the clock is made to repeat the hour last struck at any time required—an addition useful through the night, or to the blind. The modes, however, by which clocks as well as watches have been made repeaters have been very various. Repeating-clocks were first invented by Barlow, an English clergyman, and executed by Tompion in 1676. Some have been made to repeat both hours and quarters at any time, and to indicate the time by blows which might be felt but not heard. The size and weight of some church-bells are enormous. The great bell of St. Pauls, London, weighs between 11,000 and 12,000 pounds. Great Tom of Lincoln, though smaller than St. Pauls is heavier still, being fully 12,000 pounds; and Great Tom of Oxford, the largest in England, weighs 17,000 pounds. But these are all insignificant when compared with some of the Russian bells, which weigh from 50,000 to even 432,000 pounds! All bells are made chiefly of a compound of copper and tin cast in moulds in bell-foundries.

Curious Clocks.

Various and ingenious, as well as often highly curious, have been the forms and purposes displayed in the construction of clocks, even from their earlier epochs down to the present day. We have already instanced some of an ancient date which pointed out the motions of the sun and moon, the ebb and flow of the tides, &c. Others of a more fanciful description followed. The famous cathedral clock of Strasburg was formed previous to 1580; and besides many other curious details, had the four quarters of the hour struck by four figures, emblematical of the distinguishing periods of human life. The first was struck by a child with an apple, the second by a youth with an arrow, the third by a man with a bludgeon or staff, and the fourth by an old man with a crutch; these were followed up by Death himself, who struck the hour at last. Other ancient clocks displayed

* Before quitting the subject of pendulums, it is worthy of remark that their mutual action or sympathy, while oscillating near each other on the same wall, so long as they are mutually connected by a rail or shelf common to both, so long as the cases of the clocks to which they belong are either fixed to each other or standing on the same flooring plank, is a very singular phenomenon, observed by Huygens, Ellicot, De Luc, Reid, and many other artists. One pendulum will even stop another, it is said, in such circumstances, and will again cause it to resume its vibrations till it stop, alternately, itself. It has also been found that two clocks with pendulums of nearly equal length and power, or weight, though differing in their measurement of time while apart, will so vibrate in unison when thus connected, as to keep time together with the most surprising accuracy, till they are again separated, or till the plank connecting them be sawn asunder. This singular but not altogether unaccountable influence appears to be not unlike that sympathy of sound between two musical instruments tuned in unison, wherein, when a chord of one is struck, the other, placed in a proper situation, though untouched, responds or echoes back the sounds at first called forth. And as in the combinations of certain medical substances, or in various other combinations, the general result of all the elements is obtained as a steady mean to be depended on, without the special failure, fault, or disadvantage of any one element in the combination, accuracy of time keeping, of a remarkable kind, might readily be obtained by this singular mode of bringing out, by a combination of pendulum clocks, an average rate of motion. "It is the opinion of an eminent foreign artist," says Reid, the author of a standard article on clock and watch-making in the new edition of the "Encyclopædia Britannica," afterwards enlarged and separately republished, "that a few clocks placed in this way would communicate the motion of their pendulums to each other, till they came all at last to beat at the same instant;" an opinion in which Reid himself expresses his entire concurrence

processions of saints, with obeisance to the virgin and child, &c.; and scarcely a town of any importance was without some curiosity of this sort peculiar to itself. Many curious clocks were invented in the seventeenth century, among which were a variety measuring time, or at least moved, by balls running down inclined planes, swallowed up by and traversing the bodies of brazen serpents, or descending in metallic grooves, to be again thrown up by Archimedean screws; some were made to go by their own weight, descending inclined planes, and thus avoiding the casualties to which main-springs and weight lines are liable; others, by means of springs, were even made to ascend such planes. One was simply and ingeniously hung like a lamp from the ceiling, and was kept going by its own descent, the winding up consisting merely of pushing it again towards the ceiling. In another, the dial formed the brim of a plate, filled with water, in which swam a tortoise, turning marvellously with the hour, and ever pointing towards it—by magnetic attraction, as every one would now readily conceive; and this favourite idea was varied by many other simple contrivances. Within the last few years, not a little wonder of a similar kind, we recollect, was excited by a puzzle-clock, with an hour-hand proceeding from the centre of a crystal dial-plate, perfectly transparent, and moving without any visible connection with mechanism. In this case a piece of glass itself, rotating in the interior of the dial, constituted the requisite mechanism. The illumination of clocks was a favourite idea in the seventeenth and eighteenth centuries; and little more than twenty years since this plan was adopted for public clocks. It was first applied in Glasgow, where one clock is lighted (though very imperfectly) from without, as two others are, through translucent dials, from within. A somewhat better system of lighting is adopted in Edinburgh; and in London, the pure brilliancy of the Bude light has recently contributed to the improvement of this very useful practice. A clock was made by George III. which registered the daily fluctuations of the barometer by means of a pencil floating on the surface of the mercury, and made to traverse a circular card divided into 365 parts by radii lines, and turned on its centre by the clock once a year. The fluctuations of the wind were proposed by Sir Christopher Wren to be registered on a similar principle—an idea which has been recently revived. A curious time-keeping method of insuring the presence and attention of night-watchmen has been successfully tried of late years at Derby, and we believe elsewhere in England. It consists of a clock with pins projecting round the dial, which can only be pushed inwards at a certain interval, when the watchman's presence and attention are required to unlock the case and do so, otherwise his neglect and the exact quarter of an hour at which he was absent is shown by "the telltale." Among other recent inventions is a lock-clock, to prevent bankers' safes, &c., from being opened except at stated intervals. The greatest novelty, however, in the art of clock-making, is the electro-magnetic regulation of clocks, by which the dials of all the clocks in a town, or even in different towns, may be made simultaneously, and, as it were, by sympathy, to indicate the same moment of time.

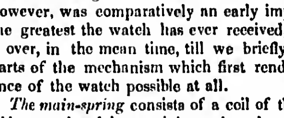
WATCHES.

Clocks and watches are certainly among the most perfect, as, in the civilized world, they are the most indispensable, machines ever produced by human ingenuity. "To become a good watchmaker," says Berthoud, "it is necessary to be an arithmetician, in order to find the revolution of each wheel; a geometrician, to determine the curve of the teeth; a mechanician, to find the forces that must be applied; and an artist, to be able to put it to execution the principles and rules which these sciences prescribe. He must know how fluids resist bodies in motion; the effects of heat and cold on different metals; and, in addition to these acquirements, he must be endowed by nature with a happy genius." No one who has not closely attended to the matter, can conceive the difficulty which has been experienced even in dividing circles for the wheels of a watch into the requisite number of rigorously equal parts, and in "pitching" them in, or adjusting them one with another. All the resources of art shown by Ramsden, Troughton, and other eminent mathematical instrument makers, have been here called into requisition. And as to the delicacy of touch and adjustment necessary in the mere regulation of the mechanism, after being thus accurately made and "pitched in," some slight idea may be formed from the fact, which we give in the words of Mr. Thomson, that "a second (a mere pulsation) is divided into four or five parts, marked by the vibrations of a watch-balance, and each of these divisions is frequently required to be lessened an exact 2880th part of its momentary duration!" England has great honour in having advanced the art of watch-making to its present high condition.

Main-spring and Fusee.

The invention of the main-spring in place of the weight was the first pre-requisite in the formation of the watch. But although the main-spring was applied as the maintaining power to time-pieces of a very imperfect description, called watches, about the middle of the sixteenth century, and although the balance had, in such instruments as these, assumed its present form of a vibrating ring, with the greatest weight, of course, accumulated round a circumference, it was not until the spiral hair-spring was applied to the balance, some time after the invention of the pendulum, as a substitute in clocks for the balance itself, that a comparatively useless machine was converted into a time-measurer nearly as accurate, even in its ordinary form, as the pendulum clock. Though the invention of the balance-spring, however, was comparatively an early improvement, and the greatest the watch has ever received, we must pass it over, in the mean time, till we briefly describe those parts of the mechanism which first rendered the existence of the watch possible at all.

The main-spring consists of a coil of thin elastic steel ribbon, enclosed in a miniature barrel or "drum," to the inner side of which the outer end of the coil is fixed, while the inner is fixed to an axis at the centre of the drum, and round which it may be wound or twisted, so as, by its elasticity and recoil, to cause the drum to make as many revolutions as it makes turns itself while it unwinds. Here, then, we have the main power which sets the whole mechanism of the watch in motion. But it is evident that this power, if thus at once applied to the wheels, would cause them to move with less and less rapidity as it became uncoiled, and as its springing power, of course, became exhausted; so that, unless the wheels were so constructed that only the middle turns were required to be in action, and not those in which it is at its greatest or its least power, a force sufficiently equal even for ordinary purposes could not be thus obtained. French spring clocks, strange to say, are still in general made on this defective principle; but English watches and spring-clocks are supplied with a "fusee," which corrects the inequalities of the main-spring with a simplicity only equalled by its ingenuity.

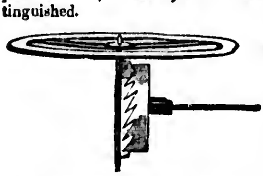


The fusee is a cone with a spiral groove, attached to the side of the first wheel of the watch, and connected with the barrel or drum containing the main-spring by a chain, hooked, at its ends, to both. The figure to the right in the above cut, is the fusee; that to the left is the drum.

In winding a watch, the key is placed on the axis of the fusee, and the chain is wound off the barrel on to the cone of the fusee. When fully so wound, the spring is at its greatest power of recoil; but the chain being then round the smallest part of the cone, the influence of the spring on the wheels is at its least amount; while, just as the power of the spring relaxes and diminishes, the cone enlarges, and its lever influence hence increases. The fusee, in short, is a variable lever, worked by the main-spring, with more purchase when it has less power, and with less purchase when it has more power. It is a very beautiful contrivance, completely answering the intended purpose, when properly made. By means of a spring contained in the interior of the fusee-wheel, the watch is maintained in motion, while the fusee itself is turned by the watch-key in winding up the main-spring. This is called *the going fusee*. When the watch or spring-clock has no fusee at all (and in very flat watches no fusee *can* be introduced), the barrel is immediately attached to the first wheel. In every case, however, the power of the spring is conveyed through the wheels by nearly the same arrangement in all watches and clocks to

The Escapement.

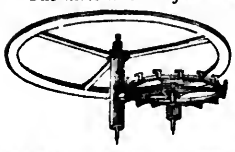
On the peculiar construction of this part of the mechanism, so as best to keep up the vibrations of the balance, the superiority of one watch over another principally depends; though much, of course, also depends on the skill of the workman, and the quality of his materials, in the construction of *every* part of so delicate a machine. The escapement, however, according to its peculiar form, is that by which the watch is chiefly distinguished.



The *vertical watch* is so named from its old vertical escapement.

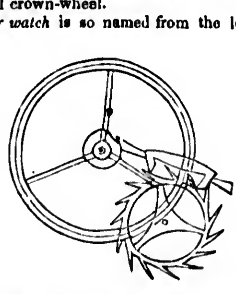
This particular mode of escapement is still made in common watches, though found not to produce a sufficient accuracy.

The *horizontal or cylinder watch* is so named from the horizontal escapement of Graham, introduced in the beginning of last century.

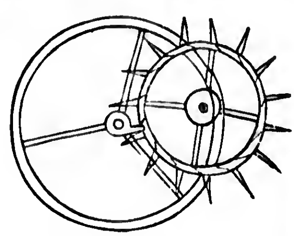


In this mode of escapement the impulse is given to a hollow cut in the cylindrical axis of the balance, by teeth of a peculiar form projecting from a horizontal crown-wheel.

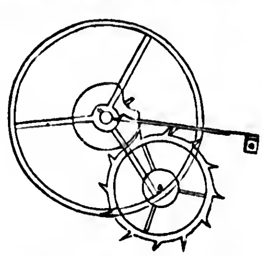
The *lever watch* is so named from the lever escapement of Mudge, in which the impulse is given to the balance by a lever attached to anchor pallets.



The *duplex watch* is so named from the duplex escapement of Hooke, perfected by Tyrer, in which the impulse is given by a double wheel.



The *detached watch* is so named from the detached escapement of Berthoud, improved by Arnold and Earnshaw, in which the vibrations of the balance are free or detached from the influence of the crown-wheel unless at the instant when it receives its impulse and unlocking, the wheels standing still till then.



This mode of escapement, which requires no oil, forms a peculiar feature of the chronometer or marine time-keeper.

On the respective merits of these different kinds of watches a few useful hints will be afterwards given. There are many other escapements, but those only now pointed out are in general use.

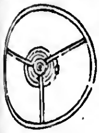
Balance and Balance-Spring.

These are the only other parts of the mechanism of the watch of which it is necessary here to treat.

The balance, as may be seen from the representation of it in connection with the different escapements just noticed, is a wheel finely poised on its axis; the pivot holes in which it turns being frequently, in chronometers and clocks, as well as in watches, jewelled, or made of small rubies, diamonds, &c., as those of other of the wheels also are, for the sake of durability. The natural effect of an impulse given to such a wheel would be a complete rotation on its axis. This, however, as we have already seen, is convertible, by various escapements, into a vibratory motion. But as in clocks the pendulum was found to be a most invaluable adjunct, absorbing, as it were, in its own more or less extended oscillation, every inequality in the rotation of the wheel-work, or the vibration of the balance, something of precisely the same nature for watch escapements was the great desideratum when the balance-spring or hair-spring was invented; and, from this analogy, it even acquired the name of the pendulum-spring—improperly so, however, as Reid remarks, especially as there is a pendulum-spring of another description altogether.*

* This little instrument, the hair-spring, is no less remarkable for the extreme delicacy of its construction, than for the great value which it shows the possibility of giving to a piece of steel of exceedingly small and insignificant appearance

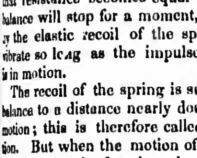
Simple and obvious as the suggestion of the regulative influence of a spring, applied to the vibrating mechanism of the watch balance in place of either weight or pendulum, may now appear, especially after the idea of the main-spring, as a substitute for the maintaining weight, had been suggested, this has been held to be a crowning invention in the mechanism of the watch; and the honour of its first suggestion has been claimed by no less than three very eminent men—by Dr. Hooke, by Abbe Hautefeuille, a Frenchman, and by Huygens, the Dutch astronomer. It was ultimately proved, that although Huygens had applied for a patent at Paris in 1674, Hautefeuille had done so several years before; while Hooke had made a similar application in England in 1658. To Hooke, therefore, must be attributed the first idea of the balance-spring.



In its application to the balance of a watch, one of the extremities of the spring is fastened to a point independent of the balance, while the other is attached near its axis.

When the balance is at rest, the spring is inclined neither way, this position being called the point of rest; but when the impulse is given to the balance by the crown-wheel of the escapement, it is clear that now a rotatory motion of the balance cannot take place, even though there should be nothing in the form of the escapement to prevent it; the balance will now only move round so far as the impulse given is able to overcome the elastic resistance of the spring; and when that resistance becomes equal to the impulse given, the balance will stop for a moment, and then be driven back by the elastic recoil of the spring, continuing thus to vibrate so long as the impulse is repeated or the watch is in motion.

The recoil of the spring is sufficient to drive back the balance to a distance nearly double the length of its first motion; this is therefore called the long arc of vibration. But when the motion of the balance is free, with a certain length of spring, the *long* arc of vibration is made in less time than the short one, to which the impulse is given; with a spring of greater length the principle is reversed; whence it was concluded by Le Roy and Berthoud, that equality of time or *isochronism*, in unequal vibrations, could be more easily obtained by lengthening the spring than by tapering it. In principle, too, the stronger and shorter the spring, the quicker will be its vibrations. Thus, effects of an extremely varied description can be produced on the motions of a watch by the slightest difference of length and taper in a hair-spring. And it is thus that the correctness of the time-keeping is essentially dependent on the principle adopted in the formation of this apparently most insignificant little appendage. So much is this the case, that, if the hair-spring be isochronal in a free or detached escapement, the time shown will be the same, notwithstanding changes in the motion of the wheels, or even in the power of the main-spring. In England, where time-keepers have been brought to their greatest perfection, it is considered that isochronism is most easily obtainable by using the cylindrical helical spring, which is applied to all marine chronometers.



manual labour. Four thousand hair-springs scarcely weigh more than a single ounce, but cost often more than £1000. "The chisel of the sculptor," as Mr. Thompson justly remarks, "may add immense value to a block of marble, and the cameo may become of great price from the labour bestowed, but art offers no example wherein the cost of the material is so greatly enhanced by human skill as in the balance-spring."

One of the most recent improvements in watches, or rather in chronometers, has been invented and patented by Mr. Dent, of London, and consists in coating the balance and balance-spring with gold by the electro-metallurgic process (see article on Electricity), by which means they are secured from rust. Another invention of the same gentleman is that of balance or hair-springs made of *glass*, which, singular to say, appear decidedly preferable to those of steel, their principal disadvantage being the difficulty of making them with certainty or accuracy.

Compensation.

But let a watch be ever so perfect—in the correction of the inequalities of its main-spring by a fusee mathematically adjusted to it, in the formation, and the position or pitching in of all its wheels and pinions, in the principle and execution of its escapement, and even in the accuracy with which its hair-spring vibrates in equal times—still it will vary in the time it indicates *on every change of temperature*, however slight, unless it be *compensated*.

From what we have already stated in treating of the compensation pendulum in clocks, the intelligent reader will readily appreciate the difficulties to be here overcome, and will probably conclude, that as in clocks the compensation has been effected by means of the pendulum, so in watches it must have been effected by means of the balance-spring or balance: such is the fact; but as there was no room here, and indeed no analogous opportunity, for the introduction of mercury, the idea of compensation by virtue of the different degrees of expansion in different metals, as in the gridiron pendulum, was the only one that remained to be entertained; and here also the ingenuity of human invention has indeed triumphed; and the method of making compound balances for watches has been justly considered one of the most curious of our metalline manufactures. When completed, the compensation balance consists of a double or compound rim or ring, the outer part of which is of brass, and the inner of steel, to which the brass is added while in a molten state. The opposite sides of this ring are united by a steel bar, the whole of the steel part, indeed, being filed out of one piece of metal. One half of the ring is then cut or filed away at one side of the bar, and the other half at the other side, as represented in the figure last above given; and the balance is loaded either with small screws, as in that figure, or with sliding weights on each half of the ring, in order to regulate the rate of the chronometer or watch. The compensation, then, is thus effected: An increase of temperature *diminishes* the elastic force of the hair-spring, which would cause the machine to *lose* time; but the same degree of heat expands the outer or brazen part of the ring of the balance more than it does the inner or steel part—brass expanding more than steel by heat, and contracting more by cold—and so, not being able to separate, a curvature of the whole arm of the ring *inwards* ensues, which lessens the inertia or checking weight of the balance; so that the hair-spring now *requires* less force to influence it to the same degree as before; and thus its *loss* of power is *compensated*. On the other hand, cold *increases* the elastic force of the hair-spring, which would cause the machine to *gain* time; but the brass contracting more than the steel, curves the arm outwards, and increases the inertia, or resistance of the balance, allowing the spring no more influence over it now than it had before. The screws are turned in or out, or the place of the sliding weights adjusted, by experiments on the rate of the machine; so that if an increase of temperature causes it to gain time, or a decrease to lose, the screws must be turned outwards, or the weights moved farther from the ends of the arms; if the contrary be the case, then of course the contrary changes must be made.

The compensation curb is another instrument for cor recting variations in the rate of going from variations in temperature. It limits or extends the length of movement in the hair-spring itself, by a self-moving action, also caused by a difference in the effect of change of temperature on two different metals, and is called a curb, from the name of a small piece of mechanism which operates similarly on the balance-spring in regulating a watch by hand.

CHRONOMETERS.

The term *chronometer* is, properly speaking, applicable to all time-keepers, but it is now more usually applied to marine time-keepers only, which are machines of a size between watches and clocks. Some watches, however, made like chronometers in every respect but in size, are called pocket chronometers. But neither of these are any thing else than merely such time-keepers as combine all those chief excellencies in horological invention just described, including compensation balance, cylindrical spring, detached escapement, &c., so as to constitute the most accurate time-measurer possible; the purpose of marine chronometers being to discover the longitude at sea; for it is only necessary to ascertain the exact difference in time between two places on different meridians, in order to determine their difference of longitude, or distance eastward or westward of each other. Reverting to what has been already said on this subject in the first article of the present series, the general reader will at once perceive that, so soon as a time-keeper could be made that would keep time with perfect accuracy, such an instrument, set to the time of any sea-port, for instance, in Britain—whose precise meridian or longitude was known—and carried abroad in a vessel sailing thence, would afford the means of ascertaining the longitude at sea, by simply observing the instant that the sun reached his meridian there, when of course it would be mid-day, or 12 o'clock noon; and at the same time observing the difference between this time and that shown by the time-keeper, which would necessarily be different if the longitude was different—the amount of the difference giving him his longitude, on the calculation that 15 degrees east or west make *one hour* of time, or 15 geographical miles *one minute*. If, for example, the time-keeper had been set to time at the meridian of Greenwich observatory [where, in fact, chronometers are now usually adjusted, and where a signal hoisted every day on the instant that 12 o'clock strikes, or rather on the instant that the sun arrives at the meridian there, proclaims the true time of day, on that meridian, to all the mariners in sight of it, that they may be able, without trouble or mistake, to adjust their chronometers accordingly], and if it was but 11 o'clock on the time-keeper thus set, while it was, of course, 12 o'clock or mid-day at the time and place where the meridian was taken at sea, then that place must have been in longitude 15 degrees *west* of the meridian of Greenwich; if, on the other hand, it was one o'clock instead of 11 at that moment, the longitude must have been 15 degrees *east*, not west, of the meridian of Greenwich. By knowing also the time when any particular star passed the meridian at Greenwich, the navigator, in a similar manner, could calculate his longitude by an observation of the same star at sea. Lunar observations, eclipses, or any other of the celestial phenomena, might be made use of on similar principles.

It was a clear perception of the fact, that the longitude might thus be at any time determined, could time-keepers be made to measure time with accuracy, that led Sir Isaac Newton and others to recommend to government the offer of a public reward for the accomplishment of so desirable an object; and it was the hope of reaping the splendid reward of £20,000, which government accordingly did offer, that formed the very main-spring to all those high exertions of horological ingenuity which led to the final success of John Harrison, after an unwearied labour of forty years—a success which, in turn, resulted in the present highly advanced state of horology, the perfection of which, as a most scientific art, is perhaps only paralleled by the perfection of astronomy as a cognate science deeply indebted to it, and indeed to which it is as indispensable, in almost every respect, to the present condition of society.

USEFUL HINTS.

For the attainment of habits of punctuality, for the regulation of the usual routine of business and of every day life, for the morning's timely arousement, and the evening's sufficient repose, and for other and innumerable purposes of convenience, necessity, and pleasure—much, in reality, often depends on the judicious selection of a time-keeper. And even the character of a young man has been known to be much influenced by the quality of his watch, the possessor of an accurate time-keeper becoming ambitious to emulate its excellence, and thus gradually acquiring habits remarkable for punctuality. It is therefore to be regretted—even though in many cases a very indifferent time-keeper may be thought all that is required for general purposes—that no efficient instruction can be given to the inexperienced, especially towards the selection of a watch, as none but a workman possessing the highest knowledge of his art is capable of forming a correct opinion of its relative merits. The hints given by a skilful and practical artist himself, however, who has had years of the most attentive and constant experience, cannot but be deemed invaluable; and as such, we would especially recommend a popular little volume, recently issued by Messrs. Boone of New Bond Street, namely, "Thomson's Time and Time-Keepers," for the useful as well as pleasing and interesting instruction, to the inexperienced in horology, with which it is stored. A work such as this is a novelty, opening up the rather abstruse science of horology to the general reader, much in the same way in which the highly popular works of Professor Nichol have opened up the more sublime and still more abstruse science of astronomy.

Among many valuable hints for the proper selection of time-keepers contained in Mr. Thomson's little volume, we shall take the liberty of briefly instancing the following; and first of clocks:—These, in general, measure time more accurately than watches, especially eight-day weight or long-clocks, which are also cheapest. Long and heavy pendulums are to be preferred. The pendulum should occupy the whole available length of the case, except in regulators, or in pendulums beating seconds. A light pendulum shows a clock to be badly constructed, or deficient in power. Steel rods are better than brass, well-seasoned and varnished wood than steel, and compensation-rods than either. The clock should be steadily fixed to the wall, or firmly placed on three feet sufficiently far apart, so that the mechanism may be uninfluenced by the oscillations of the pendulum. Clocks are regulated by lengthening the pendulum to make them lose, and by shortening it to make them gain; this is very generally done by turning a nut or screw *below* the weight or *bob* of the pendulum, *to the right to gain, or to the left to lose*; or, if the screw is *above* the weight, the rule is *reversed*. Many French clocks, and a few of English ones, are liable to derangement in striking, unless the hands are moved rapidly *forward*. The hands of English clocks, in general, may be turned either way without injury, and the same with a watch, unless it has an alarm. An intelligent careful man may be safely trusted with the cleaning or repairing of clocks, while a diversity of talent and experience is necessary to qualify him for the manipulation of watches. "The possessor of a good picture would doubtless inquire into the ability of the artist before he intrusted him to retouch it; and this caution is equally necessary for a watch, as many of the best construction have sustained irreparable injury from the hands of unskilful workmen. Even watches (which are by far the greatest number) require the aid of better hands than those which constructed them." A clever artist may enable even a bad watch to perform tolerably well. Watches should ordinarily be cleaned every second or third year; small, flat, or complicated ones oftener. All require care in handling. They should be regularly wound as nearly at the same hour as possible: and while being wound, should be held steadily in the hand, so as to have no circular motion themselves. When hung up let the watch have support, and be perfectly at rest; or when laid horizontally, let it be placed on a soft substance for more general support, otherwise the motion of the balance will degenerate a pendulous motion of the watch, causing much variation in time. Should a watch vary by heat or cold, as when worn or not worn in the pocket, the hands may be set to time; but the regulator should not be altered, if set to the ordinary temperature of the season. Compensation-watches, if properly constructed, do not so vary. A trial even of a year or two is no proof of the substantial worth of a watch. Dealers themselves may be deceived. A duplex watch may be very bad, while a vertical one may be very good, so that workmanship is as important as principle. Many low priced and bad watches have eight or even ten holes jewelled, while many good and costly ones have but four: a hole can be jewelled for three shillings. "The high sounding description, the handsome exterior, the offered trial, and enticing cheapness, are effective baits to the short-sighted." External ornament forms but a small item of expense, and the prices therefore will, in general, point out the comparative qualities of the work in the shop of an artist of known integrity and ability. The large thick old watch is less absurd than some recently made little nicker than half a crown [or even much smaller, as in the latest and rarest novelty among the beautiful and ingenious Genevese watches, one of which recently seen at Geneva by one of the editors of the present series of papers, was about the size of a shilling]. The lever watch is capable of great accuracy, and is preferable to the vertical, though the principle of the latter is more generally understood and more easily repaired; lever watches, however, are neither expensive to repair nor liable to derangement. The horizontal or cylinder-watch is liable to great tear and wear, but performs with considerable accuracy. The duplex watch, with a compensation balance, when well constructed, and treated with ordinary care, will keep time with the greatest accuracy, but being delicate, it does not stand violent exercise; a bad duplex watch is most expensive to repair. The detached watch, the escapement of which is the only one used in marine chronometers, is the most perfect, but requires care. Repeaters are expensive to repair as well as to purchase, but may be as accurate as others. Watches showing seconds are often useful, and, if well made, are neither expensive nor easily deranged. A watch may be handsome, yet bad, but a good watch is seldom unsightly. The spring for shutting the shells is not so good as the snap; it often allows dust to penetrate to the works. The covers of hunting-watches will not protect the glass when the hunters are very flat. The extreme accuracy of marine chronometers is partly produced by their being kept constantly in a horizontal position. They are only required to show *equal* time; whether they gain or lose is of no consequence, provided they are regular, and *keep* their known rate.

KEY TO THE CALENDAR.

JANUARY.

JANUARY and February are said to have been added to the list of months by the second Roman king, Numa Pompilius, in the year before Christ 672. The name of the former month is unquestionably from Janus, the god of the year of the Roman mythology, to whom the first day was sacred, and in whose honour it was celebrated with riotous feastings and givings of presents. We learn from Ovid's Fasti, that a Roman workman did not spend the Kalends or 1st of January entirely in debauchery: he wrought a little at his trade, for the sake of luck throughout the year.

1. *Circumcision.*—A festival of the Romish Church, from about the year 487, and of the Church of England since 1550, in honour of the circumcision of Christ. The banks and public offices are shut on this day. As first day of the year, it is celebrated throughout the modern Christian world with festive rejoicings, too often approaching or exceeding the bounds of propriety. In England, till a period not very remote, it was customary to usher in the year by drinking spiced liquor from the *Wassail Bowl*, so called from the Anglo-Saxon *Waes-hael* (Be healthy), the toast used on the occasion. The custom without the name still exists in Scotland. It was also customary on this day to give and receive gifts, originally with the superstitious design of securing good fortune for the year, and afterwards for affection and to promote good neighbourhood. Even the kings of England accepted presents from their courtiers on this morning. The 1st of January, under the name of *Le jour de l'an*, continues in France to be distinguished by a universal system of present-giving, in which the royal family partakes. It has been calculated that sweetmeats to the value of £20,000 are sold in Paris on this day.

6. The *Epiphany*, a festival in honour of the manifestation of the infant Jesus to the three wise men of the East, who came to worship him. It began to be celebrated in 813. This continues to be observed as a festival in the English Church, and is marked by the shutting of many of the public offices. The popular name for the festival is *Twelfth Day*, with reference to its occurring twelve days after Christmas. Twelfth Day, and more particularly Twelfth Night, are distinguished by joyful observances. It is a tradition of the Romish Church, that the three wise men were kings, and many sets of names have been furnished for them, Caspar, Melchior, and Balthazar, being the set best known: their remains were said to have been recovered in the fourth century by the empress Helena, and the skulls are still shown, under circumstances of great pomp and ceremony, in the great church at Cologne. Perhaps it is owing to this idea of the regal rank of the wise men, that a custom has existed from early ages throughout Europe, of choosing a person to act as king on Epiphany. In England, this custom has blossomed out a little. Both a king and queen were chosen. It was done by placing beans in a large cake. The cake was divided among the company and whoever of the male sex got a bean was king, whoever of the female sex queen. Latterly, other characters

have been added, and these were expressed on slips of paper. The Twelfth Night cake continues to be eaten by merry companies, and the characters of king, queen, &c., being drawn in that manner, are supported amidst much jocularity till midnight. There is reason to suppose that the custom of choosing a king is also connected with ancient heathen rites, as in Rome a king of the Saturnalia was chosen by beans. Twelfth cake in England is generally covered with hardened white sugar and many little ornaments, and its abundant appearance in the windows of bakers and confectioners on this day never fails to arrest the attention of strangers. In Scotland, there is not the least trace of either a religious or popular observance of Twelfth Day.

Till the reign of George III., it was customary at court on Twelfth Night to hold a public assembly for playing the game of basset, in which the king and royal family took part, the winnings being for the benefit of the groom-porter, an officer who on those days had an especial charge of the games of chance played in the palace, at which he acted as umpire.

The day after Twelfth Day was a popular rustic festival, under the mock name of *St. Distaff's* or *Rock Day*. (Rock is the appellation of a quantity of lint put upon a distaff.) It seems to have been a sort of farewell to the festivities of Christmas.

18. *Septuagesima Sunday.*—[It is necessary here to mention that the Movable Feasts and Holy-Days of the church are nearly all regulated by Easter—that is, so long before or after Easter. Easter, the great festival of the church, is itself movable. According to canonical regulations, Easter-day is always the first Sunday after the full moon which happens upon, or next after, the 21st day of March; and if the full moon happens upon a Sunday, Easter Sunday is the Sunday after. The first of these movable feasts is Septuagesima Sunday, which occurs on January 18th, when Easter Sunday is on March 22d. In this place, we propose setting down the movable feasts on the earliest days on which they ever occur; and Septuagesima Sunday is therefore put under January 18th. All the rest will follow in order, as in the calendar for a year on which they occur on the earliest possible day.] Quadragesima is an ancient name of Lent, as meaning the forty day's fast. The first Sunday in Lent hence got the name of Quadragesima. Early in the seventh century, Pope Gregory appointed three Sundays of preparation for Lent, and assuming a decimal reckoning for convenience, they were respectively called, reckoning backwards, Quinquagesima, Sexagesima, and Septuagesima.

21. *St. Agnes's Day*, a festival of the church of Rome. The annals of canonization present no image of greater sweetness and purity than St. Agnes. She is described as a very young and spotless maid, who suffered martyrdom in the tenth persecution under Dioclesian, in the year 306. A few days after her death, her parents going to make the offerings of at[illegible] at her tomb, beheld a vision of angels, amidst which [illegible] their daughter, with a snow-white lamb by her [illegible]fore usual[illegible] represented with a lamb [illegible]ter. Perhaps this legend has been partly founded on the resemblance of the name Agnes to *Agnus*, Latin for *a lamb*, for jingles of sound often led to more important ideas in the middle ages. At Rome, on St. Agnes's Day, during mass, and while the Agnus is saying, two lambs, as white as snow, and covered with finery, are brought in and laid upon the altar. Their fleeces are afterwards shorn and converted into palls, which are highly valued.

Throughout the Christian world, and in England as much as elsewhere, it was customary for young women, on St. Agnes's Eve, to endeavour to divine who should be their husbands. This was called *fasting St. Agnes's Fast*. The proper rite was to take a row of pins, and pull them out one after another, saying a pater-noster, and sticking one pin in the sleeve. Then, going to rest without food, their dreams were expected to present the image of the future husband. In Keates's poem, entitled "The Eve of St. Agnes," the custom is thus alluded to:—

> They told her how upon St. Agnes' Eve,
> Young virgins might have visions of delight,
> And soft adornings from their loves receive,
> Upon the honied middle of the night,
> If ceremonies due they did aright;
> As, supperless to bed they must retire
> And couch supine their beauties, lily-white,
> Nor look behind, nor sideways, but require
> Of heaven with upward eyes for all that they desire.

25.—*Sexagesima Sunday*; eight weeks before Easter.

Conversion of St. Paul.—A festival of the Romish and English churches, and, in London, a holiday at the public offices, excepting the Excise, Stamps, and Customs. The populace in former times thought this day prophetic as to the weather of the year:—

> If St. Paul's day be fair and clear,
> It doth betide a happy year;
> If blust'ring winds do blow aloft,
> Then wars will trouble our realm full oft;
> A[illegible] ance to snow and rain,
> Th[illegible] all sorts of grain.

In Germany, when the day proved foul, the common people used to drag the images of St. Paul and St. Urban in disgrace to duck them in the river.

30. *The Martyrdom of King Charles I.*—A holiday of the English Church, in whose behalf Charles is held to have lost his life; observed by the closing of all the public offices, except the Stamps, Excise, and Customs. A motion in the House of Commons in 1772, to repeal so much of the act of 12th Charles II., cap. 30, as relates to the ordering of the 30th of January to be kept as a day of fasting and humiliation, was lost by 125 against 97. The sheet in which the head of Charles was received upon the scaffold, presenting large black stains from his blood, together with his watch, are preserved at Ashburnham Church in the county of Sussex, having been given at the time to his friend Lord Ashburnham. The cap, of laced satin, which he wore on the scaffold, and which he directed to be sent to his friend the Laird of Carmichael in Scotland, passed through the hands of that gentleman's descendants, the Earls of Hyndford, and is now the property of Robert Logan, Esq., residing at New Lanark.

Natural History.—January, in our climate, is the coldest month of the year, on an average; for in some years February and March are both colder. The store of heat acquired in summer is now completely dissipated, and the sun has not yet attained sufficient power to replace it. In the central parts of the Island of Great Britain, the general average of the thermometer this month is 37 degrees. Vegetation is nearly at a stand during January. Our ancestors thought it necessary that it should be a severe month, for the sake of the rest of the year. This mode of judging, however, is not confirmed by modern experience; for a mild winter is often followed by a warm summer. A few flowers, as the crocus, mezereon, and polyanthus, are occasionally seen to blossom in the latter part of January; and about the same time (in England) the hedge-sparrow, thrush, and wren, begin to pipe.

FEBRUARY.

The establishment of February as the second month of the year by Numa Pompilius has already been mentioned. According to Ovid in his "Fasti," a curious record of Roman customs, all objects which were thought to have the effect of moral purgation in the religious ceremonials of that people were called Februa. Ceremonials of this kind took place at this season; hence the name of the month. The vanity of Augustus is said to have been the cause of this month being so much shortened. The arrangement of Julius Cæsar seems to have contemplated an alternation of months of thirty with those of thirty-one days. August was one of thirty days; but when Augustus gave it his name, he could not endure that it should be one of the shorter class, and therefore gave it an additional day, at the expense of February, already one of that class. Our Saxon ancestors called February *sprout kale*, from the sprouting of the cabbage, still called kale in Scotland.

1. *Quinquagesima Sunday*: seven weeks before Easter: called also Shrove Sunday.

2. *Candlemas Day*, or the Purification of the Virgin, a festival of the Church of Rome, and holiday in the English Church. It is said to have been founded upon Roman rites in which candles were carried. The early fathers of the Church held it in commemoration of the attendance of Mary in the Temple, forty days after child-birth, as commanded by the law; and it was their custom on this day to bless candles and distribute them among the people, by whom they were carried in solemn procession. The saying of Simeon respecting the infant Christ in the Temple, that he would be a *light* to lighten the Gentiles, probably supplied an excuse for adopting the candle-bearing procession of the heathen, whose external religious practices the founders of the Romish Church made a practice of imitating, in order to take advantage of the habits of the people. Apparently, in consequence of the celebration of Mary's purification by candle-bearing, it became customary for women to carry candles with them when, after child-birth, they wanted to be *churched*. It was to this custom that William the Conqueror referred in his famous remark on a jest of the king of France. The latter, on hearing that William seemed too fat and unwieldy to take the field, said, "Methinks the king of England lies long in child-bed." "When I am churched," said William, "there will be a thousand lights in France." And he made good his boast.

Candlemas Day is a holiday at the public offices, excepting the Stamps, Excises, and Customs. It is called a Grand Day in the Inns of Court, a Gaudy Day at the two universities, and a Collar Day at St. James's, being one of the three great holidays, during the terms, on which all legal and official business is suspended.

There is an ancient superstitious notion, universal in Europe, that if Candlemas be a sunshiny day, the winter is not half finished. The Germans say—The badger peeps out of his hole on Candlemas Day, and if he finds snow he walks abroad; if he sees the sun shining, he draws back again into his hole. It is an ancient custom in Scotland for scholars on this day to make presents of money to their masters, and to enjoy it as a holiday.

3. *St. Blaise's Day*.—St. Blaise, who has the honour of a place in the church of England calendar, was a bishop of Sebaste in Armenia, and suffered martyrdom in 316. He is the patron saint of the craft of woolcombers, and his name was once considered potent in curing sore throats. At Bradford there is still a septennial procession of the wool trade upon his day. Formerly, it was celebrated extensively by fires lighted on hills, and this is still done in Scotland on the previous evening, under the name of the Candlemas Blaze, the resemblance of the name Blaise to blaze having apparently suggested the practice.

Shrove Tuesday.—According to the plan already laid down, we place Shrove Tuesday upon this day of the month of February. As the day before the commencement of Lent, it has been from an early age celebrated throughout Christian Europe by feasting and merry-making of such an extravagant nature, as to appear designed to impart a disgust with all such indulgences, in order to make the subsequent mortifications less felt. It is the concluding day of the time of Carnival, which in various Catholic countries is of greater or less extent, but celebrated with most distinction at Venice and Rome. Carnival is obviously a term from *caro* and *vale*, as meaning a farewell to flesh, this article of food being unused during the whole of Lent. In these two Italian cities, and partially in many others, the Carnival is distinguished by shows, masquerades, races, and a variety of other amusements. The people may be said to live for several days in public. The wealthier classes parade about in their carriages, from which they pelt each other with sweetmeats. Whim and folly are tolerated in their utmost extent, so that only there be nothing said or done to burlesque ecclesiastical dignitaries. In Germany, the masqueings and mummings of the time of carnival, called there *Faschings*, are said to have given birth to the dramatic literature of the country.

The main distinction of Shrove Tuesday, in the early times of our own history, was the eating of pancakes made with eggs [illegible]. The people indulged in games at football, at which there was generally much license; also in the barbarous sport of *throwing at cocks*. In the latter case, the animal being tied by a short string to a peg, men threw sticks at it in succession, till an end was put to its miseries and its life at once. Cockfights were also common on this day, not only amongst the rustics, but at the public schools, the masters condescending to receive the defeated and slain cocks as a perquisite. The festive and mirthful observances of Shrove Tuesday are now much decayed; but the eating of pancakes or fritters still continues.

4. *Ash Wednesday*, the first day of Lent, a holiday of the Church of England, observed by the closing of all the public offices, excepting the Stamps, Excise, and Customs. The palms or substitute branches, consecrated and used on palm Sunday of one year, were kept till the present season of another, when they were burnt, and their ashes blessed by the priests and sprinkled on the heads of the people; hence the name given to the day. The sprinkling of ashes was performed with many ceremonies and great devotion. On this day, also, persons convicted of notorious sin were put to open penance. In England it is still a season for the saying of the "commination" in the prayer-book, by which the doers of certain kinds of wickedness are cursed.

8. *First Sunday in Lent*.—The Wednesday, Friday, and Saturday after this Sunday are called Ember Days, and the week in which they occur Ember Week. On Ember days, our forefathers ate no bread but what was baken in a simple and primitive fashion under hot ashes; hence the name. The other Ember Days of the year are the Wednesdays, Fridays, and Saturdays after the Feast of Pentecost, Holyrood Day (Sept. 14), and St. Lucia's Day (Dec. 15).

14. *St. Valentine's Day*.—St. Valentine was a priest of Rome, martyred in the third century, but he seems to have had no connection with the notions and practices to which his day has since been given up. This, it is scarcely necessary to say, is a day thought to be especially devoted to the business of Cupid and Hymen. Possibly, its being about the season when the birds choose their mates is the cause. Antiquaries have also pointed out that the Lupercalia, feasts of ancient Rome in honour of Pan and Juno, were held at this time, and that amongst the ceremonies was a game in which young persons of the opposite sexes chose each other jocularly by lot.

St. Valentine's Day is now almost everywhere a degenerated festival, the only observance of any note consisting in the sending anonymous letters, by way of practical joke, and this confined very much to the humbler classes. The approach of the day is heralded by the appearance in the printsellers' shop windows of vast numbers of missives calculated for use on this occasion, each generally consisting of a single sheet of paper on the first page of which is seen some ridiculous coloured caricature of the male or female figure, with a few burlesque verses below. More rarely, the print is of a sentimental kind, such as a view of Hymen's altar, with a pair undergoing an initiation into wedded happiness before it, while Cupid flutters above, and hearts transfixed with his darts decorate the corners. These are paltry frivolities compared with the observances of St. Valentine's day at no remote period. Ridiculous letters were then unknown; and if letters of any kind were sent, they contained only a courteous profession of attachment from some young man to some young maiden, honied with a few compliments to her various perfections, and expressive of a hope that his love might meet with return. But the true proper ceremony of St. Valentine's Day was the drawing of a kind of lottery, followed by ceremonies not much unlike what is generally called the game of forfeits. Misson, a learned traveller of the early part of the last century, gives apparently a correct account of the principal ceremonial of the day. "On the eve of St. Valentine's Day," he says, "the young folks in England and Scotland, by a very ancient custom, celebrate a little festival. An equal number of maids and bachelors get together; each writes his or her true or some feigned name upon separate billets, which they roll up, and draw by way of lots, the maids taking the men's billets, and the men the maids'; so that each of the young men lights upon a girl that he calls his *valentine*, and each of the girls upon a young man whom she calls hers. By this means each has two valentines; but the man sticks faster to the valentine that is fallen to him than to the valentine to whom he is fallen. Fortune having thus divided the company into so many couples, the valentines give balls and treats to their mistresses, wear their billets several days upon their bosoms or sleeves, and this little sport often ends in love."

In the various jesting ceremonies of the day, there always seems to have been a disposition to believe that the person drawn as a valentine had some considerable likelihood of becoming the associate of the party in wedlock. At least, we may suppose that this idea would be gladly and easily arrived at, where the party so drawn was at all eligible from other considerations. The common people seem to have imagined that an influence was inherent in the day, which rendered in some degree binding the lot or chance by which any youth or maid was now led to fix attention on a person of the opposite sex. It was supposed, for instance, that the first unmarried person of the other sex whom one met on St. Valentine's morning in walking abroad, was a destined wife or husband.

15. *Second Sunday in Lent.*

22. *Third Sunday in Lent.*

24. *St. Matthias the Apostle.*—A festival of the Church of England. St. Matthias was chosen by lot after the Crucifixion, in place of the traitor Judas (Acts i. 23).

Natural History.—The popular voice allots a course of snow, rain, and their hybrid sleet, to this month, and considers it necessary that such should be its features, in order that all the powers of humidity may be exhausted before the commencement of March, when an opposite kind of weather is looked for. It is indeed true that frost followed by regular thaw, and that succeeded by the sharp winds of March, bring the ground into the most favourable state for ploughing.

The general average of the thermometer is 39 degrees; that of different years varies from 30 to 42. The snowdrop and crocus are the chief ornaments of our flower-borders at this season. The primrose will also flower, and the hepatica come forth in some strength. In England, the raven and rook build their nests; the house-pigeon has young; the ringdove coos, the goldfinch sings, and thrushes pair. In Scotland, the notes of the thrush and blackbird give token of the approach of spring.

MARCH.

March, which with the ancients ranked the first month of the year, was named in honour of Mars, the supposed father of the founder of Rome. Our Anglo-Saxon ancestors called it *Lenct Monath*, that is, Lent or Spring Month.

1. *Mid Lent Sunday.*—A holiday of the Church of England. It was considered as incumbent upon all true Christians on this day to pay a visit, if possible, to their mother church, or church of their native parish, and there make some small offering. The epistle for the day accordingly contains an appropriate allusion, *Hierosolyma mater omnium*, Jerusalem the mother of all (Gal. iv. 21). And it was customary on the same day for people to visit their parents, carrying with them some gift, and receiving the parental blessing in return, together with a mess of furmety—that is, a porridge composed of whole grains of wheat, boiled in milk, and sweetened and spiced. This practice was called "going a mothering," and the day was sometimes called *Mothering Sunday*. The festival is supposed, with all its observances, to have taken its rise in the heathen festival of the Hilaria, celebrated by the ancient Romans in honour of the mother of the gods, on the ides of March.

St. David's Day.—The interest attached to this saint and his day is confined to the Welsh, whose patron saint St. David is considered. The most rational accounts of St. David represent him as Archbishop of Menevy (since, from him, called St. David's) in the sixth century. He is said to have been the illegitimate son of a prince of Cardigan, and uncle of the famous, but more than half fabulous, King Arthur. Learning, and more particularly asceticism, the great sources of promotion in those days, raised him to high esteem and ecclesiastical rank, and gave him the reputation of a power to perform miracles. At a synod called at Brevy in Cardigan, in 519, in consequence of the Pelagian Heresy, he made an eloquent and convincing display against the erroneous doctrines, which were therefore condemned. He died in 544, at an advanced age, and was buried in the church of St. Andrew, but in 962 his remains were transferred to Glastonbury Abbey.

While the Welsh venerate the memory of St. David, they are unacquainted with our idea of him as their patron saint, a notion which has sprung up in consequence of the popular fiction of the Seven Champions of Christendom. They observe the 1st of March as the anniversary of his death. On this day, all true Welshmen, whether in their own country or far removed from it, make it a point of conscience to wear a leek in their hats, and this custom is alluded to in writings of considerable antiquity. How the leek has become connected with St. David and the affections of Welshmen, is not ascertained. The most probable story is, that at a great battle between the Welsh and Saxons in the sixth century, the former, by advice of St. David, adorned their hats with leeks, for the sake of distinction from their enemies, taking the herb from a neighbouring field, where they grew in abundance. The victory gained by the Welsh being partly attributed to this cause, the leek was ever after held in veneration, and associated with the name of St. David. "The most honourable and loyal society of Ancient Britons," instituted in London 1714, and who support a school in the metropolis for the support and education of poor Welsh children, have an annual procession on St. David's Day, on which occasion each member wears a representation of the leek in his hat, the marshals in front being decorated in like manner. In the household expenses of the Princess Mary, in 1544, is a gift of fifteen shillings among the yeomen of the king's guard for bringing a *leek* to her grace on St. David's Day.

8. The *Fifth Sunday in Lent*.—It was popularly distinguished as *Care* or *Carling Sunday*, terms which appear to be of a very dubious import. The peasantry and yeomanry used to steep peas and afterwards parch them, and then, frying them with butter, made a feast of them on the afternoon of this day. It is thought not unlikely that the custom bore some reference to the superstitious notions which the ancients entertained respecting beans, as containing the souls of the departed. The peas, as eaten in the north of England, were called *carlings*. We may presume that the day took its name from this word, *carling* being in time softened into *Care*. It figures in an old rhyme which enumerates the Sundays of Lent by popular appellations—

"Tid, Mid, and Misera.
Carling, Palm, and good Pace-day."

The three first words are supposed to have been derived from the beginnings of certain psalms—thus, *Te deum*, *Mi deus*, *Miserere* mei.

15. *Palm Sunday*, called in the English Prayer-book the Sunday next before Easter; also sometimes called Passion Sunday, as being the commencement of Passion Week, or the week celebrative of the sufferings or passion of our Lord. It is a festival of great antiquity and a partly joyous character, as more particularly commemorating the brilliant though short-lived popularity of the reception which Christ met with on entering Jerusalem, immediately before his passion. On this day, in Catholic countries, the priests bless branches of palm, or or some other tree, which are then carried in procession, in memory of those strewed before Christ at his entrance into the holy city. The procession is as splendid as circumstances will admit of: and after it is done, the boughs used are burnt, and their ashes preserved, that they may be laid on the heads of the people next Ash Wednesday, with the priest's blessing.

After the Reformation, 1536, Henry VIII. declared the carrying of palms on this day to be one of those ceremonies not to be contemned or dropped. The custom was kept up by the clergy till the reign of Edward VI., when it was left to the voluntary observance of the people. Fuller, who wrote in the ensuing age, speaks of it respectfully, as "in memory of the receiving of Christ into Hierusalem a little before his death, and that we may have the same desire to receive him into our hearts." It has continued down to a recent period, if not to the present day, to be customary in many parts of England to go *a palming* on the Saturday before Palm Sunday; that is, young persons go to the woods for slips of widow, which seems to be the tree chiefly employed in England as a substitute for the palm, on which account it often receives the latter name. They return with slips in their hats or button-holes, or a sprig in their mouths, bearing the branches in their hands. Not many years ago, one stall-woman in Covent-Garden market supplied the article to a few customers, many of whom, perhaps, scarcely knew what it meant. Slips of the willow, with its velvety buds, are still stuck up in some rural parish churches in England.

17. *St. Patrick's Day*, a high festival of the Romish Church. The interest attached to this saint and his day is, however, chiefly confined to the Irish, whose patron saint he is considered; though that term, as in the case of St. David, is of modern and English origin. The Irish venerate St. Patrick as the person who introduced Christianity into their country. He is said to have been born at Kilpatrick, near Dunbarton in Scotland, and to have first visited Ireland as a boy and a prisoner. Afterwards travelling into Gaul and Italy, and growing up as a learned priest, he was commissioned by Pope Celestine to convert the Irish, a task which he immediately commenced, and carried into effect with unexampled ardour and perseverance. He travelled throughout the whole of Ireland, preaching everywhere to the barbarous people, whom he baptized in multitudes. He also ordained clergy to preside over them, gave alms to the poor, made presents to the kings, founded monasteries, and, in short, established the Christian religion and a full apparatus for its support in Ireland. Monkish annals and popular tradition attribute to him an immense number of miracles, most of which have probably no basis in fact. He died in 432, at Down in Ulster, and was there buried.

As the Welsh are solicitous to display the leek on St. David's Day, so are the Irish to show the *shamrock* on that of St. Patrick. The shamrock is a bunch of trefoil, a species of grass. It is associated with St. Patrick and his day in consequence, as popular story goes, of the saint having made a very adroit use of the plant in his first preaching immediately after landing. The people being staggered by the doctrine of the Trinity, and disposed to show some violence to him, he took up a trefoil growing by his side, and illustrated the point by showing its three blades growing on one stalk; whereupon they were immediately convinced, and became converts. In Dublin, St. Patrick's Day is, or was lately, a scene of festivity and mirth unparalleled. "From the highest to the lowest, all seem inspired by the saint's beneficence. At day-break, flags fly from the steeples, and the bells ring out incessant peals till midnight. The rich bestow their benevolence on the poor, and the poor bestow their blessings on the rich, on each other, and on the blessed St. Patrick. The 'green immortal' shamrock is in every hat. Sports of manly exercise, exhibit the capabilities of the celebrated shilelah. Priestly care soothes querulousness; laughter drowns casualty; lasses dance with lads; old women run about to share cups of consolation with each other; and by the union of wit, humour, and frolic, this miraculous day is prolonged till after the dawn of next morning."*

19. *Maundy Thursday*, called also Shere Thursday, the day before Good Friday. Its name of Shere Thursday appears to have arisen from the practice which the priests had of shearing their hair on this day, to make themselves as trim as possible for Easter. The other name is more doubtful, but seems most probably to have been derived from *maund*, an old English word for a basket, in consequence of the distribution of gifts on this day in baskets—the word *maundy* used by old authors for alms or gifts being apparently derived in its turn from the practice of this day. The religious customs of the day consisted in works of humility and in conferring gifts on the poor. The object seems to have been to commemorate, or imitate, the humility of Christ in washing the feet of his disciples—the giving of maundies being an additional good work. Cardinal Wolsey, at Peterborough Abbey, in 1530, "made his maund in our lady's chapel, having fifty-nine poor men whose feet he washed and kissed; and after he had wiped them, he gave every of the said poor men twelve pence in money, three ells of good canvas to make them shirts, a pair of new shoes, a cast of red herrings, and three white herrings; and one of these had two shillings"—the number of the poor men being probably in correspondence with the years of his age. Even royalty condescended to this practice. The king of England was accustomed on Maundy Thursday to have brought before him as many poor men as he was years old, whose feet he washed with his own hands, after which his majesty's maunds, consisting of meat, clothes, and money, were distributed among them. Queen Elizabeth, when in her

* Hone's Every-day Book.

thirty-ninth year, performed this ceremony at her palace of Greenwich, on which occasion she was attended by thirty-nine ladies and gentlewomen. Thirty-nine poor persons being assembled, their feet were first washed by the yeomen of the laundry with warm water and sweet herbs, afterwards by the sub-almoner, and finally by the queen herself, kneeling; these various persons, the yeomen, the sub-almoner, and the queen, after washing each foot, marked it with the sign of the cross above the toes, and then kissed it. Cloths, victuals, and money, were then distributed. This strange ceremonial, in which the highest was for a moment brought beneath the lowest, was last performed in its full extent by James II. King William left the washing to his almoner; and such was the arrangement for many years afterwards. "Thursday, April 15, [1731], being Maundy Thursday, there was distributed at the Banqueting House, Whitehall, to forty-eight poor men and forty-eight poor women (the king [George II.]'s age being forty-eight), boiled beef and shoulders of mutton, and small bowls of ale, which is called dinner; after that large wooden platters of fish and loaves, viz. undressed, one large old ling, and one large dried cod; twelve red herrings and twelve white herrings, and four half-quarter loaves. Each person had one platter of this provision; after which were distributed to them shoes, stockings, linen and woollen cloth, and leathern bags, with one penny, twopenny, threepenny, and fourpenny pieces of silver and shillings—to each about four pounds in value. His Grace the Lord Archbishop of York, Lord High Almoner, performed the annual ceremony of washing the feet of a certain number of poor in the Royal Chapel, Whitehall, which was formerly done by the kings themselves, in imitation of our Saviour's pattern of humility." For a considerable number of years, the washing of the feet has been entirely given up; and since the beginning of the reign of Queen Victoria, an additional sum of money has been given in lieu of provisions.

20. *Good Friday.*—This day, as the presumed anniversary of the Crucifixion, has for ages been solemnly observed throughout Christian Europe, the only exceptions being in Presbyterian countries, such as Scotland. In Catholic times, the observances of the day in England were of the same character with those which are still maintained in many parts of the continent. It is still a solemn festival of the Church of England, and the only one besides Christmas which is honoured by a general suspension of business. Strict church-of-England people abstain from all kind of animal food, even from cream to tea; such, we are informed by Boswell, was the custom of Dr. Johnson. The churches are well attended, and it is considered proper to appear there in black clothes.

Among the usages of this day was a strange ceremony of creeping to the cross, which even the king was not exempt from performing. The king also distributed rings at Westminster Abbey for the cure of the cramp. The ceremonious burying of a crucifix, as representing the burial of Christ, is calculated to give less surprise. It is still in some measure kept up in the service of the *Tenebræ*, performed in St. Peter's at Rome. It was also customary at great churches to have a small building in the form of a tomb, in which the host was this day deposited, by way of representing the burial of Christ. In England, and perhaps also in other countries, eggs and bacon were the kinds of food appropriate to Good Friday. The eggs laid on this day were thought to have the power of extinguishing any fire into which they might be thrown. In modern times, the only species of viands connected with the day is the well-known hot cross bun, a small spiced cake, marked with the figure of a cross, and sold not only in baker's shops, but by persons traversing the streets with baskets.

In London, as well as in almost every other considerable town in England, the first sound heard on the morning of Good Friday is the cry of "Hot Cross Buns!" uttered by great numbers of people of an humble order, who parade the streets with baskets containing a plentiful stock of the article, wrapped up in flannel and linen to keep it warm. The cry, which is rather musical, is strictly—

> Hot cross buns—
> One a penny, buns—two a penny, buns
> One a penny, two a penny—hot cross buns.

Hucksters of all kinds, and many persons who attempt no traffic at any other time, enter into the business of supplying buns on Good Friday morning. They make a stir on the streets, which lasts till church time, and it is resumed in the afternoon. About a century ago, there was a baker's shop at Chelsea, so famous for its manufacture of excellent buns that crowds of waiting customers clustered under its porch during a great part of the day. The buns were brought up from the oven on small black tin trays, and so given out to the people. The king himself had stopped at the door to purchase hot cross buns, and hence the shop took the name of the Royal Bun-House. As always happens in London when any thing original and successful is struck out, the royal bun-house soon obtained a rival, and was obliged to advertise as the Old Original Royal Bun-house. The wars of these two houses, like those of York and Lancaster, have long since been hushed to rest, and we find it stated in a recent work* that neither of them is now distinguished for this article above the other bakers' shops of Chelsea.

In old times, Good Friday was distinguished in London by a sermon preached at *Paul's Cross* (a wooden pulpit placed on stone steps, and surmounted by a cross, which stood till the time of the civil war, in the open air, near the north-east corner of St. Paul's Cathedral). The sermon was generally on the subject of Christ's passion. Connected with it, two or three others were preached on Monday, Tuesday, and Wednesday, in Easter week, at the Spital in Spitalfields, where the Lord Mayor and all the most eminent persons in London generally attended. The "Spital sermons" are still kept up, but take place in St. Bride's Church.

21. *Easter Eve.*—In Catholic times, it was customary to put out all fires on this day, and light them anew from flint. The priest blessed the new fire, and a brand from it was thought to be an effectual protection against thunder-strokes. A large wax taper, called the Paschal Taper, was also blessed and lighted beside the representative sepulchre above-mentioned, and there a vigil was kept till morning. The taper used on one of these occasions in Westminster Abbey church was 300 pounds in weight.

22. *Easter Day*, a solemn festival in celebration of the Resurrection. The word used by us is from the Saxon *oster* (rising). Easter is observed with much ceremonial, not only throughout Catholic Europe, and in the countries where the Greek Church is established, but in Turkey and the Mohammedan countries along the coast of Africa. The festival is an engraftment upon the Jewish Passover, the name of which (*pascha*) is still applied to it in almost every country besides England. The Catholic observances of Easter are of an elaborate character. At Rome, the Pope is carried in state to perform high mass in St. Peter's, from the balcony of which he afterwards blesses the people assembled in the piazza below—perhaps one of the most imposing religious spectacles which the world anywhere presents. In England, before the Reformation, the Catholic observances of Easter were as fully enacted as in any other country. Early in the morning, a sort of theatrical representation of the Resurrection was performed in the churches, t-

* Hone's Every-day Book, i. 404.

priests coming to the little sepulchre where, on Good Friday, they had deposited the host, which they now brought forth with great rejoicings, as emblematical of the rising of the Saviour. In the course of the day, the clergy had a game at ball in the church, a custom of which it is now difficult to believe that it ever could have existed.

At present, in large seats of population, Easter Sunday is distinguished by little besides the few peculiarities of the service, and the custom of going to church in attire as gay as possible. But in rural districts there still exist a few vestiges of old superstitions and customs connected with the day. It was once a general belief, and probably still is so in a few out-of-the-way places, that on Easter morning the sun danced or played immediately after his rising. People rose early and went into the fields to see this supposed phenomenon.

The viands appropriate to Easter Day in the old times were, first and above all, eggs, then bacon, tansey pudding, and bread and cheese. The origin of the connection of eggs with Easter is lost in the mists of remote antiquity. They are as rife at this day in Russia as in England. There it is customary to go about with a quantity, and to give one to each friend one meets, saying, "Jesus Christ is risen," to which the other replies, "Yes, he is risen," or, "It is so of a truth." The Pope formerly blessed eggs to be distributed throughout the Christian world for use on Easter day. In Germany, instead of the egg itself, the people offer a print of it, with some lines inscribed. Formerly, the king of England had hundreds prepared to give to his household: in a roll of the expenses of Edward I., there occurs, in the accounts of Easter Sunday, in the eighteenth year of his reign, "Four hundred and a half of eggs, eighteenpence." The custom is supposed to have been originally Jewish.

At this day, the Easter eggs used in England are boiled hard in water containing a dye, so that they come out coloured. The boys take these eggs and make a kind of game, either by throwing them to a distance on the green sward—he who throws oftenest without breaking his eggs being the victor—or hitting them against each other in their respective hands, in which case the owner of the hardiest or last surviving egg gains the day.

It was customary to have a gammon of bacon on this day, and to eat it all up, in signification of abhorrence of Judaism. The tansey seems to have been introduced into Easter feasts, as a successor to the bitter herbs used by the Jews at the Passover. It was usually presented well sugared.

It was a custom in the thirteenth century to seize all ecclesiastics found walking abroad between Easter and Pentecost, and make them purchase their liberty with money. This was an acting of the seizure of the apostles after Christ's passion. We have still what appears to be a relic of this fashion in a custom which exists in various parts of England. A band of young men go abroad, and whatever female they meet they take hold of her, and pull off her shoes, which are only returned to her upon her paying some trifling forfeit. In Durham, it is done by boys, who, on meeting any woman, accost her with, "Pay for your shoes, if you please." The trifling sums which they thus collect are spent in a feast at night. At Ripon, celebrated for its manufacture of spurs, travellers riding through the town are stripped of those articles, which in like manner they have to redeem. On Easter Monday, the women make a return by going abroad in groups, and causing the men to redeem their shoes.

"Lifting at Easter" is another old custom, which may be presumed to have originated in a design of dramatizing the events connected with Christ's passion. It consisted in hoisting individuals up into the air, either in a chair or otherwise, until they relieved themselves by a forfeit. A curious record makes us aware that, on Easter Day, in the eighteenth year of the reign of Edward I., seven ladies of the queen's household went into the king's chamber, and *lifted him*, for which fourteen pounds appears to have been disbursed as a forfeit. The men lifted the women on Easter Monday, and the women claimed the privilege of lifting the men on the ensuing day. Three hoists were always given, attended by loud huzzas.

23. *Easter Monday.*—This and the ensuing day are holidays of the church. The week commencing with Easter, and called thence Easter week, is a season of festivity, and the earlier days of it after Easter itself, are in London devoted by the working-classes to recreation and amusement, which they chiefly seek for at Greenwich fair, and in excursions to taverns near town.

25. The *Annunciation of our Lady*, a festival of the Church of England. It is commonly called in England *Lady Day*, as an abridgment of the Day of our Blessed Lady. This festival is in celebration of the incarnation of Christ, or the announcement by the Holy Ghost to Mary that she should bear the Son of God. The Annunciation is observed as a holiday at all the public offices, excepting the Stamps, Excise, and Customs. It is a gaudy day in the Romish Church. In Catholic countries, the service of this day resounds with "Hail, Mary!" uttered in a strain of the highest enthusiasm. The 25th of March is held as a quarter-day for many commercial purposes in England.

29. The first Sunday after Easter, called *Low Sunday*, because it is Easter day repeated, with the church-service somewhat abridged or *lowered* in the ceremony from the pomp of the festival the Sunday before.

Natural History.—March is eminently a spring month, and the season more particularly devoted to sowing. Its general character, as far as the extreme uncertainty of our climate warrants us to speak, is dryness. The frosts of winter, followed by the sharp dry winds of this month, have the effect of pulverizing the soil, and fitting it for the reception of the seed. The value of the weather appropriate to March is expressed in the saying, "A peck of March dust is worth a king's ransom." This month is also expected to undergo a change between its beginning and its end. The English say, "March comes in like a lion, and goes out like a lamb;" the Scotch version of the same idea is, "March comes in with an adder's head, and goes out with a peacock's tail." The general average temperature of March (41 degrees) is so little above that of February, as to make the greater dryness appear to arise in but a small degree from heat. There is in March a general bursting of the trees into leaf, of the meadows into flower, and partly, it may be added, of the birds into song. It is the season for planting gardens as well as sowing the fields, although there are few which may not be deferred for a little longer without disadvantage.

APRIL.

The Romans gave this month the name of *Aprilis*, from *aperio*, because it was the season when things *opened*. By the Saxons it was called Ostre month, probably from the same word from which Easter is supposed to have been derived. The Dutch and Germans call it Gras month.

1. *All Fool's Day.*—From a very early age, this day has been considered as one set apart for the exercise of all kinds of mirthful folly and practical joking: the term given to it we may hold as a travestie of the festival of All Saints' Day. The custom of playing off little tricks on this day, whereby ridicule may be fixed upon unguarded individuals, appears to be universal through-

out Europe. In France, one thus imposed upon is called *Un poisson d'Avril* (an April fish). In England, such a person is called an April fool; in Scotland, a gowk. Gowk is the Scotch for the cuckoo, and also signifies a foolish person, being in fact from the same root with the English word gawky. The favourite jest in Britain is to send one upon an errand for something grossly nonsensical, as for pigeon's milk, or the history of Adam's grandfather, or to make appointments which are not to be kept, or to call to a passer-by that his latchet is unloosed, or that there is a spot of mud upon his face. When he falls into the snare, the term April fool or gowk is applied with a shout of laughter. It is very remarkable that the Hindoos practise precisely similar tricks on the 31st of March, when they have what is called the Huli festival.

7 The fifteenth day after Easter is marked by an old English festival, to which the inexplicable term *Hock Day* is applied. The custom peculiar to the day consisted in the men and women of rural districts going out the road with ropes, and intercepting passengers jocularly, and raising money from them, to be bestowed, it may well be presumed, in pious uses.

23. *St. George's Day* in the Romish calendar. St. George is held as the tutelar or patron saint of England. He is said to have been a native of Cappadocia; and it is tolerably certain that he was held in great veneration by the Greeks in the fourth century. Throughout the countries once constituting the Lower Empire, in the Crimea, and in Tartary, he has for ages been worshipped, in the former countries, as a saint, in the latter as a deity. By all he is invariably represented as a man on horseback, spearing a dragon. With a regard, apparently, to his military character, our Edward III. adopted his name as his war-cry, and his figure as a badge in connection with the order of the garter; thus originated the association of St. George with England, since in many respects so conspicuous. It is remarkable that in Russia St. George is as much a favourite saint as he is in England. The sovereigns of that country have borne his emblem from a time previous to Edward III. The derivation of Russian Christianity from the Greek Church suggests a ready explanation of this fact. The English do not mark the day of their national saint with any of those observances which give St. David's and St. Patrick's days so peculiar a character; but it was customary at no distant period for people of fashion to wear a blue coat on this day, in honour of St. George.

25. *St. Mark the Evangelist's Day*, a holiday of the Church of England. It was once customary to bless the fruits of the earth on this day; hence, perhaps, a notion amongst the peasantry, that to plough or do any other work on St. Mark's day will be apt to bring down divine wrath. The eve of St. Mark was distinguished by some superstitious ceremonies. Maidens met to make the *dumb cake*. This was done by a number not exceeding three, and it was to be done in silence. At twelve o'clock, the cake being prepared, each broke off a piece and ate it; then walked backwards to her sleeping-room. It was thought that those who were to be married would hear a noise as of a man approaching. Those who heard nothing were to remain unmarried. Watching the church porch was another practice of this eve. A man went fasting and took his station there before midnight. It was thought that, during the hour between twelve and one, he would see the spirits of all who were to die in the parish during the ensuing year walk into church, in the order in which they were to die, those who were to perish by violence making gesticulations appropriate to the peculiar modes of their death. There were similar superstitions regarding the eve of St. John (June 24); which see.

26. *Rogation Sunday*.—The Sunday before Ascension is always so called. The three days immediately following are also called Rogation Days. The Archbishop of Vienne in Dauphiné, about the year 469, caused the litanies or supplications to be said on those days for deliverance from earthquakes, by which his city had been much injured. The days were thence called Rogation (that is, supplication) days. They were distinguished by great processions of ecclesiastics throughout the bounds of their districts.

30. *Ascension Day*, or *Holy Thursday*, a holiday of the Church of England, observed by the shutting of most of the public offices. This festival, which invariably occurs on the fortieth day after Easter, is designed to celebrate the ascension of Christ into heaven It was once distinguished by great festivities. On this day, also, there was a custom of the parish schoolmaster going with his pupils round the bounds of the parish, the pupils carrying peeled willow wands wherewith they struck the boundaries. This was an expedient for keeping those boundaries in memory, in an age when more accurate means of attaining the same end did not exist.

Natural History.—Mild weather, with genial showers, is the character usually given to April; but in modern times, the weather is often the reverse of this, being dry, with cold winds. On the average, indeed, there is more north wind and *less rain* this month than in any other. The progressive advance of temperature from winter towards summer is very apparent this month, the general average height of the thermometer being 46 degrees. This month is the usual seed-time for barley. In the gardens it is the busiest time of the year for seed-sowing.

MAY.

Among the Romans, this was the *mensis maiorum*, or month dedicated to the elder persons of their community, while the next was the *mensis juniorum*, or month of the younger people. Thus, most probably, arose the names of May and June. Others suppose that May would derive its name from Maia, the mother of Mercury, who was worshipped on the first day; but it is not impossible that Maia and her day were afterthoughts, when the real origin of the name of May was out of mind. The Saxons are said to have given this month the strange-looking name of Trimilchi, because they then began to milk their cows three times a day. The Romans believed it to be unlucky to marry in May.

1. *St. Philip and St. James the Less*, a holiday of the Church of England.

As a popular festival, under the name of *May Day*, this day has been celebrated from time immemorial. The celebration must, doubtless, have been prompted by nature herself: the time of the young flower and leaf, and of all the promise which August fulfils, could not but impress the minds of the simplest people, and dispose them to joyful demonstrations in word and act. The sun, as the immediate author of the glories of the season, was now worshipped by the Celtic nations under the name of Baal; hence the festival of *beltein*, still faintly observed in Ireland and the Highlands of Scotland. Even in Ayrshire, they kindled Baal's fire in the evening of May-day, till about the year 1790. The Romans held games called Floralia, at which there was great display of flowers, and where women danced, if we are to believe Juvenal, only too enthusiastically. The May-day jollities of modern Europe seem to be directly descended from the Floralia.

In England, we have to go back a couple of hundred years for the complete May-day; since then it has gradually declined, and now it is almost extinct. When it was fully observed, the business of the day began with the day itself, that is to say, at midnight. We have the authority of Shakspeare, that with the populace of England it was impossible to sleep on May morning. Immediately after twelve had struck, they were all astir, wishing each other a merry May, as they still, at the same hour on the 1st of January, wish each other a happy new year. They then went forth, with music and the blowing of horns, to some neighbouring wood, where they employed themselves in breaking down and gathering branches. These they brought back at an early hour, and planted over their doors, so that by daylight the whole village looked quite a bower. The citizens of London went a-Maying in this fashion, notwithstanding their comparative distance from woods. They went marshalled in parishes, or in unions of two or three parishes; their mayor and aldermen went also; and we read of Henry VIII. and Queen Catherine riding from Greenwich to Shooter's Hill, attended by lords and ladies, to join in the sport. In some places, the Mayors brought home a garland suspended from a pole, round which they danced. In others, and this was a more general custom, there was an established May-pole for the village, which it was their business to dress up with flowers and flags, and dance around throughout all the latter part of the day. A May-pole was as tall as the mast of a sloop of fifty tons, painted with spiral stripes of black and white, and properly fixed in a frame to keep it erect. Here lads and lasses danced in a joyful ring for hours to the sounds of a viol, and masquers personating Robin Hood, Little John, Maid Marian, and others of the celebrated Sherwood company of outlaws, as well as morris-dancers, performed their still more merry pranks. May-poles, as tending to encourage levity of deportment, were condemned by the Puritans in Elizabeth's time; James I. supported them in his Book of Sports; they were altogether suppressed during the time of the Commonwealth, but got up again at the Restoration. Now, change of manners has done that which ordinances of Parliament could not do. This object, so interwoven with our national poetical literature, is all but rooted out of the land.

A certain superstitious feeling attached to May-day. The dew of that morning was considered as a cosmetic of the highest efficacy; and women, especially young women, who are never unwilling to improve in this respect, used to go abroad before sunrise to gather it. To this day there is a resort of the fair sex every May morning to Arthur's Seat, near Edinburgh, for the purpose of washing their faces with the dew. Mr. Pepys, in his diary, gravely tells us of his wife going to Woolwich for a little air, and to gather May-dew, "which Mrs. Turner hath taught her is the only thing in the world to wash her face with." Scott, in his "Discovery of Witchcraft," speaks of a sprig of hawthorn gathered on May-day, and hung in the entry to a house, as a presumed preservative against all malign influences. There was also a practice of making fools on May-day, similar to what obtains on the first of the preceding month. The deluded were called *May-goslings*. It was held unlucky to marry in May, a notion which, as already mentioned, existed among the Romans. It still exists in Scotland, where very few marriages take place in May, the higher classes being equally superstitious on the subject with the lower.

In London, as has been said, May-day was once as much observed as it was in any rural district. There were several May-poles throughout the city, particularly one near the bottom of Catherine Street in the Strand, which, rather oddly, became in its latter days a support for a large telescope at Wanstead in Essex, the property of the Royal Society. The milkmaids were amongst the last conspicuous celebraters of the day. They used to dress themselves in holiday guise on this morning, and come in bands with fiddles, whereto they danced, attended by a strange-looking pyramidal pile, covered with pewter plates, ribbons, and streamers, either borne by a man upon his head, or by two men upon a hand-barrow: this was called their *garland*. The young chimney-sweepers also made this a peculiar festival, coming forth into the streets in fantastic dresses, and making all sorts of unearthly noises with their shovels and brushes. The benevolent Mrs. Montagu, one of the first of the class of literary ladies in England, gave these home slaves an annual dinner on this day, in order, we presume, to aid a little in reconciling them to existence. In London, May-day still remains the great festival of the sweeps, and much finery and many vagaries are exhibited on the occasion.

The Robin Hood games and morris-dancers, by which this day was distinguished till the Reformation, appear, from many scattered notices of them, to have been entertainments full of interest to the common people. Robin has been alternatively styled in at least one document as the King of May, while Maid Marian seems to have been held as the Queen. The various scattered particulars respecting these festivities, which make but dry reading by themselves, have been wrought up to some advantage by Mr. Strutt in his "Queen Hoo Hall," where he describes May-day as celebrated by the servants and dependants of an English baron of the fifteenth century.

3. *The Invention of the Cross*, a festival of the Romish Church, designed to commemorate the finding of the cross upon which Jesus had suffered, by St. Helena. The festival is shortly called *Rood Day*.

10. *Whit-Sunday*, a festival of the Church of England, designed to commemorate the descent of the Holy Spirit upon the apostles on the day of Pentecost. In Catholic countries, on this day, while the people are assembled in church, pigeons are suspended above, and wafers, cakes, oak leaves, and other things, are made to shower down upon the altar—all this as a dramatic representation of the miracle.

11. *Whit-Monday*.—A festival of the Church of England, as is

12. *Whit-Tuesday*.—These three days together are called Whitsuntide. It forms a term, for which the 15th of May is fixed. The Wednesday, Friday, and Saturday of this week are Ember Days, and the week is consequently an Ember Week. (*See 8th February*.) This also was a period of festivity among our ancestors. They now had what they called the *Whitsun Ale*, which consisted in a meeting of householders with their families at the church, after service, to partake of a feast provided by the churchwardens, at which the young danced and played at games, while the seniors looked on. In the days before the poor were supported by rates, a collection was made on this occasion, usually found sufficient to provide for them. The Whitsun Ale is now degenerated, where it exists at all, into a merry-making at a barn. Whitsunday and Martinmas terms (May 15 and November 11) are those alone regarded for the leasing of all kinds of property, paying of rents, and engaging of servants, in Scotland.

17. *Trinity Sunday*, a festival of the Church of England, which always takes place eight weeks after Easter.

21. *Corpus Christi*, a festival of the Romish Church, always held on the Thursday after Trinity Sunday. It celebrates the doctrine of transubstantiation. In all Roman Catholic countries it is observed with music, lights, flowers strewed in the street, rich tapestries hung upon the walls, and processions and plays representing Scripture subjects.

29. *Restoration Day*, a holiday of the Church of England to celebrate the restoration of monarchy in the person of Charles II., May 29, 1660, after its suppression for the preceding twelve years. The populace at one time wore oak leaves in their hats on this day, with reference to the concealment of Charles in the Royal Oak, while skulking after the battle of Worcester, 1651.

Natural History.—May is a month of the best reputation—indeed a general favourite in imagination; but it often balks the hopes of its worshippers. In favourable seasons, it presents many beautiful appearances, as herbage and foliage of the brightest green, a profusion of natural flowers, soft and genial skies, fishes leaping, swallows twittering, bees humming, the cuckoo repeating her note, and the corn coming into blade. But these appearances are often prevented or much clouded by cold east winds, most destructive to the fruit blossom. The greater prevalence of this wind during May than in any other, seems to be chiefly the cause of the well-known injunction, "Change not a clout till May be out." The general average temperature is about 51 degrees. We are now arrived at the latest period of seed-time. In the most backward parts of the country, barley is still sown, and the seeds of some of the tenderer garden plants are committed to the earth. The ash, last-budding of the trees, comes into leaf in the latter part of the month.

JUNE.

The probable origin of the name of this has been explained at the same time with that of May.

11. *St. Barnabas the Apostle*, a holiday of the Church of England. In the days of old style, the 11th of June was the longest day of the year—hence an ancient rhyme—

> Barnaby bright.
> The longest day and the shortest night.

15. *St. Vitus's Day*.—St. Vitus was a Sicilian martyr. From him, though for what reason is unknown, is named a well-known nervous affection of the limbs, proceeding from a disordered state of the visceral system. It was a popular belief that rain on this day indicated rain for thirty days thereafter.

24. *St. John's Day*, the Nativity of St. John the Baptist, a holiday of the Church of England. The *Eve of St. John*, variously called *Midsummer Eve*, was formerly a time of high observance amongst the English, as it still is in Catholic countries. Bonfires were everywhere lighted, round which the people danced with joyful demonstrations, occasionally leaping through the flame. A certain number of citizens formed a watch, which perambulated the streets all night. It was also believed that, on this eve, by fasting, waking, pulling certain herbs, and going through certain ceremonies, it was possible to obtain an insight into futurity on some important points. *Fasting St. John's Fast* was a great feat of young women a century or two ago. There was also a custom of holding vigil in the church-porch, precisely the same as described under St. Mark's Day (April 25).

29. *St. Peter's Day*, a high festival of the Romish Church, and a holiday of the Church of England. It is celebrated at Rome with illuminations and magnificent ceremonials. In England, till a recent period, the bonfires and watchings of St. John's Eve were also customary on the eve of this festival.

Natural History.—In the central parts of our island, this is in general a dry coldish summer month. The days, however, are at the longest; and though June ranks only third highest as to temperature, drought or evaporation reaches the extreme point. June here resembles the May of more southern climes. The foliage being now quite fresh and fully expanded, and the verdure of the pastures and corn fields being also at the best, the face of nature appears to the greatest advantage. Towards the end of the month we meet with a near coincidence of four stages of vegetation—the earing of wheat, the flowering of the rose, the ripening of strawberries, and the commencement of hay harvest. The general average of the thermometer is 57 degrees. In the course of the month we have the flowering a great number of fine perennials and shrubs, so that the gardens are usually in great glory. It is also the time when weeds give the gardener the greatest trouble.

JULY.

This, being at first the fifth month of the Roman year, was called Quintilis. It became the seventh in consequence of the reform of the calendar by Julius Cæsar, in whose honour, as he was born in it, Augustus gave it the present name.

3. The day fixed in the calendars as the first of the *Dog-Days*, the last being the 11th of August. The dog-days precede and follow the heliacal rising of the star Sirius (in the constellation of the Greater Dog) in the morning, which in Pliny's time was on the 18th of July. The extreme heat of this season of the year, although to us palpably the effect of the continued high position of the sun, was connected by the ancients with the appearance of this star in the morning. They considered the dog-star as raging, and gave the time the appellation of the Dog-Days. The liability of dogs to rabies in consequence of the heat of the season was connected with the same star, though there was nothing but accident in the collusion; and they butchered these animals without mercy. At Argos, there was a festival expressly instituted *for the killing of dogs* during this season. By the precession of the equinoxes, the heliacal rising of Sirius in the morning has been changed to the latter end of August, and in a few thousand years more it will take place in the depth of winter.

4. *The Translation of St. Martin Bullion*, noticed as a festival in the Church of England calendar, though not observed. There is an old saying, not heretofore in print, "If the deer rise up dry and lie down dry on St. Bullion's Day, it is a sign there will be a good gose har'st;" meaning, apparently, that dry weather at this season is favourable to the crops.

St. Ulric's Day.—On this day, in ancient Catholic times, the people brought fish to the altar to obtain the favour of St. Ulric, and one sat there selling the same back to the public for the benefit of the Church.

7. *The Translation of St. Thomas à Becket*, noticed as a festival in the Church of England calendar.

15. *St. Swithin's Day*—remarkable on account of a well-known popular notion, that if it rain on this day, there will be more or less rain for forty days to come. St. Swithin lived just a thousand years ago. He was an eminently pious and learned bishop of Winchester, and priest to King Egbert. He was the deviser and originator of tithes in England. The story runs that, being buried by his own request in the churchyard of the cathedral, the priests a hundred years after felt desirous of giving him greater honour, and commenced the work of translating his remains into the interior. This was on the 15th of July. They were stopped in their work by a heavy fall of rain; neither could they resume their duty next day, for the heavy rain still continued. In short, this rain lasted forty days, by which time the priests became convinced that it was designed to stop them in a work which, though well meant on their part, was ill taken on that of the saint; and they gave up the point. Ever since then, it has been held as a maxim, that if there be rain on St. Swithin's Day (the 15th of July), there will be rain for the forty ensuing days. In a scientific work on the climate of London, it is acknowledged that, "in a majority of our summers, a showery period, which with some latitude as to time and local circumstances, may be admitted to constitute daily rain for forty days, does come on about the time indicated by this tradition—not that any long space before is often so dry as to mark distinctly its commencement."

20. *St. Margaret's Day*.—This day figures in the Church of England calendar. St. Margaret was a holy Italian virgin, martyred in 278. She seems to have been the Christian Lucina: formerly, at Paris, there was a flocking to church on this day of all women who were

pregnant or thought they might be so in the course of the year.

25. *St. James the Apostle*, a holiday of the Church of England. In Catholic times, it was customary for the priests on this day to bless the apples. On St. James's Day, but according to old style (7th August, new style), oysters appeared in London, and there is a popular notion that he who eats oysters on that day will never want money for the rest of the year.

Natural History.—July is the warmest month of the year, the general average temperature being 61 degrees. With us it may be accounted the most important, as its temperature in a good measure regulates the ripening of the crop, that is to say, determines whether it shall be early or late; and in our climate this for the most part may be reckoned a criterion of its value. Flora is in her glory this month. The greatest display of flowers in the whole year takes place in the course of July in our climate. The list includes all the hardy annuals and a great many others. At the same time all our small fruit are in abundance, cherries and strawberries in the beginning being followed by currants, gooseberries, and raspberries, in all their varieties. In the early part of the month barley and oats come into ear, and sometimes in very forward seasons a little barley is cut before the end of July; but very rarely any other kind of grain is ready for the sickle before August. A great part of the produce of the garden comes to perfection, such as early cabbage, cauliflower, turnips, peas, beans, lettuce, &c. Early potatoes also make their appearance, but are not mature till next month.

AUGUST.

In early Roman times this month was called Sextilis, as being the sixth of the year. The Julian arrangement made it the eighth. It acquired the name *Augustus*, in honour of the second of the Cæsars, to whom it had been a fortunate period, he having in it assumed his first consulship, celebrated three triumphs, subdued Egypt, received the oath of allegiance of the legions that occupied the Janiculum, and terminated the civil wars of Rome. As already mentioned, being dissatisfied with its being a month of thirty days, he took a day from February to make it one of the longer class, like that of his uncle Julius. At the same time, September and November were each deprived of a day, which was added in the one case to October, and in the other to December.

1. *Lammas Day*, called also the *Gule of August*. It is now only remarkable as a day of term for some purposes. It was probably one of the great festival days of our heathen ancestors; and it is worthy of observation that it occurs exactly three months after another of these—Beltane. Cromac, Bishop of Cashel in the tenth century, records that in his time four great fires were lighted up on the four great festivals of the Druids, namely, in February, May, August, and November: probably Beltane and Lammas were two of these. Lammas seems to have been held as a day of thanksgiving for the new fruits of the earth. It was observed with bread of new wheat; and there was a custom in some places at no distant period for tenants to be bound to bring in wheat of the new crop to their lord on or before this day. The most rational explanation of the word is that which derives it from the Saxon *Hlaf-Masse* (loaf-mass, or the loaf-festival), the *f* being in time softened away on account of the difficulty of pronouncing it before *m*. Till the middle of the last century, the shepherds in various parts of Scotland were accustomed to hold festive meetings on Lammas day, on the tops of conspicuous hills, turf towers and benches having been previously constructed for the purpose. The Gule of August is probably from the Celtic *Cul* or *Gul* (a festive anniversary). The early Christian priesthood, finding this word in ogue, Latinised it into Gula, which means throat. This, taken in connection with its being the day of the festival of St. Peter ad Vincula (instituted in honour of a relic of St. Peter's chains), seems to have suggested to them to make up a story of the daughter of the tribune Quirinus having been cured of a disorder in the throat by kissing the said relic on the day of its festival. And the Celtic *Gul* (an adversary) has thus been the remote cause of a Christian festival being instituted to *Gula* (the throat), and held on the day of St. Peter's Chains.

15. *The Assumption of the Blessed Virgin*, a grand festival of the Romish Church, and a day noted in the calendar of the Church of England. It was instituted in 813, to celebrate the ascension of the Virgin into heaven. In Catholic countries, this day is marked by splendid ceremonies and processions.

24. *St. Bartholomew's Day* a holiday of the Church of England. Bartholomew was an apostle, but there is no scriptural account of his labours or death. The legend of the Romish Church represents him as preaching in the Indies, and concluding his life by being flayed alive by order of a brother of the king of Armenia. In memory of his death, it was customary at our monastic institutions, in the middle ages, to distribute small knives amongst the people. The day has a horrible celebrity in connection with the massacre of the Protestants at Paris in 1572.

Natural History.—The mean average heat of this month (60 degrees) approaches so near that of July, that a warm dry August often compensates for a low temperature in the preceding month. In the beginning of August, we have often the heaviest rain of the whole year, termed in Scotland the Lammas Flood. July and August, always our warmest, are often our wettest months. Southerly and westerly winds have now the ascendency, but in the case of very heavy rain the wind usually falls. Harvest, in the average, commences about the middle of this month, but in late seasons not till the very end. The order of ripening of our cereal grains is—barley, wheat, oats. The earliest of our larger fruit begin to ripen this month—apples and pears, but hardly plumbs. The latter and more tender exotic annuals now come into flower, such as the amaranths, xeranthemum, zinnia, jacobea, China asters, &c.; also the gigantic biennial shepherd's club, which sows itself, and the also gigantic annual sunflower. St. John's wort, monkshood, flox, also flower about this time.

SEPTEMBER.

This was the seventh month in the Roman year before the Julian reform of the calendar. The two first syllables of the name are thus readily accounted for; the last, which also figures at the end of the names of the three following months, is an ancient particle of doubtful signification.

1. *St. Giles's Day.*—This saint's day figures in the Church of England calendar. A native of Greece, he travelled into France in 715, and became abbot of Nismes. He literally obeyed the scriptural injunction by settling his patrimony for the benefit of the poor, and on one occasion gave his coat to a sick mendicant, who was cured miraculously by putting it on. St. Giles has thus become the patron saint of beggars and cripples. St. Giles's Church, Cripplegate, London, and the High Church in Edinburgh, are dedicated to him; and he is the patron saint of the Scottish capital, as far as it can be said to have one.

8. *The Nativity of the Blessed Virgin*, a grand festival of the Romish Church, and still retained in the Church of England calendar. This festival has been held in honour of the Virgin, with matins masses, homilies, collects, processions, and other ceremonies for upwards of a thousand years. According to the Catholic writers,

a religious contemplative, every year upon the 8th of September, heard most sweet music in heaven, with great rejoicings of angels. Once he asked one of them the cause, and was told that upon that day was celebrated in heaven the nativity of the mother of God. The birthday of the Virgin being thus miraculously communicated to mankind, Pope Servius instituted a festival to hold it in honour.

14. *Holy Rood Day*, or the day of the Exaltation of the Holy Cross, a festival of the Romish Church, still retained in the Church of England calendar. It celebrates the miraculous appearance of a cross in the heavens to the emperor Constantine. The Wednesday, Friday, and Saturday after Holy Rood Day, are Ember Days, and the Week in which they occur consequently an Ember Week.

21. *St. Matthew the Apostle*, a festival of the Church of England.

29. *The Festival of St. Michael and all the Holy Angels*; shortly, *Michaelmas Day*, a grand festival of the Romish and English churches. St. Michael is singled out for particular mention as being the chief of angels, or archangel. The theological character of Michael is obscure. Suffice it here to quote the remark of Whatley, in his exposition of the book of Common Prayer, that "the feast of St. Michael and all Angels is observed, that the people may know what benefits are derived from the ministry of angels."

Michaelmas, besides being one of the quarter days in England for the payment of rents and wages, has been distinguished from an early period in that and other countries as the time for the annual election of corporation officers, magistrates, and other civil guardians of the peace. It has been suggested that the selection of the day for this purpose might arise from "the old opinion of tutelar spirits, who have, or are thought to have, the particular charge of certain bodies of men, or districts of country, as also that every man had his guardian angel, who attends him from the cradle to the grave, from the moment of his coming in to the moment of his going out of life."

It is an ancient and extensively prevalent custom to have a goose for dinner on Michaelmas day. Queen Elizabeth is said to have been eating her Michaelmas goose when she received intelligence of the defeat of the Spanish Armada. Very curious and recondite origins have been assigned to this custom, but it seems to have arisen simply from the goose being at its best immediately after it has had the range of the reaped harvest fields.

Natural History.—This is often the finest month of the year; yet as with other portions of our seasons, it is not to be depended on. In temperature (the general average is 55 degrees) it ranks between May and June, yet the first three weeks are often as warm as any part of the summer; but there is usually a sensible falling off in the latter part. In Scotland the bulk of the harvest work of the season is usually effected during this month. It is likewise the time when large fruit comes to perfection. The flower borders have still a gay appearance, the latest exotic annuals only beginning to flower at this time. The dahlia, a magnificent flower of recent introduction, appears in all its grandeur during September. It has been remarked that at no other season is the house-fly so numerous.

OCTOBER.

As already explained, October has its name from having been the eighth month of the Roman year before the Julian reform of the calendar. In the time of the emperor Domitian it was called Domitianus, in his honour; but after his death that name was abandoned by general consent, from a wish to sink the memory of so execrable a tyrant. The Saxons called October *Wyna'-monat* (wine month), from its being the time when wines were annually brought into Germany (none being then made in that country).

2. The festival of the *Holy Angel Guardians* in the Romish Church.

9. The day of *St. Dennis*, the patron saint of France. St. Dennis was put to death, with some companions, in the year 272, upon an eminence near Paris, since called from that circumstance Montmartre (*Mons Martyrum*). According to the legend, his head had no sooner been cut off, than the body rose, and taking up the head, walked with it two miles. Portraits of St. Dennis, carrying his head in his hand, abound in old prayer-books.

18. The day of *St. Luke the Evangelist*, a festival of the Church of England. This day was appointed to be St. Luke's festival in the twelfth century.

St. Luke was usually represented in the act of writing, with an ox by his side, having wings and large horns. The natural habit of this animal in ruminating upon its food, caused it to be selected as an emblem of meditation, appropriate to this evangelist. At Charlton, a village near Blackheath, about eight miles from London, a fair is held on St. Luke's Day, and at this fair there was kept up until a very recent period a curious custom originating evidently in the emblem of St. Luke. People came to this fair masked; the men generally wore women's clothes; and many bore horns upon their heads. It was a scene of wild riot and confusion. The booths had horns of various animals, gilt and otherwise, for sale, and even the gingerbread was marked with that figure. "Horns! Horns!" was the universal cry. The gentry used to come in multitudes to see the sports of this occasion. Some fragments of a stained-glass representation of St. Luke and his horned companion still exist in a window of the parish church.

25. *The festival of St. Crispin and St. Crispinian.* The name of St. Crispin is in the Church of England calendar. Crispin and Crispinian are said to have been two Roman youths of good birth, brothers, who, in the third century, went as Christian missionaries to France, and preached for some time at Soissons. In imitation of St. Paul, they supported themselves by working at the trade of the shoemaker during the night, while they preached during the day. They were successful in converting the people to Christianity, until arrested in their course by Rictius Varus, governor under the emperor Maximian Herculeus. Butler, in his "Lives of the Saints," says: "They were victorious over this most inhuman judge by the patience and constancy with which they bore the most cruel torments, and finished their course by the sword about the year 287." The two young martyrs were of course canonized, and a splendid church was built to their honour at Soissons, in the sixth century. The shoemaker craft throughout the whole Christian world have from an early period regarded Crispin and Crispinian as their patron saints, but particularly the first. They often celebrate the day set apart for these saints in the calendar, with processions, in which Crispin, Crispinian, an Indian prince, and some other personages whom tradition has associated with their history, are represented in splendid antique dresses. Sometimes a coronation of Crispin is part of this ceremony, for there is a notion that he was a royal personage, and hence we find the shoemakers, in Scotland at least, assuming for their arms a leather knife, surmounted by a crown, and styling themselves "the royal craft." Whether they celebrate the day by procession or not, they are sure to distinguish it by giving themselves up for the time to jollity.

28. The day of *St. Simon and St. Jude*, a festival of the English Church. Simon, usually surnamed the Canaanite, remained with the other apostles till after Pentecost

it has been surmised that he visited Britain, and there suffered martyrdom. Jude, otherwise called Thaddeus, and thought to have been a son of Joseph by a former wife, is said to have suffered martyrdom in Persia.

On this day, formerly, it was considered proper to indue winter vestments. It was always expected to be rainy. A character in an old play called the *Roaring Girl*, says, "As well as I know 'twill rain upon Simon and Jude's Day." In another production of the Elizabethan stage, some one exclaims, "Now a continual Simon and Jude's rain beat all your feathers as flat down as pancakes." Perhaps there is some connection between this notion and the emblem assigned to the day in old calendars, namely, a ship, which seems to have been adopted in consideration of Simon and Jude having been fishermen.

Natural History.—During this month, the average temperature of which is 49¼ degrees, there are usually decided symptoms of the approach of winter; yet the weather of the month is often of a steady and agreeable character. Bare harvest fields, some of which are in the course of being ploughed for winter wheat, form a conspicuous feature of external nature. The foliage of the trees become changed from green into a variety of tints, which gives the woods a beautiful appearance, and is generally admired, although felt to betoken that they are soon to be stripped of their summer honours. The migratory birds assemble, and commence their annual flight to more genial climes—the swallow to the shores of Africa, the nightingale to Lower Egypt, and the puffin and some others either to Africa or to Spain. Towards the end of the month, if high winds prevail, the trees are a good deal bared. In the gardens less decline is to be remarked. The flower-borders still have a gay appearance; the hollyhock, dahlia, and some other flowers, being yet in good condition. This is the time of the laying up of potatoes. In England, it was the favourite time for brewing, on account of the equable temperature; and *October* is a secondary name for the yeoman's brown beverage. In this month the gossamer has a striking appearance, floating like an aërial veil over the fields, and meshing the passing traveller.

NOVEMBER.

November obtained its name from being the ninth month in the Roman year, before the reform effected by Cæsar. Our Saxon ancestors called it *wint-monat* (wind month).

1. *All Saints' Day*, a festival of the Romish and English churches—otherwise called *All Hallow Day*. The evening of the 31st October is called All Hallow Even, or Hallow E'en, as being the vigil or eve of All Hallow Day. Hallow-tide is a comprehensive name for both days. The Romish Church designed this day to be held in honour of all those saints who had not particular days appointed for them.

It does not appear that All Saints' Day or its Eve, was ever marked by very particular observance in the Catholic Church. Nevertheless, there is scarcely any time more distinguished by the common people throughout the British islands than All Hallow Eve or Hallowe'en. This is probably owing to the fact of November 1st having been one of the four great festivals of our Pagan ancestors. The 1st of February, the 1st of May, and the first of August were the other three; the antient names of the two latter are still in vogue—Beltane and Lammas. These four days were celebrated by the kindling of fires in conspicuous places, and performing certain ceremonies. The fires of Beltane and Lammas have already been spoken of; it is probable that those of the February festival are kept up in the *Candlemas blaze*, with a slight change of day. Fires were kindled in Wales, Ireland, the Scottish Highlands, and even in England, on the 1st of November, until a very recent period; and the custom may still be kept up in some remote places.

Pennant states as follows:—"In North Wales there is a custom upon All Saints' Eve of making a great fire called *Coel Coeth*. Every family, about an hour in the night, makes a great bonfire in the most conspicuous place near the house, and when it is almost extinguished, every one throws a white stone into the ashes, having first marked it; then having said their prayers turning round the fire, they go to bed. In the morning, as soon as they are up, they come to search out the stones, and if any of them are found wanting, they have a notion that the person who threw it in will die before he sees another All Hallow Eve." The Welsh also practise many of those rites for divining the future, which are so prevalent on Hallowe'en in other parts of the United Kingdom. It is mentioned by another writer that they dance round and jump through the bonfires, and at the conclusion always run away "to escape the black short tailed sow."

General Vallancey states that the Irish have now generally substituted a candle illumination for the fire of the 1st of November.

The Rev. Mr. Shaw, in his "History of Moray," written in the latter part of the last century, speaks of the Hallow Eve fire being still kindled in Buchan. In the "Statistical Account of Scotland," published at the close of the century, the same fire is spoken of as kept up in various parts of the Highlands. In the parish of Callendar for instance, "On All Saints' Eve, they set up bonfires in every village. When the bonfire is consumed, the ashes are carefully collected in the form of a circle. There is a stone put in, near the circumference, for every person of the several families interested in the bonfire: and whatever stone is moved out of its place, or injured before the next morning, the person represented by that stone is devoted, or *fey*, and is supposed not to live twelve months from that day." How strange thus to find a superstitious custom of this nature existing in a form so nearly identical in Wales and Perthshire.

Several writers in the Gentleman's Magazine, in the latter part of the last century, speak of Hallow Eve fires being still kindled in various parts of England, chiefly by persons of the Catholic persuasion. The practice seems to have been to carry about a quantity of burning stuff, under the name of *tinley* or *tindle*.

These ceremonies appear to be among the earliest connected with the 1st of November. They are, or have recently been, everywhere prevalent throughout these islands. As they are obviously of a Pagan character, we conclude that the notability of this season is of older date than the introduction of Christianity, and that its character as All Saints' Day has comparatively little affected the popular mind.

We have notices from both Perthshire and Ireland of the 1st of November being partly regarded as the proper time for returning thanks for the realized fruits of the earth. The Irish, in this regard, called it *La Mas Ubhal*, that is, the day of the apple fruit, and celebrated it with a drink or mess composed of bruised roasted apples among ale or milk. This drink in time acquired the strange appellation of *lamb's wool*, a corruption, apparently, of the name of the day in the Celtic language.

Ringing of bells was one of the modes of celebrating Hallowmas in England in the days of our ancestors. It was a Roman Catholic practice, being designed in some way to favour the souls of departed Christians. For this reason Queen Elizabeth prohibited it.

It was also a custom of our Catholic forefathers to have a cake baken on this eve for every member of the family, as a *soul mass cake* or *soul cake*. It was composed of oatmeal, and seeded; and pasties and furmety were incidental to the same evening. In families of good condition, a quantity were baken and set up on a board, like the shew-bread in old pictures in the Bible, to be given to visiters, or distributed among the poor. There was a ryhme for the occasion—"A soul cake! a soul cake! Have mercy on all Christian souls for a soul cake!" People went from parish to parish *a-souling*, as they called it, that is, begging in a kind of chant for soul-cakes, or any thing to make them merry on this eve. It is very curious to find that a century and a half ago the inhabitants of St. Kilda, so far removed from all other parts of Britain, had a custom of baking a large triangular cake, furrowed on the edges, on All Saints' Night.

Essentially connected with all these customs are those better known ones which Burns has so well and so faithfully described in his poem of *Halloween*. All over the British islands, the festive and fortune-telling practices of this evening are very nearly the same. As some proof of this, passages from an English, Irish, and Scottish poet may be presented side by side:—

Two hazel-nuts I threw into the flame,
And to each nut I gave a sweetheart's name:
This with the loudest bounce me sore amazed,
That in a flame of brightest colour blazed;
As blazed the nut, so may thy passion grow,
For 'twas thy nut that did so brightly glow.
The Spell, by Gay.

These glowing nuts are emblems true
Of what in human life we view:
The ill-matched couple fret and fume,
And thus in strife themselves consume;
Or from each other wildly start,
And with a noise for ever part.
But see the happy, happy pair,
Of genuine love and truth sincere;
With mutual fondness, while they burn,
Still to each other kindly turn;
And as the vital sparks decay,
Together gently sink away:
Till life's fierce ordeal being past,
Their mingled ashes rest at last.
Nuts-Burning, All Hallowe'e, by Charles Graydon.

Jean slips in twa wi' tentie ee,
Wha 'twas she wadna tell
But this is Jock and this is me,
She says into hersel';
He bleezed owre her, and she owre him,
As they wad ne'er mair part,
Till fuff! he started up the lum,
And Jean had e'en a sair heart
To see't that night.
—Halloween, by Burns.

Nuts, besides being thus used for divination, are cracked and eaten; and hence, in the north of England, All Hallow Eve is often called *Nut-crack Night*. Apples are also extensively eaten, this consumpt of fruit having probably some reference to the heathen character of the day, as that of thanksgiving for the produce of the season. The fortune-telling customs described by Burns, besides the above, are—for the girls to pull stalks from a corn-stalk, and ascertain, from the presence or absence of the top pickle, an interesting point in their moral history—for a solitary female to go to a kiln, and throwing a blue clue into the pot to wind it, expecting that ere finished it will be held back, when, by inquiring who holds, a response will be obtained disclosing the name of the future husband—to eat an apple at a looking-glass, expecting to see a vision of the future husband peeping over the shoulder—to sow hemp-seed in the yard, saying, "Hemp-seed, I saw thee, hemp-seed, I saw thee, and her that is to be my true love come after me and draw thee," expecting that, on looking over the shoulder, a vision will be obtained of the future spouse in the act of pulling grown hemp—to win three wechts o' naething in the barn, expecting to see a like vision—to fathom a barley-stack thrice, expecting at the last to embrace your mistress—to dip a shirt sleeve in a rivulet at the meeting point of the lands of three proprietors, and then hang it by the fire to dry, trusting to see such a visionary person come in and turn the other side—to pull stalks of deceased cabbages, blindfolded, without choice, and augur, from their straightness or crookedness, the figure of the future spouse, from the earth which clings to the root, the fortune she will bring, and from the taste of the heart, her temper—finally, to set three dishes on the floor, one empty, one with clean, and one with foul water, and cause the company to approach them blindfolded and dip in a hand; when he who dips in the empty one is expected to remain unmarried, he who dips in the foul one to marry to a widow, and he who dips in the clean one to marry a female not hitherto married. The whole of these rites are as familiar to the Welsh, Irish, and Northumbrian, as to the Ayrshire peasantry. Many of them are also practised in England on St. John's Eve, the 23d of June.

Hallowe'en is still observed, but the more daring rites are generally given up. Meetings of young persons take place, and a plentiful store of nuts and apples being provided, a few simple amusements are practised. The experiment of the burning nuts, to test the duration of love or friendship, is still a favourite. Ducking for apples is another. A tub being provided, nearly full of water, and the fruit thrown in, the young people endeavour to seize an apple with their teeth—a task of much more difficulty than might be supposed, and which generally puts the dress and tresses of fair experimentalists into considerable disorder. The baffled efforts of the various parties raise, of course, shouts of laughter. Or a cross stick is suspended by a string from the ceiling, with a short burning candle on one end and an apple on the other. While it swings rapidly round, lads and lasses, with their hands tied, endeavour to catch the apple with their teeth, but generally suffer a good deal from the candle before they succeed in their object. Here, also, failure is a source of infinite amusement. It is rather remarkable that Burns has not introduced into his poem any notice of these sports, which, like the others, are prevalent over the whole of her Majesty's home dominions. It may not be out of place here to remark, that the jest of the apple and candle is nearly the same as that of the quintain, a favourite sport of our ancestors, commonly practised in summer. The quintain was a heroic figure of wood, on a vertical pivot, used as a butt for the practice of tilting. In this case it had a cross board, one end of which was broad, while the other was furnished with a heavy bag of sand. The trick was, to come tilt against the broad end, and escape receiving a knock-down blow from the sand-bag.

2. *All-Souls' Day*, or the *Commemoration of the Faithful Departed.*—A very solemn festival of the Romish Church, which has masses and ceremonies appropriate to the occasion, designed in favour of the souls of all the dead. "Odillon, Abbot of Cluny, in the ninth century, first enjoined the ceremony of praying for the dead on this day in his own monastery; and the like practice was partially adopted by other religious houses until the year 998, when it was established as a general festival throughout the western churches. To mark the pre-eminent importance of this festival, if it happened on a Sunday, it was not postponed to the Monday, as was the case with other such solemnities, but kept on the Saturday, *in order that the church might the sooner aid the suffering souls*; and that the dead might have every benefit from the pious exertions of the living, the remembrance of this ordinance was kept up by persons dressed in black, who went round the different towns, ringing a loud and dismal-toned bell at the corner of each street, every Sunday evening during the month, and calling upon the inhabitants to remember the deceased suffering the expiatory flames of Purgatory, and to join in prayers for the repose of their souls."*

5. The anniversary of the discovery of the Gunpowder

* "Brady's Clavis Calendaria."

Plot in 1605, and of the landing of King William III. in 1688; observed in the British dominions as a holiday, and celebrated by the Church of England by a form of prayer with thanksgiving. There is also a popular celebration of this day. From an early hour, the boys go about collecting materials for a bonfire, or money wherewith to purchase them. In some, perhaps most places, they carried with them a frightful figure composed of an old suit of clothes stuffed with straw, to represent Guy Fawkes. They called on the passengers and householders to "remember Guy," or shouted some balderdash rhymes. In the evening, the bonfire is lighted with Guy Fawkes in the middle of it, amidst tumultuous merriment. The firing of guns as a token of rejoicing, we are glad to say, is now discontinued on this day, and we trust the other absurd usages will soon likewise disappear.

11. *St. Martin's Day*, or *Martinmas*, in the Church of England calendar. Popularly, this is one of the most remarkable days of the year, especially in Scotland, where Whitsunday and *Martinmas* are the two great terms for leases and engagement of servants, the latter being that at which the occupation of farms usually commences. Formerly, it was a quarterly term day in England: a payment of corn at Martinmas occurs in the Doomsday Survey. On the continent, from an early age, the day has been distinguished convivially; and this apparently for two reasons, namely, that now the people first tasted the wines of the season, and killed the animals required to be salted for their winter provisions. The entrails of these animals, prepared as sausages, or blood-puddings, became the subject of an immediate feast, while the rest of the meat was salted and set aside. In some countries, also, the goose, which is elsewhere enjoyed at Michaelmas, was now presented. The killing of beeves at Martinmas for winter provision was formerly universal in northern Europe, in consequence of there being no means of keeping them alive in winter; since the improvement of husbandry in some countries, the custom has been given up, and fresh meat used all the year round. The feasting upon the entrails was equally universal. So much was all this associated with Martinmas, that in Scotland a beeve killed at that time was called a *mart* or *mairt*. In the old book of laws attributed (erroneously) to David I. of Scotland, it is provided that "the fleshours sall serve the burgesses all the time of the slauchter of *Mairts*." In Northumberland, also, a Martinmas bullock is called a *mart*. Tusser, in his curious metrical treatise on husbandry, written in the time of Henry VIII., says—

> When Easter comes, who knows not than
> That veal and bacon is the man?
> And *Martinmas beef* doth bear good tack,
> When country folks do dainties lack.

Bishop Hall, in his Satires, written in the time of James I., mentions

> —— Dried flitches of some smoked beeve,
> Hanged on a writhen wythe since *Martin's eve*.

It appears that the contents of the puddings, as made in England, were composed of blood, suet, and groats; and there was an enigmatical proverb thence arising, that "blood without groats was nothing," meaning that birth without fortune was of little value. Down to near the end of the last century there was not a family above the poorest condition in the rural districts of Scotland which had not a *mart*, or a share in one, and salted meat was the only food of the kind used in winter; now, there is no such practice known, except as a matter of tradition.

Martin, in whose honour this festival was at first instituted, is said to have been born in Lower Hungary about 316, and to have originally been a soldier. After a number of miraculous adventures, he settled as a hermit in the hollow of a rock near Tours in the south of France, where he was greatly venerated. He died bishop of Tours in 397. When a few fine days occurred about this time of the year, they were called *St. Martin's summer*.

23. *St. Clement's Day*, in the Church of England calendar. Clement is spoken of by St. Paul as one of his fellow-labourers. Monkish imagination has supplied him with a history and a martyrdom. He is said to have been thrown into the sea with an anchor fixed about his neck. An anchor is therefore assigned to him as an emblem: of this the metropolis presents a conspicuous memorial in the anchor which forms the vane of the church of St. Clement Danes, in the Strand. St. Clement is held as the patron saint of the blacksmiths. It was formerly customary for boys, and the lower class of people generally, to go about on this day begging for liquor, wherewith they made a regale at night. Hence, in a certain class of old almanacs, the day was signified by the figure of a pot.

29. This is one of the days on which *Advent* may commence. Advent [literally, the Coming] is a term applied from an early period of ecclesiastical history to the four weeks preceding Christmas, which were observed with penance and devotion, in reference to the approaching birth of Christ. There are four Sundays in Advent, the first of which is always the nearest Sunday to St. Andrew's Day (November 30).

30. *St. Andrew's Day.*—The festival day of this saint is retained in the Church of England calendar. St. Andrew was one of the apostles. His history, as related by the Catholic writers, represents him as martyred in the year 66 at Patræ in Greece, upon a cross of the form of the letter X, which accordingly is still recognised as St. Andrew's Cross. A supposed relic of this cross, carried to Brussels in the middle ages, caused its figure to be adopted as a badge for the knights of the Golden Fleece. Some relics of the apostle himself are said to have been carried by a Greek devotee named St. Regulus, to Scotland, where they were placed in a church built at a place which subsequently became distinguished by the name of St. Andrews. St. Andrews became the seat of the Scottish primacy; and from this cause probably it was that St. Andrew was in time considered as the patron saint of Scotland. In that country, however, there is scarcely any observance of this day in any manner; it is only when Scotsmen are abroad, and have occasion to select a day for an annual convivial meeting, that St. Andrew's Day comes into notice. There used to be a procession of Scotsmen on this day in London, with singed sheeps' heads borne before them. It is remarkable that St. Andrew is also a tutelar saint of the Russians, probably in consequence of the Greek locality of his martyrdom. There is an ancient and widely prevalent custom connected with St. Andrew's day, to which Luther has adverted. Maidens, on the eve of this day, stripped themselves, and sought to learn what sort of husbands they were to have by praying in these terms—"Oh, St. Andrew, cause that I obtain a good pious husband; to-night show me the figure of the man who will take me to wife."

Natural History.—In this month the business of vegetation experiences its death. The trees are now thoroughly stripped of their foliage. It is reputed as a gloomy month; but the temperature is sometimes agreeable in the earlier part of it, and its average for the whole term is 43 degrees. A considerable number of plants remain in flower throughout November. The gloom of the month is said to have a depressing effect on the spirits of the English nation; let those who are liable to such influences lay to heart the following remarks of Johnson in the "Idler:"—"The distinction of seasons is produced only by imagination acting upon luxury. To temperance every day is bright, and every hour is propitious to diligence. He that resolutely excites his faculties, or exerts his virtues, will soon make himself superior to the seasons, and may set at defiance the morning mist and the evening damp, the blasts of the east and the clouds of the south. Instead of looking for spring with anxious and caring mind, enjoy the present day; there are pleasures even in November."

DECEMBER.

So called as being originally the *tenth* of the Roman year. Our Anglo-Saxon ancestors called December *winta monat*, that is winter month; but, after becoming acquainted with Christianity, this name was changed into *heligh monat*, or holy month, with reference to the celebration of the nativity on its twenty-fifth day.

6. *St. Nicholas's Day.*—Retained in the Church of England calendar. St. Nicholas was Archbishop of Myra, in Greece, A. D. 342. He is regarded as the patron saint of children and of mariners, probably in consequence of his benevolent zeal in the protection of orphans and stranded seamen. Churches built near the sea are in many instances dedicated to St. Nicholas. He is also said to have shown much kind interest in the fate of young women, sometimes secretly throwing purses into the chamber-windows of those who lacked dowries. Hence has arisen a custom prevalent over a large part of the Christian world. On his eve, presents are hid in the shoes of those to whom any one wishes to give a pleasing surprise; and these, being found in the morning, are jocularly said to be gifts from St. Nicholas.

St. Nicholas is also considered as the tutelar saint of scholars, or clerks, and of robbers. The fraternity of parish-clerks have thought themselves entitled by their name to adopt him as their patron. How robbers should have come to be called St. Nicholas's clerks, or St. Nicholas's knights, it is not easy to see, unless it were from the coincidence of his name with one of the slang appellations of the devil.

Throughout the middle ages, there was a universal custom of electing a kind of mock bishop on St. Nicholas's Day. A boy, possibly taken from among the choristers, was chosen by his associates as bishop, arrayed in suitable vestments, and endued with appropriate powers, which he enjoyed for some days. The infant prelate was led along in a gay procession, blessing the grinning multitude as he went, and he was even allowed to sing mass and to mount the pulpit and preach. Edward I., in his way to Scotland, in 1299, heard vespers by a boy bishop at the chapel of Heton, near Newcastle. The boy bishop at Salisbury is said to have had the power of disposing of any prebends that fell vacant during his term of office; and one who died at that time had a monument in the cathedral, representing him in his episcopal robes. Mr. Wharton is of opinion that we see some faint traces of the rise of dramatic entertainments in the strange mummeries connected with the election of the Boy Bishop.

8. *The Conception of the Blessed Virgin*, in the Romish and English calendars.

11. The fourteen days from this to Christmas Eve were called the *Halcyon Days*, and supposed to be, in their calm and tranquil character, an exception from the season. The term, which is now a regular adjective in our language, is derived from the bird king-fisher or halcyon, which, from the days of Aristotle at least, has been the subject of a curious superstition. The ancients supposed that it built its nest on the ocean, and brought forth its young at the winter solstice. To account for the preservation of the nest and young amidst the severity of the season, they imagined that the bird had a power of lulling the raging of the waves during the period of incubation; and this power was believed to reside in its song.

13. *St. Lucia's Day*—Retained in the Church of England calendar. St. Lucia was a young lady of Syracuse, who obtained a high character for a devout and charitable life, and died in the year 304. The last of the four series of Ember Days commences on the Wednesday following this festival.

16. *O Sapientia.*—This day is so marked in the church calendar, probably from an anthem sung on this day in the Romish Church, beginning, "O sapientia quæ ex ore altissimi prodidisti," &c.

21. *St. Thomas the Apostle*, a festival of the English Church. It was customary in England for women to go *a-gooding* on St. Thomas's Day; that is, they went about begging money, and presenting in return sprigs of palm and bunches of primroses, probably with a view to the decoration of their houses against Christmas.

25. *Christmas Day*, observed from an early period as the nativity of our Lord, and celebrated not only by the religious ceremonies from which the name of the day is partly taken, but by popular festivities of the most joyful kind. In England, Christmas is held by the church as a solemn festival, and distinguished by the complete cessation of business—an honour paid to no other day besides Good Friday. But within the last hundred years, the festivities once appropriate to the day have much fallen off. These at one time lasted with more or less brilliancy till Candlemas, and with great spirit till Twelfth Day; but now a meeting in the evening, little different from a common dinner party, though sure to be marked by a roast and plum-pudding, and pretty generally followed by a game at cards, is all that distinguishes Christmas in most families.

In former times, the celebration of Christmas began in the latter part of the previous day—Christmas Eve. The house was first decked with holly, ivy, and other evergreens. Candles of an uncommon size were then lighted under the name of Christmas Candles; an enormous log, called the Yule Clog, or Christmas Block, was laid upon the fire: the people sat round regaling themselves with beer. In the course of the night, small parties of songsters went about from house to house, or through the streets, singing what were called Christmas Carols—simple popular ditties full of joyful allusions to the great gift from God to man in the Redeemer. A mass was commenced in the churches at midnight, a custom still kept up in the Catholic Church. At one period, the people had a custom of wassailing the fruit trees on this evening; that is, they took a wassail bowl, threw a toast from it to the tree, and sung a song, expecting thus to secure a good crop of fruit the next season. It was thought that, during the night, all water was for a short time changed into wine, and that bread baked on this eve would never become mouldy. These notions are essentially foolish, but as they are all well-meant adorations of the simple spirit of the people, they should not be hastily condemned.

The carols were more generally sung in the morning of Christmas Day. A contributor to the "Gentleman's Magazine," in 1811, describing the manner in which Christmas is celebrated in the North Riding of Yorkshire, says: "About six o'clock on Christmas Day I was awakened by a sweet singing under my window; surprised at a visit so early and unexpected, I arose, and looking out of the window, I beheld six young women and four men welcoming, with sweet music, the blessed morn." It may scarcely be imagined how delightfully at such a moment would fall upon the half-slumbering ear such strains as the following:—

God rest you, merry gentlemen,
Let nothing you dismay,
For Jesus Christ our Saviour
Was born upon this day,
To save us all from Satan's power,
When we were gone astray.
Oh tidings of comfort and joy,
For Jesus Christ our Saviour
Was born on Christmas Day.

In Bethlehem in Jewry
  This blessed babe was born,
And laid upon a manger
  Upon this blessed morn;
The which his mother Mary
  Nothing did take in scorn.
    Oh tidings, &c.

Christmas carols are among the oldest of English songs. A collection of them was printed by Wynkyn de Worde in 1521. They are still printed on single sheets, which are sold by chapmen or dealers in cheap literature. There is also more than one modern collection of these curious productions of former ages.

The religious service of Christmas Day receives but a small share of attention from old writers. In fact, the day was chiefly distinguished by the popular festivities. Its grand feature was a feast, of great abundance, and at which a few particular dishes regularly appeared, above all, plum-porridge and mince-pie. In every great hall, whether of a man of rank or of a great corporation, there was a boar's head ushered in by minstrelsy. It was customary for the rich and noble to treat their humble dependants, and to meet with them on terms of equality, as considering that all men are regarded alike by the religion of him whose natal day they were celebrating. A sort of license prevailed. A branch of the mistletoe being hung up in the hall or over the doorway, the youths were understood to have a right to kiss any maiden whom they could inveigle under it. At York, the freedom of the time was so extreme, that there were regular proclamations allowing women of evil repute and gamblers to come to the city and walk about openly for a certain number of days. It was also customary to elect a person as *Lord of Misrule*, who went about taking the lead in every kind of extravagant sport and merriment which the wit of man could devise. The election and functions of this personage were perhaps the most singular part of the festival. According to Stow, "at the feast of Christmas, there was in the king's house, wherever he lodged, a Lord of Misrule, or Master of merry Disports, and the like had ye in the house of every Nobleman of honour or good worship, were he spiritual or temporal. The Mayor of London, and either of the Sheriffs, had their several Lords of Misrule, ever contending, without quarrel or offence, who should make the rarest pastime to delight the beholders. These lords, beginning their rule at Allhallond Eve, continued the same till the morrow after the Feast of the Purification, commonly called Candlemas Day: in which space there were fine and subtle disguisings, masks, and mummeries, with playing at Cards for Counters, Nayles, and Points in every House, more for pastimes than for gaine."

The management of the plays usually acted at Christmas in the halls of colleges and law societies, fell to the care of the Lord of Misrule. The particular functionary elected in the inns of court in London, after exercising all the duties and going through the parade of royalty for a fortnight, at an expense of a couple of thousand pounds, was knighted at Whitehall by the real sovereign of the land.

In Scotland, before the Reformation, the religious houses had a similar officer for the Christmas revels, called the *Abbot of Unreason*, whose particular functions are graphically pourtrayed by Scott in his novel of "The Abbott." The custom was suppressed by statute in 1555.

26. *St. Stephen's Day*, observed as a festival of the Church of England. There was formerly a widely prevalent dogma that it was good to bleed horses about this time of the year, and St. Stephen's Day was that chosen by most people for this purpose. On this day, also, blessings were implored upon pastures.

27. *St. John the Evangelist's Day*, observed as a festival by the Church of England. Because John drank poison, without dying in consequence, it was supposed that those who put their trust in him were safe from all injury from that cause.

28. *Childermas* or *Holy Innocent's Day*, observed by the Church of Rome with masses for the children killed by Herod. It was considered unlucky to marry, or to begin any work, on Childermas Day. The learned Gregory says, "It hath been a custom, and yet is elsewhere, to whip up the children upon Innocent's Day morning, that the memory of Herod's murder might stick the closer, and in a moderate proportion to act over the 'crueltie again in kinde.'"

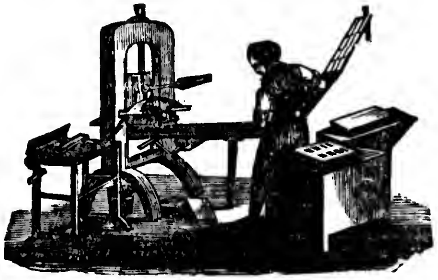
31. The last day of the year is called in Scotland *Hogmanay*, a word which has fruitlessly exercised the wits of the etymologists. The Scottish people, overlooking Christmas in obedience to the behests of their religious teachers, have transferred the merriment of the season to Hogmanay and New Year's Day, which they accordingly abandon to all kinds of festivity. Handsel Monday, or the first Monday of the year, is also an occasion of festivity. On Hogmanay, the children in small towns perambulate among the neighbours of the better class, crying at their doors, "Hogmanay!" or sometimes the following rhyme:—

Hogmanay, trollolay,
Gie's of your white bread and none of your gray;

in obedience to which call, they are served each with an oaten cake. In the evening, there are merry makings, which are always prolonged to twelve o'clock, which has no sooner struck than all start up excitedly, and wish each other a happy new year. Small venturous parties take a kettle with hot ale posset, called "a het pint," and go to the houses of their friends, to wish them a happy new year. Whoever comes first, is called in that house "the First Foot," and it is deemed necessary on such occasions to offer the inmates both a piece of cake and a sip from the posset kettle, otherwise they would not be lucky throughout the year. This is called "*First-Footing*." Next day, all people go about among all other people's houses; presents are given among relations; and dinner-parties close the evening. Formerly, the first Monday of the year was also much observed as a festive day, and time for giving presents, from which latter circumstance it was called *Handsel Monday*. The Handsel Monday, old style, is still, in some rural districts, the chief feast day of the season. On the evenings of Christmas, Hogmanay, New Year's Day, and Handsel Monday, parties of young men and boys went about disguised in old shirts and paper vizards, singing at the various houses for a small guerdon. These *guizarts*, as they were called, also acted a rustic kind of drama, in which the adventures of two rival knights, and the feats of a doctor, were conspicuous. Almost everywhere in Scotland the festive and frolicsome observances of the New Year tide have much declined.

Natural History.—December is the darkest, but not the coldest month of the year: the general average temperature is 40 degrees. The deciduous trees are now completely stripped of their foliage, and the ground often shows a snowy covering, although it is rarely that there is much strong ice in December. Amidst the general desolation, the pines and other evergreens form an agreeable resting-place for the eye. The rose also continues to blow during this month. Formerly, the Glastonbury thorn was a great wonder in England, being supposed to blow regularly on Christmas Day. The monks of the abbey there represented it as the staff of Joseph of Arimathea, which, being inserted by him in the ground, had miraculously sprouted out into a living tree. But it seems to have been only a member of a certain species of thorn well known in the east for blowing in the depth of winter.

PRINTING—ENGRAVING—LITHOGRAPHY



ORIGIN AND HISTORY OF PRINTING.

PRINTING is the art of producing impressions from characters or figures, movable and immovable, on paper or any other substance. There are several distinct branches of this important art—the printing of books with movable types, the printing of engraved copper and steel plates, and the taking of impressions from stone, called lithography. Our object, in the first place, is to describe the art of printing books or sheets with movable types, generally called *letterpress printing*, and which may undoubtedly be esteemed the greatest of all human inventions.

The art of printing is of comparatively modern origin: four hundred years have not yet elapsed since the first book was issued from the press; yet we have proofs that the principles upon which it was ultimately developed existed amongst the ancient Chaldean nations. Entire and undecayed bricks of the famed city and tower of Babylon have been found stamped with various symbolical figures and hieroglyphic characters. In this, however, as in every similar relic of antiquity, the object which stamped the figures was in one block or piece, and therefore could be employed only for one distinct subject. This, though a kind of printing, was totally useless for the propagation of literature, on account both of its expensiveness and tediousness. The Chinese are the only existing people who still pursue this rude mode of printing by stamping paper with blocks of wood. The work which they intend to be printed is in the first place carefully written upon sheets of thin transparent paper; each of these sheets is glued, with the face downwards, upon a thin tablet of hard wood; and the engraver then, with proper instruments, cuts away the wood in all those parts on which nothing is traced; thus leaving the transcribed characters in *relief*, and ready for printing. In this way, as many tablets are necessary as there are written pages. No press is used; but when the ink is laid on, and the paper carefully placed above it, a brush is passed over with the proper degree of pressure. The Chinese chronicles state that the above mode of printing was discovered in China about fifty years before the Christian era, and the art of paper-making about 145 years afterwards; previous to which period, all their writings were transcribed or printed in volumes of silk cut into leaves of proper dimensions.

It is a somewhat curious circumstance, that amongst the first attempts at printing by means of wood-engraving, which can be traced to have been made in Europe, was the making of playing-cards for the amusement of Charles VI. of France. This was towards the latter end of the fourteenth century. Thereafter came prints from wood-blocks of human figures, single or in groups; the earliest existing specimen of which is in the possession of Earl Spencer, and dated 1423. It is by an unknown artist. These prints were at first without any text, or letterpress, as it is modernly termed; but after the ground-work of the art had been completed, its rise towards perfection was almost unparalleled in rapidity. Its professors composed historical subjects with a text or explanation subjoined. The pages were placed in pairs facing each other; and as only one side of the leaf was impressed, the blank pages came also opposite one another; which, being pasted together, gave the whole the appearance of a book printed in the modern fashion.

The next step in the science of typography was that of forming every letter or character of the alphabet separately, so as to be capable of re-arrangement, and forming in succession the pages of a work, thereby avoiding the interminable labour of cutting new blocks of types for every page. It is exceedingly remarkable, that this most important and yet simple idea should not have occurred to the Romans; and what renders it the more surprising, is the fact, which we learn from Virgil, that brands, with the letters of the owner's name, were in use in his time for the purpose of marking cattle. The credit of the discovery was reserved for a German, John Guttenberg (or Guttemberg), who accomplished this important improvement about the year 1438. As this man was the first great improver of typography, to the study of which he exclusively devoted his whole time and attention, a short sketch of his life will only be a part of the history of the art. Guttenberg, who is supposed to have been born at Mayence, or Mentz, in the beginning of the fifteenth century, settled at Strasburg about the year 1424. In 1435, he entered into partnership with Andrew Drozhennis (or Dritzehen), John Riff, and Andrew Heelmon, citizens of Strasburg, binding himself thereby to disclose certain important secrets connected with the art of printing, by which they would attain opulence. The workshop was in the house of Dritzehen, who, dying shortly after the work was commenced, Guttenberg immediately sent his servant, Lawrence Bieldich, to Nicholas, the brother of the deceased, and requested that no person might be admitted into the workshop, lest the secret should be discovered, and the *forms* (or fastened-together types) stolen. But they had already disappeared; and this fraud, as well as the claims of Nicholas Dritzehen to succeed to his brother's share, produced a lawsuit among the surviving partners. Five witnesses were examined; and from the evidence of Bieldich, Guttenberg's servant, it was incontrovertibly proved that Guttenberg was the first who practised the art of printing with movable types, and that, on the death of Andrew Dritzehen, he had expressly ordered the forms to be broken up, and the characters dispersed, lest any one should discover his secret. The result of this lawsuit, which occurred in 1439, was a dissolution of partnership; and Guttenberg, after having exhausted his means in the effort, proceeded, in 1445-6, to his native city of Mentz, where he resumed his typographic labours. Being ambitious of making his extraordinary invention known, and of value to himself, but being at the same time deficient in the means, he opened his mind to a wealthy goldsmith and worker in precious metals, named John Fust or Faust, and prevailed on him to advance large sums of money in order to make further and more complete trials of the art. Guttenberg being thus associated with Fust, the first regular printing establishment was begun, and the business of printing carried on in a style corresponding to the infancy of the art. After many smaller essays with respect to the capabilities of his press and movable types, Guttenberg had the hardihood to attempt an edition of the Bible, which he succeeded in printing complete, between the years 1450 and 1455. This celebrated Bible, which was the first important specimen of the art of printing, and which, judging from what it has led to, we should certainly esteem as the most extraordinary and praiseworthy of human productions, was executed with cut-metal types, on six hundred and thirty-seven leaves; and, from a copy still in existence in the Royal Library of Berlin, some of them appear to have been printed on vellum. The work was printed in the Latin language.

The execution of this, the first printed Bible—which has justly conferred undying honours on the illustrious Guttenberg, was, most unfortunately, the immediate cause of his ruin. The expenses incident to carrying on a fatiguing and elaborate process of workmanship, for a period of five years, being much more considerable than what were originally contemplated by Fust, he instituted a suit against poor Guttenberg, who, in consequence of the decision against him, was obliged to pay interest, and also a part of the capital that had been advanced. This suit was followed by a dissolution of partnership; and the whole of Guttenberg's apparatus fell into the hands of John Fust, who, from being the ostensible agent in the business of printing, and from the wonder expressed by the vulgar in seeing printed sheets, soon acquired the name of a magician, or one in compact with the devil, and under this character, with the appellation of Dr. Faustus, he has for ages enjoyed an evil notoriety.

Besides the above-mentioned Bible, some other specimens of the work of Guttenberg have been discovered to be in existence. One in particular, which is worthy of notice, was found some years ago among a bundle of old papers in the archives of Mayence. It is an almanac for the year 1457, which served as wrapper for a register of accounts that year. This, says Hansard, would most likely be printed towards the close of 1456, and may consequently be deemed the most ancient specimen of typographic printing extant, with a *certain* date. That Guttenberg was a person of refined taste in the execution of his works, is sufficiently obvious. Adopting a very ancient custom, common in the written copies of the Scriptures and the missals of the church, he used a large ornamental letter at the commencement of books and chapters, finely embellished, and surrounded with a variety of figures as in a frame. The initial letter of the first psalm thus forms a beautiful specimen of the art of printing in its early progress. It is richly ornamented with foliage, flowers, a bird, and a greyhound, and is still more beautiful from being printed in a pale blue colour, while the embellishments are red, and of a transparent appearance. What became of Guttenberg immediately after the unsuccessful termination of his lawsuit with Fust, is not well known. Like the illustrious discoverer of the great Western Continent, he seems to have retired almost broken-hearted from the world, and to have spent most of the remainder of his days in obscurity. It is ascertained, however, that in the year 1465 he received an annual pension from the Elector Adolphus, but that he only enjoyed this small compensation for his extraordinary invention during three years, and died in the month of February, 1468.

It long formed a subject of contention amongst antiquaries and Bibliomaniacs, by what means Guttenberg formed his types, but it is now pretty clearly ascertained that they were at first all individually cut by the hand. The mode of *casting* types in moulds has been very generally, and seemingly correctly, assigned to Guttenberg's successor, Shœffer. This individual was an industrious young man of inventive genius, an apprentice with Faust, who took him into partnership immediately after his rupture with Guttenberg, and who is supposed to have been initiated into the mysteries of the art by the latter. The first joint publication of Faust and Schœffer was a beautiful edition of the Psalms, which came out only about eighteen months after their going into partnership. Along with it appeared a declaration by them, claiming the merit of inventing the cut-metal types with which it was printed; but this pretension was evidently false; and, in fact, it afterwards appeared that the book had been four years in the press, and must, consequently, have been chiefly executed by Guttenberg. It is worthy of notice that the above publication was the very first to which the date, printer's name, and place of publication, were affixed.

To Schœffer, however, as said before, must be awarded the honour of completing Guttenberg's invention, by discovering the method of casting the characters in a *matrix*. In an account of Schœffer, given by Jo. Frid. Faustus of Aschaffenburg, from papers preserved in his family, we are informed that the artist privately prepared matrices for the whole alphabet, and showed the letters cast from them to his master Faust, who was so well pleased that he gave his daughter, Christina, to him in marriage. Faust and Schœffer concealed the new improvement, by administering an oath of secrecy to all whom they intrusted, till the year 1462, when, by the dispersion of their servants into different countries at the sacking of Mentz, by the Archbishop Adolphus, the Invention was publicly divulged, and the art was spread throughout Europe.

EARLY PROGRESS OF PRINTING.

Haerlem and Strasburgh were the first places to which the art of printing was transplanted from Mentz, and this at so early a date, that each of these places has its respective advocates as being the birth-place of it. From Haerlem, it passed into Rome in 1466, where its first professors were Conrad Sweinheim and Arnold Pannartz, who introduced the present Roman type in the following year, in printing Cicero's *Epistolæ Familiares*. The Gothic character, from which our own *black-letter* was derived, was the next which was employed by the ancient printers; after which, in 1476, the first set of Greek characters was cast by the Italians—whether at Venice, Milan, or Florence, is a disputed point. In 1488, however, all previous attempts at the Greek character were eclipsed by a splendid edition of Homer's works, published at the last-named place, in folio, and printed by Demetrius, a native of Crete. The first book in the Hebrew character was an edition of the Pentateuch, printed in 1482; the whole Bible, including the New Testament, not being executed till 1488. This was done at Soncino, a small town in the Duchy of Milan.

In 1467, printing was set up in the city of Tours; at Routhlingen and Venice in 1469; and, it is believed, at the same time in Paris. This city was the tenth town in Europe in which the printing-press was established;

it was set up by Ulrich Gering, a native of the Canton of Lucerne, in the house of the Sorbonne, and in the year 1469. This Gering had been taught the art by Elias Helie von Lauffen, who introduced it into Switzerland, and he commenced the operations of the Lucerne press, by publishing Marchesini's Biblical Lexicon Mamotrectus sive Primicerius, in the year 1470. The first work which issued from Gering's press, at the Sorbonne, was the Epistolæ Gasparini Pergamensis; it was also published in the year 1470. Gering continued his labours until 1508, and died on the 23d of August 1510, bequeathing very considerable property for the benefit of young scholars and the poor of Paris. Strasburg was the next town which had the advantage of a press, and soon afterwards Lyons—the one in 1471, the other in 1473. It was introduced into Russia about the year 1560.

About the year 1496, the letter which we now call *Italic* was invented by Aldus Manutius, a Roman by birth, who set up the business of a printer in Venice. At first, Manutius used his Italic, or Venetian, as he called it, for the printing of entire volumes; but this was not generally approved of by typographers, and after a short period, Italic was employed only for particular words, prefaces, and introductions. Latterly, it has been the practice to use Italic only in very particular cases, as its constant requisition indicates a poor style of literary composition.

PRINTING IN ENGLAND.

The early history of printing in England is obscure. The credit of introducing the art into that country was long believed to be due to Mr. William Caxton, a mercer and citizen of London, who, during his travels abroad, and his residence for many years in Holland, Flanders, and Germany, had thoroughly informed himself of the process, and upon his return, was induced, by the encouragement of many men of wealth and rank, to set up a press in Westminster Abbey, about the year 1471. Such was the tradition amongst writers, and it is still generally believed. Its groundlessness was ascertained about the time of the Restoration, when a little book, which previously had been little thought of, fell under the notice of the curious, as bearing date at Oxford in the year 1468, being three years antecedent to the presumed commencement of Caxton's labours. This book, copies of which are yet extant, is a small quarto of forty-one leaves, entitled "Exposicio Sancti Jeronimi in Symbolum Apostolorum ad Papum Laurentium." At the same time (1664), a work was published by a Mr. Atkins of London, entitled "Original and Growth of Printing in England;" in which an account is given of an ancient chronicle, said to have been found in the archbishop's palace at Lambeth, containing the particulars attending the first introduction of the art. By the latter, it would appear that it took place during the reign of Henry VI., under the auspices of Thomas Bourchiers, Archbishop of Canterbury, who sent R. Tournour, master of the robes, and William Caxton, merchant, to Haerlem, who persuaded an under workman, named Corsellis, to come to England and set up a press at Oxford. The manuscript mentions, that the transaction cost King Henry 1500 merks. But a single press was soon found insufficient for England; upon which the king set up another at St. Alban's, and a third at Westminster; the last being placed under the charge of William Caxton, in the year 1471.

It would be useless for us here to enter into the merits of the question concerning the authenticity of the above-mentioned chronicle, which at one time divided the literary world to a violent degree. We shall only observe, that the result of the disputation appears to be this:—The existence of the book before named establishes beyond a doubt that books were printed at Oxford by Corsellis several years before Caxton set his press to work at Westminster, and therefore that that city has the honour of having been the first seat of the art in England; but Caxton was the first who introduced the printing with *moulded metal types*, the works by his predecessor having been executed merely with wooden ones. It is by our early writers not having attended sufficiently to this line of demarcation between the two stages of the art, that the misunderstanding has, as far as we can judge after much careful investigation, solely arisen.

After the art of printing had been thus introduced into Oxford and Westminster, it spread to St. Alban's, Cambridge, Tavistock, Worcester, Canterbury, Ipswich, &c., in almost all cases by the encouragement of the churchmen of these places, and generally with the view of printing works of piety. About the year 1500, or probably somewhat earlier, Pynson was, by patent of Henry VII., invested with the office of king's printer, which may be regarded as the first instance of an appointment of this nature. At the close of the fifteenth and the commencement of the sixteenth century, London possessed a number of printers, but none whose name has been so celebrated as that of Wynken de Worde, a foreigner, who had been instructed under Caxton. He improved the art considerably, and was the first printer in England who introduced the Roman letter—all previous printing, and much of a later date, being in the black or German letter.

Although at first countenanced by the clergy, the art of printing was soon looked upon with extreme jealousy by the church, which at length discovered that this invention was but too certainly calculated to revolutionize the whole fabric of society. The earliest efforts of the art, as we have seen, were directed to the multiplication of the Bible; but for a period of sixty or seventy years from the date of the invention, all the copies of the Scriptures which were printed were in the Latin or some other classic language, not understood by the people. But now a new era commenced. Certain printers began to issue the Bible in the English tongue, translated from the original, and this gave mighty offence to the church, or Romish hierarchy.

In 1526, Richard Grafton, a gentleman of liberal education, having adopted the profession of printing, issued an edition of the New Testament in the English language, which drew down the wrath of the then Bishop of London. A proclamation was issued by this prelate prohibiting its use. "Understanding (says this document) that many children of iniquitie, maintayners of Luther's sect, blynded through extreame wickedness, wandrying from the way of truth, and the catholic fayth, craftely have translated the New Testament into our English tongue, entermedlying therewith many heretical articles and erroneous opinions, pernicious and offensive, seducying the simple people,' &c. The proclamation goes on to order all copies of the said New Testament to be brought to the bishop's vicar-general, to be burnt, under pain of excommunication, and incurring the suspicion of heresy. It does not appear that the fulminations of the bishop were of much effect. The New Testament having been readily purchased, it led to the publication, in 1535, of the whole Bible in the English language, into which it was translated by Miles Coverdale. But this noble undertaking was accomplished abroad. In 1539, England had the honour of producing an edition of the Bible in the English tongue, under the auspices of Cranmer and Henry VIII., the work being executed by Grafton and Edward Whitechurch.

The progress of the art in England, after its first rush into notoriety, was remarkably slow. In the sixteenth century, it was interrupted by the broils consequent on the Reformation, and in the seventeenth century by the still greater harassments of the civil war, and the gloomy religious spirit which prevailed up till the Restoration. This last event was even unfavourable to it, by introducing a general licentiousness and contempt for any solid and respectable literature. At this period there was an act of parliament still in force, preventing more than twenty printers to practise their art in the kingdom. "At the fire of London in 1666, the booksellers dwelling about St. Paul's lost an immense stock of books in quires, amounting, according to Evelyn, to £200,000, which they were accustomed to stow in the vaults in the metropolitan cathedral, and of other neighbouring churches. At that time the people were beginning to read again, and to think; and as new capital naturally rushed in to replace the consumed stock of books, there was considerable activity once more in printing. The laws regulating the number of printers soon after fell into disuse, as they had long fallen into contempt. We have before us a catalogue (the first compiled in this country) of 'all the books printed in England since the dreadful fire, 1666, to the end of Trinity term, 1680,' which catalogue is continued to 1685, year by year. A great many—we may fairly say one-half—of those books are single sermons and tracts.

"The whole number of books printed during the fourteen years from 1666 to 1680, we ascertain, by counting, was 3550, of which 947 were divinity, 420 law, and 153 physic—so that two-fifths of the whole were professional books; 297 were school-books; and 353 on objects of geography and navigation, including maps. Taking the average of these fourteen years, the total number of works produced yearly was 253; but deducting the reprints, pamphlets, single sermons, and maps, we may fairly assume that the yearly average of new books was much under 100. Of the number of copies constituting an edition, we have no record; we apprehend it must have been small, for the price of a book, as far as we can ascertain it, was considerable.

"Roger North, speaking of those booksellers of his day who had the nack of getting up volumes on temporary matters, says, 'They crack their brains to find out selling subjects, and keep hirelings in garrets, on hard meat, to write and correct by the grate; so puff up an *octavo* to a sufficient thickness, and there is *six shillings* current for an hour and a half's reading.' In a catalogue, with prices, printed twenty-two years after the one we have just noticed, we find that the ordinary cost of an octavo was *five shillings*."*

After the Revolution of 1688, the business of printing rapidly increased, by the demands for sheets of intelligence or news, as well as for a better class of literary productions. In the reign of Queen Anne, printing was increased still further by the issue of the Guardian, Spectator, and other literary sheets; and in 1731, it received considerable impetus by the establishment of the Gentleman's Magazine, being the first of the class of larger periodicals.

Printing was introduced into Scotland, and begun in Edinburgh, during the year 1507, only thirty years after Caxton had brought it into England. Since that period it has continued to be pursued with success in the Scottish metropolis, and, within the last thirty years, has there become the most distinguished craft in the city. Printing was not known in Ireland till about the year 155., when a book in black-letter was issued from a press in Dublin; but till the year 1700, very little printing was executed in Ireland, and even since that period, the country has acquired no celebrity whatever in this department of the arts, although possessing some respectable printing establishments.

PROGRESS ON THE CONTINENT AND IN AMERICA.

The progress of printing on the Continent of Europe has been remarkably slow. Unless in the free states of Germany, where the art is pursued to an incalculable extent, the profession of the printer is almost everywhere under the severest restrictions, and little can be published without coming first under the scrutiny of censors appointed by the governments. The art is carried on in Paris perhaps with a greater degree of freedom than usual in other continental capitals, and from the presses in that city some exceedingly elegant works have been issued. But at Paris, as everywhere else, there is a general inferiority in the mechanism of the printing-office, when compared with that now in use in England and Scotland, except in those cases in which the presses employed have been imported from Great Britain.

While the art of printing has been by slow degrees creeping through the despotically governed states of Europe, and establishing itself at isolated spots in Oriental countries, everywhere creating distrust, and nowhere allowed to be exercised with perfect freedom, it has readily taken root and flourished among the civilized inhabitants of North America. The first printing-press established in the American colonies was one set up at Cambridge, in Massachusetts, in the year 1638, the era of the foundation of Harvard College of that place. It was only established by the exertions and joint contributions of different individuals in Europe and America; and there is no doubt that the mechanism and types were imported from England. The first work which issued from this press was the Freeman's Call, and the second the Almanack for New England, both in 1639; the first book printed was the New England version of the Psalms, an octavo volume of 300 pages. In 1676, books began to be printed at Boston; in 1686, printing became known in Philadelphia; and, in 1693, in New York. In the year 1700, there were only four printing-presses in the colonies. Since that period, and especially since the revolution, which removed every thing like a censorship of the press, the number of printing-presses has greatly increased. The mechanism of the press has likewise been much improved in that country; and the Americans have copied the patent steam-press of Cowper of London, and now possess machines of this description. In 1800, the number of presses had increased to 300; in 1830, they amounted to 1200; and we learn that they are still increasing in number and extending their influence. A few years ago, the Cherokees, one of the tribes of native Indians, set up a press, and commenced a newspaper—a circumstance which may be regarded as an extraordinary proof of the growth of knowledge in America.

We shall now proceed to a description of the art in its various branches, though without entering into the more minute, and what would be tiresome, details of the profession.

OF THE TYPES.

Printers in early times made the letters which they used, but, in process of time, the necessity for a division of labour created the distinct trade of a manufacturer of types, and it is only in rare instances in the present day that printers supply their own letter. The preparation of types requires much delicacy and skill. The first step in the process is the cutting of a punch or die, resembling the required letter. The punch is of hardened steel, with the figure of the letter cut, the reverse way, upon its point. On this die being finished, it is struck into a piece of copper, about an inch and a quarter long, one-eighth of an inch deep, and of a width proportionate to the size of the type to be cast. This copper, being so impressed with the representation of the letter, is called the matrix. The matrix is now fixed into a small instrument or frame, called the mould, which is composed of two parts. The external surface is of wood, the internal of steel. At the top is a shelving orifice, into which the metal is poured. The space within is of the size of the required body of the letter, and

* Penny Magazine.

is made exceedingly true. The melted metal, being poured into this space, sinks down to the bottom into the matrix, and instantly cooling, the mould is made to open with the instantaneous movement of a spring, and the type is cast out by the workman. This process of casting types is executed with great celerity. Of course, every separate letter in the alphabet, every figure, point, or mark, must have its own punch and matrix. In casting types, the founder stands at a table, and has beside him a small furnace and pot of heated metal, which he lifts with a small ladle. Type metal is a compound of lead and regulus of antimony, the latter giving hardness to the composition. The proper proportions of these metals is regulated by the size of the type, a greater quantity of antimony being employed for small than large letters.

When the type is cast from the mould, it is in a rough state, and as soon as a heap has accumulated on the caster's table, they are removed by a boy, who breaks off the superfluous tag of metal hanging at the end of each type. From the breaking-off boy the types are removed to another place, where a boy is constantly engaged in rubbing or smoothing their edges upon a stone. Being now tolerably well cleaned, they are next removed to a table, and set up in long lines upon a frame, where they are polished and made ready for use. Whatever be the size of the types, they are all made of a uniform height, and must be perfectly true in their angles, otherwise it would be quite impossible to lock them together. A single irregular type would most likely derange a whole page. The height of a type is, or ought to be, exactly one inch; but founders, much to their discredit, do not act with uniformity in this particular, the letters of some founders being higher than those of others. But all the types of one class of any founder are always uniform in size and height; and to preserve their individuality, all the letters, points, &c. belonging to one class, are distinguished by one or more notches or nicks on the body of the type, which notches range evenly when the types are set. These nicks, as we shall immediately see, are also exceedingly useful in guiding the compositor. Types are likewise all equally grooved in the bottom to make them stand steadily.

The varieties of size of types in the present day amount to forty or fifty, enlarging by a progressive scale from the minutest used in printing pocket Bibles, to the largest which is seen in posting-bills on the streets. Printers have distinct names for each size of letter, and use about twelve sizes in different descriptions of book-work; the smallest is called *Diamond*, and then follow, in gradation upwards, *Pearl*, *Ruby*, *Nonpareil*, *Minion*, *Brevier* (the type with which this sheet is printed), *Bourgeois*, *Long Primer*, *Small Pica*, *Pica*, and *English*. The larger sizes generally take their names thus—*Two-line Pica*, *Two-line English*, *Four*, *Six*, *Eight*, or *Ten-line Pica*, &c. Other nations have adopted different designations for their letters, principally from the names of their inventors; for instance, the French entitle Small Pica, *Philosophie*, from the first maker of the letter. Some of these classes of letters have derived their names from having been first employed in the printing of the prayers in the Romish church. Thus, *Pica*, from the service of the mass, termed *Pica*, or *Pie*, from the glaring contrast between the black and white on the page—*Primer*, from *Primarius*, the book of prayers to the Virgin—*Brevier*, from *Breviary*—*Canon*, from the *canons* of the church, &c.

All kinds of type are sold by weight by the founders, the price varying in amount according to the size of the letter. The smallest size, *Diamond*, costs about 12s. per pound; *Brevier*, about 3s. 6d.; *English*, about 2s.; and so in proportion for all intermediate sizes. Expensive as types thus are, their prices will not appear too high considering the immense outlay in cutting the punches and the general manufacture. In the *Diamond* size, 2800 go to a single pound weight of the letter *i*, and of the thinnest *space* about 5000.

A complete assortment of types is called a *Fount*, which may be regulated to any extent. Every type-founder has a scale showing the proportional quantity of each letter required for a fount; and a peculiar scale is required for every language. For the English language, the following is a type-founder's scale for the small letters of a fount of types of a particular size and weight:—

a	8500	h	6400	o	8000	v	1200
b	1600	i	8000	p	1700	w	2000
c	3000	j	400	q	500	x	400
d	4400	k	800	r	6200	y	2000
e	12000	l	4000	s	8000	z	200
f	2500	m	3000	t	9000		
g	1700	n	8000	u	3400		

It will be seen from this scale that the letter *e* is used much more frequently than any other character.

Types are nowhere manufactured so well as in Great Britain, and for their elegance and regularity of form, they have been much indebted to the late William Caslon, letter-founder, in London. Mr. Caslon was originally an engraver of ornamental devices on the barrels of fire-arms, and a maker of bookbinders' tools. The neatness with which he executed his work brought him into notice, and he was appointed to cut a fount of Arabic letters for an edition of the New Testament. This occurred about the year 1720, and from this period he entered on a successful career as a letter-founder. Hitherto the types used in England had been mostly imported from Holland; but Caslon's letters, by their decided superiority over those of all competitors at home and abroad, soon put a stop to the importation of foreign types, and were held in such estimation, as to be frequently sent to continental countries. From 1720 till 1780, few books were printed in England with the types of any other than this foundery, which still continues in existence in London.

The ingenuity and success of Caslon meet with a parallel in the case of the late Mr. Alexander Wilson, type-founder, in Glasgow. This person, by a strong effort of perseverance under difficulties, began to cut punches for types at his native town, St. Andrews, about the year 1740, and there opened a letter-foundery—the first established in Scotland—in company with an equally enterprising individual named Bain. In 1744, Messrs. Wilson and Bain removed with their foundery to the neighbourhood of Glasgow, where it long flourished. The types produced by Mr. Wilson were exceedingly neat, and even elegant, and became the real foundation of the fame of the Messrs. Foulis, printers, whose editions of the Classics were printed from them. Branches of the Glasgow letter-foundery were afterwards established in the English and Scottish capitals. In Edinburgh, besides the foundery of the Messrs. Wilson, grandsons of the first of the name, the principal establishment of the kind is that of Messrs. Miller and Company, whose types we consider as standing in the first class in respect of neatness, beauty, and regularity. They are largely employed in the printing of Bibles, newspapers, and other works in which a small type is required.

The large letters used in posting and hand-bills are manufactured chiefly at Sheffield. In this kind of types very great improvements have also been made in recent times; and the varieties are becoming yearly more numerous and varied in character. The letter used in printing in North America is made principally at New York and Philadelphia; and the style of both typography and presswork in that country is rapidly improving, and now competing with the products of the English press. The type used in this edition of CHAMBERS'S INFORMATION FOR THE PEOPLE, was cast in the foundry of L. Johnson & Co., Philadelphia.

COMPOSING.

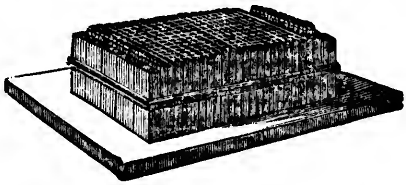
All the types in use in the printing-office are sorted in *cases*, or shallow boxes, with divisions. There are two kinds of cases—the *upper* and *lower case*; the latter lying nearest the compositor upon the frame for their support. In the upper case are placed all the capitals, small capitals, accented letters, figures, and characters used as references to notes. In the lower case lie all the small letters, points, and spaces to place between the words. In the lower, no alphabetical arrangement is preserved; each letter has a larger or smaller box allotted to it, according as it is more or less frequently required; and all those letters most in request are placed at the nearest convenient distance to the compositor. By this ingenious and irregular division of the lower case, much time is saved to the compositor, who requires no label to direct him to the spot where lies the particular letter he wants. To a stranger in a printing-office, nothing appears so remarkable as the rapidity with which the compositor does his work; but habit very soon leads the hand rapidly and mechanically to the letter required. When Italic letters have to be introduced, they are taken from a separate pair of cases of the same fount.

The process of composing and forming types into pages may now be adverted to. Placing the copy or manuscript before him on the upper case, and standing in front of the lower case, the compositor holds in his left hand what is termed a composing-stick. Sometimes this instrument is of wood, with a certain space cut in it of a particular width; but more commonly it is made of iron or brass, with a movable side, which, by means of a screw, may be regulated to any width of line. In either case the composing-stick is made perfectly true and square. One by one the compositor lifts and puts the letters of each word and sentence, and appropriate points, into his stick, securing each with the thumb of his left hand, and placing them side by side from left to right along the line. When he places a letter in the stick, he does not require to look whether he is placing it with the face in its proper position. His object is accomplished by looking at what is called the *nick*, which

must be placed outwards in his composing-stick. (See adjoining representation of a type.) This is one of those beautiful contrivances for saving labour which experience has introduced into every art, and which are as valuable for diminishing the cost of production as the more elaborate inventions of machinery. When he arrives at the end of his line, the compositor has a task to perform in which the carefulness of the workman is greatly exhibited. The first letter and the last must be at the extremities of the line: there must be no spaces left in some instances, and no crowding in others, as we see in the best manuscript. Each metal type is of a constant thickness, as far as regards that particular size of letter; though all the letters are not of the same thickness. The adjustments, therefore, to complete the line with a word, or at any rate with a syllable, must be made by varying the thickness of the spaces between each word. A good compositor is distinguished by uniformity of spacing: he will not allow the words to be very close together in some instances, and with a large gap between them in others. His duty is to equalize the spacing as much as he possibly can; and this is in some cases very troublesome. In composing poetry, or similar matter, where there is always a blank space at one of the ends of the line, spacing is very easily accomplished by filling up the blank with larger spaces, or *quadrats*. But whether prose or poetry, the matter of each line must be equally adjusted and *justified*, so as to correspond in point of compactness with the previously set lines. The process of composing is greatly facilitated by the compositor using a thin slip of brass, called a *setting-rule*, which he places in the composing-stick when he begins, and which, on a line being completed, he pulls out and places upon the front of the line so completed, in order that the types he sets may not come in contact with the types behind them, but glide smoothly into their places to the bottom of the composing-stick.

When the workman has set up as many lines as his composing-stick will conveniently hold, he lifts them out by grasping them with the fingers of each hand, and thus taking them up as if they were a solid piece of metal. He then places the mass in an elongated board, termed a *galley*, which has a ledge on one or perhaps both sides. The facility with which some compositors can lift what is called a *handful* of movable type without deranging a single letter, is very remarkable. This sort of skill can only be attained by practice; and one of the severest mortifications which the printer's apprentice has to endure, is to toil for an hour in picking up about a thousand letters, and then see the fabric destroyed by his own unskilfulness, leaving him to mourn over his heap of broken type, technically called *pie*.

Letter by letter, and word by word, is the composing-stick filled; and by the same progression the galley is filled by the contents of successive sticks. When the compositor has set up as many lines as will fill a page, he binds them tightly round with cord, and removes them from the galley. The annexed cut is a representation of a small page of types tied up, and placed on a board.



Sometimes, as in the case of newspaper and similar work, the *handfuls* of type are accumulated till they fill the galley, and are then removed in long columns. After the matter is thus so far prepared, it is the duty of the pressman to take an impression or *first proof* from the types, in order that the compositor may correct the errors which are sure to have been made. Proofs are usually taken by means of an old large press kept for the purpose. After the galley matter is corrected, and re-corrected by the compositor, it is divided into pages of the size wanted; and head-lines, or figures indicating the number of the page, being added, the pages are arranged upon a large firm table, and there securely fixed up in an iron frame or *chase*, by means of slips of wood and wedges, or *quoins*.

This process, which is called *imposing*, being completed, and the face of the types being levelled by a *plainer* and mallet, the *form*, as it is called, is proved and prepared for press. Proof-sheets being taken, they are subjected to the scrutiny both of a *reader* employed in this peculiar function in the office, and of the author. These having made their marks pointing out words and letters to be altered or corrected, the compositor once more goes over the form, correcting the errors by lifting out the letters with a bodkin, and when revised, the sheet is pronounced ready for working. It may be explained that the imposing table at which all these corrections are made, is usually composed of smooth stone or marble on the top, and requires to be a substantial fabric.

It need scarcely be told that the size of books greatly varies; but the sizes are all reducible to a standard determined by the number of leaves into which a sheet of paper is folded. The most common size is octavo, each sheet of which contains eight leaves, or sixteen pages; the next is *duodecimo*, containing twelve leaves, or twenty-four pages in the sheet; and the next *octodecimo*, or eighteens, containing thirty-six pages in a sheet. There are many other sizes, such as the larger *quarto*, the smaller *twenty-fours*, &c. To know how to place pages of types in a form so as to produce, when printed, a regular series upon paper, is one of the branches of the art to be acquired by the young compositor.

PROGRESSIVE IMPROVEMENTS IN TYPOGRAPHY.

The following particulars relative to the early productions of the press, will show how the style of book-printing was gradually improved:—"With respect to their forms, they were generally either large or small folios, or at least quartos; the lesser sizes were not in use. The leaves were without running title, direction word, number of pages, or divisions into paragraphs. The character itself was a rude old Gothic mixed with Secretary, designed on purpose to imitate the handwriting of those times; the words were printed so close to one another, that it was difficult and tedious to be read, even by those who were used to manuscripts, and to this method, and often led the inattentive reader into mistakes. Their orthography was various, and often arbitrary, disregarding method. They had very frequent abbreviations, which in time grew so numerous and difficult to be understood, that there was a necessity of writing a book to teach the manner of reading them. Their periods were distinguished by no other points than the double or single one—that is the colon and full point; but they a little after introduced an oblique stroke, thus /, which answered the purpose of our comma. They used no capital letter to begin a sentence, or for proper names of men or places. They left blanks for the places of titles, initial letters, and other ornaments, in order to have them supplied by the illuminators, whose ingenious art, though in vogue before, and at that time, did not long survive the masterly improvements made by the printers in this branch of their art. Those ornaments were exquisitely fine, and curiously variegated with the most beautiful colours, and even with gold and silver; the margins, likewise, were frequently charged with a variety of figures of saints, birds, beasts, monsters, flowers, &c., which had sometimes relation to the contents of the page, though often none at all. These embellishments were very costly; but for those that could not afford a great price, there were more inferior ornaments, which could be done at a much easier rate. The name of the printer, place of his residence, &c. &c., were either wholly neglected, or put at the end of the book, not without some pious ejaculation or doxology. The date was likewise omitted, or involved in some crampt circumstantial period, or else printed either at full length, or by numerical letters, and sometimes partly one and partly the other—thus, one thousand CCCC and lxxiiii, &c.; but all of them at the end of the book. There was no variety of characters, no intermixture of Roman and Italic; they are of later invention: but their pages were continued in a Gothic letter of the same size throughout. They printed but few copies at once, for 200 or 300 were then esteemed a large impression; though, upon the encouragement received from the learned, they increased their numbers in proportion."

About 1469-70, alphabetical tables of the first words of each chapter were introduced, as a guide to the binder. Catch-words (now generally abolished) were first used at Venice, by Vindeline de Spire. Early printed books had no signatures. Signatures are those letters of the alphabet which are put at the bottom of the right hand pages of sheets to distinguish their order. When the alphabet is finished, a second begins A a, or 2 A, instead of a single A; and when that is terminated, A a a, or * A, begin the third, and so on. In order to indicate more correctly the order of each sheet, printers add figures to the initial letter on the third, fifth, and seventh pages: the numbers of these figures, which do not pass the middle of the sheet, point out the size of the edition. Thus A 2 on the third page, A 3 on the fifth, and A 4 on the seventh, show a work to be in 8vo; in the 12mo size, A 5 on the ninth page, and A 6 on the eleventh page, &c.; but it is now customary to give signatures only on the first and third pages of 8vo, and on the first, third, and fifth pages of 12mo.

In some modern French works, figures are substituted for letters, and the other leaves are marked by asterisks. The invention of signatures is ascribed by M. Marolles to John of Cologne, who printed at Venice in 1474; the Abbe Rive attributes it to John Koelhof, a printer at Cologne, and a contemporary with the former, from whom we have a work dated in 1472. It is, however, of little consequence who was the originator, for, on the whole, signatures are rather a clumsy expedient merely to direct the binder in folding the sheet, and are generally much too conspicuous upon the pages.

One of the chief improvements in the style of typography has been the dismissal of abbreviations and connected letters from the founts. Formerly, abbreviations were very common: the word *the* was indicated by the letter *y* and a small *e* above it; the conjunction *and* was indicated by &, which is a contraction of *et*. There were many of this species of abbreviations in printing both the English and Latin languages, and these were not more unseemly than the connected letters; such, for instance, as the junction of the letters *c* and *t* by a curve stroke from the top of one to the other. In recent times all these connected letters have been disused, with the exception of *ffl* and *fl*, because the head of the common *f* would press against the *l*, and be broken. Another very great improvement has been effected in the dismissal of the long *s*, in the case of two of this letter coming together.

STEREOTYPING.

We may now offer a brief explanation of the process of stereotyping, which has been of immense service to literature. Stereotyping is the manufacturing of fictitious pages of types, and the invention is generally attributed to a Mr. William Ged, of Edinburgh, about the year 1725. When the art was properly made known, it was hailed with acclamation by the printing and publishing world; but as experience developed its powers, it was found to be strictly applicable only to a particular kind of work.

When a page is intended to be stereotyped, the same process of putting up the types is gone through that we have already described; instead, however, of being carried to the press, the page is plastered over with liquid stucco to the thickness of about half an inch, so that a level cake is formed on the surface of the types. As soon as the stucco hardens, which it does almost immediately, the cake is separated from the types, and on being turned up, shows a complete hollow or mould-like representation of the faces of the types, and every thing else in the page. There being no longer any use for the types, they are carried of and distributed. As for the cake, it is put into an oven, and baked to a certain degree of heat and hardness, like a piece of pottery. It is next laid in a square iron pan, having a lid of the same metal, with holes at the corners. At the bottom of the pan there is a movable plate, called the floating plate; and upon this plate, which has a smooth accurate surface, the mould is placed with its face downwards. The lid being now placed and held tightly on by a screw, the pan, by the assistance of a crane and other mechanism, is immersed in a pot of molten lead, and being allowed to fill by means of the holes, it is at length taken out and put aside to cool. On opening the pan a curious appearance is presented. The lead has run into the mould side of the cake, and formed a thin plate all over, exhibiting the perfect appearance of the faces of the types on which the stucco was plastered. Thus is procured a plate or fictitious page of types, not thicker than the sixth of an inch. When the plate comes out of the pan, it is in a somewhat rude state, and has to be carefully pruned at the edges, its little specks picked clean, and, if necessary, one or more bad letters cut out, and replaced by soldering in the heads of movable types. The plate is also planed upon the back by means of an ingenious rotatory cutting machine upon which it is fixed.

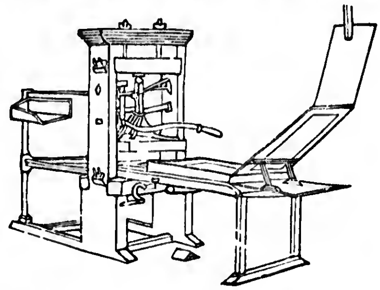
The stereotype plates, so prepared, are next taken to the printing-office, and made ready for press. This is done by placing them upon iron or wooden blocks, so that both plate and block make up the exact height of a page of real types. They are fixed to the blocks by the aid of small metal catches at the sides, head, and foot, which catches are held fast by slips of *furniture* properly wedged. Notwithstanding the great care taken in making the plates level and of a uniform thickness, it is seldom that they are perfect; and to make them as accurate as possible for a fair impression, scraps of thin pasteboard or paper are placed between them and the blocks at the thinnest parts. When the impression is completed, the plates are unfixed, packed up, and laid aside for future use. Now for the specific utility of stereotyping.

In all cases of common book-work, it is best to print from types to the amount of the copies required, and then distribute the types; but in most cases of books published in parts, sheets, or numbers, stereotyping becomes absolutely necessary. It is easy to perceive the reason for this. When books are published in numbers, it often happens that many more copies are sold of one number than of another, and unless the types be kept up to complete sets in the hands of the publishers, or to print copies according to the increased demand, a serious loss is sustained. The manufacture of stereotype plates, is, therefore, simply a means of keeping up fictitious types to answer future demands, at an expense greatly inferior to that of keeping the actual pages standing, or of putting the types up anew.

In the case of Chambers's Edinburgh Journal, a new feature of utility was for the first time developed in the stereotyping art. It was desired to have a separate impression of that work in London, and stereotyping furnished the means. The types being first set up and imposed, are sent to the foundery, where *two sets* of stereotype plates are cast from them, one to be retained for use in Edinburgh, and the other to be sent to London, and there subjected to a separate press. The expense of setting up the types anew in London, and the danger of errors being incurred from the want of editorial supervision, are thus avoided. Had not the stereotyping process been available, the arrangement for a separate impression of the Journal might not have been entered upon, and the progress of the work in circulation consequently obstructed to an indefinite extent. Advantage was afterwards taken of the art to the same purpose by the proprietors of other cheap periodicals, particularly the Penny Magazine, of the cuts of which we believe upwards of a dozen sets of stereotype copies are sent to be printed in different parts of the world.

PROCESS OF PRINTING.

The duties of the compositor do not involve the process of printing. When the forms are duly prepared in the composing-room, they are carried into the press-room, where they come under the charge of the pressmen. The earliest printing-presses were exceedingly rude, and seem to have resembled the common screw press, with a contrivance for running the form under the point of pressure. This must have been not only a laborious and slow operation, but one exceedingly defective, from the difficulty of regulating the impression, and the risk of injuring the faces of the types. The defects in these original presses were at length remedied by an ingenious Dutch mechanic, William Jansen Blaew,



who carried on the business of a mathematical instrument maker at Amsterdam. He contrived a press, in which the carriage holding the form was wound below the point of pressure, which was given by moving a handle attached to a screw hanging in a beam having a spring, which spring caused the screw to fly back as soon as the impression was given. This species of press, which was almost entirely formed of wood, continued in general use in every country in Europe till the beginning of the present century. With certain lever powers attached to the screw and handle, it is here represented.

In connection with the representation of the old common press, the process of printing may be described. The form, being laid on the sole of the press, is fixed at the sides so as to render it immovable from its position. There are two men employed; one puts ink on the form either by means of stuffed balls or by a composition roller—the other works the press. The latter lifts a blank sheet from a table at his side, and places it on what is called the *tympan*, which is composed of parchment and blanket stuff, fitted in a frame, and tightened like the top of a drum (and hence its name), and which, by means of hinges connecting it with the sole, folds down like a lid over the form. As the sheet, however, would fall off in the act of being brought down, a skeleton-like slender frame, called a *frisket*, is hinged to the upper extremity of the tympan, over which it is brought to hold on the paper. Thus, the frisket being first folded down over the tympan and the tympan next folded down over the form, the impression is ready to be taken. This is done by the left hand of the pressman winding the carriage below the *platten* or pressing surface, and the impression is performed by the right hand pulling the handle attached to the screw mechanism. The carriage is then wound back, the printed sheet lifted off and another put on the tympan, the form again inked, and so on successively. In the above engraving the press appears with the frisket and tympan sloping upwards, ready to receive the sheet, the frisket being sustained from falling backwards by a slip of wood depending from the ceiling. One of the greatest niceties connected with this art, is the printing of the sheet on the second side in such a manner that each page, nay, each line, shall fall exactly on the corresponding page and line on the side first printed. To produce this desirable effect, two iron points are fixed in the middle of the sides of the frame of the tympan, which make two small holes in the sheet during the first pressure. When the sheet is laid on to receive an impression from the second form, these holes are placed on the same points, so as to cause the two impressions to correspond. This is termed producing *register*, and unless good register is effected, the printing has a very indifferent appearance. Expert workmen perform these operations with surprising rapidity, though with considerable labour. Two men employed at press take the process of pulling and inking for alternate quantities. After the forms are wrought off, they are washed in a solution of potash to remove the remains of the ink, which is of a thick oleaginous character, and then carried back to the composing-room to be distributed. This last operation is very speedily performed by the compositors.

To suit paper for printing, it is necessary to wet it some hours previous to its being used. This is done by dipping alternate quires in water, and afterwards pressing the mass with a heavy weight, till the whole is in a half dry or damp state.

After the sheets are printed, they are hung up on poles in the printing-office to be dried. On being dried, they are individually placed between fine glazed boards, and in this condition subjected in a mass to the pressure of a powerful press. On removal, the indentations of the types are found to be levelled, and the whole sheet to be smooth and ready for the operations of the book-binder. Latterly a great improvement has been effected in the smoothing process, by employing the hydraulic or water press, which gives an enormous pressure with little aid from manual labour.

INK AND INKING-ROLLERS.

Much of the beauty of good printing depends on the quality of the ink, which it requires considerable skill to manufacture. The ink used by the earliest printers was of such excellent quality, that in many instances it remains intensely black to this day; but a long period afterwards elapsed, during which very bad ink was employed. Within the present century, great improvements have taken place in the composition of printing ink, which is now produced of a good quality in London by several manufacturers; it is, however, still inferior to the finer kinds of ink used in Paris, the French having evidently surpassed the English in producing a pure and intensely black ink which will preserve its colour. Printing ink is composed of genuine linseed oil, boiled to the consistency of a syrup, and then well-mixed and ground with lamp-black. The qualities desired in the composition are depth and durability of colour, and that it should be stiff without strong adhesion, and keep soft and mellow, but dry quickly after being put upon the paper. It is made of different qualities, from 1s. 6d. to 5s. and upwards per pound weight.

One of the greatest of recent improvements in the art of printing is in the mode of inking the forms. From the days of Guttenburg, this had been done by stuffed cushions, or balls covered with skins, by which no regularity could be preserved, and no speed acquired. Earl Stanhope, when he invented his improvement on the press, attempted the plan of inking by means of rollers, but he could not discover any species of skin suitable for the purpose; all that this nobleman so anxiously desired, was at length accomplished, in consequence of a chance observation of a process in the Staffordshire potteries, where rollers formed of a composition were used. A Mr. Forster, employed at a bookseller's printing-office at Weybridge, was the first who applied it to letter-press printing, by spreading it, in a melted state, upon coarse canvas; the inventors of printing machines soon caught the idea, and, by running the composition as a coat upon wooden cylinders, produced the perfect inking-rollers.

The composition is formed of treacle and glue, which, being heated and melted together, are poured into long iron moulds, in which the central rod has previously been inserted. The process resembles that by which moulded candles are made, the central rod being nearly in the same predicament in the one case as the wick in the other When taken out of the mould the roller is a cylinder of soft and elastic matter, resembling India rubber. If required for the hand-press, it is connected with a handle after the manner of a garden roller. The ink being placed, in moderate quantity, at the back of a smooth metal table, the workman, grasping the handle, draws the roller backwards and forwards along the table, distributing a little ink equably all over its surface; and having thus diffused some ink all over the roller, he applies the same to the types, drawing it backwards and forwards over them, to make sure that all have been inked. By this plan the types are inked more equably than by the balls, and in less than half the time.

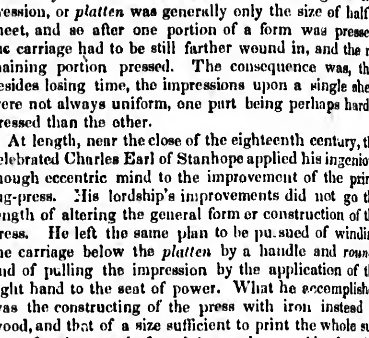
Within these few years, a plan has been devised for moving the rollers over the forms by an apparatus attached to the press. Self-inking presses are now coming into use.

IMPROVED PRINTING PRESSES.

As already mentioned, the original printing-press as slightly improved by Blaew, remained in general use throughout Europe till the beginning of the present century. Its defects were of such a nature, that it seems wonderful that no effort was made, during so long a time, to remedy them. The surface communicating the impression, or *platten* was generally only the size of half a sheet, and so after one portion of a form was pressed, the carriage had to be still farther wound in, and the remaining portion pressed. The consequence was, that besides losing time, the impressions upon a single sheet were not always uniform, one part being perhaps harder pressed than the other.

At length, near the close of the eighteenth century, the celebrated Charles Earl of Stanhope applied his ingenious though eccentric mind to the improvement of the printing-press. His lordship's improvements did not go the length of altering the general form or construction of the press. He left the same plan to be pursued of winding the carriage below the *platten* by a handle and *rounce*, and of pulling the impression by the application of the right hand to the seat of power. What he accomplished was the constructing of the press with iron instead of wood, and that of a size sufficient to print the whole surface of a sheet, and of applying such a combined action of levers to the screw as to make the pull a great deal less laborious to the pressman; the mechanism altogether being such as to permit much more rapid and efficient working.

The *Stanhope press*, which is here represented, consists of a massive frame of iron, cast in one piece. This is the body of the press, in the upper part of which a nut is fixed for the reception of the great screw, and its point

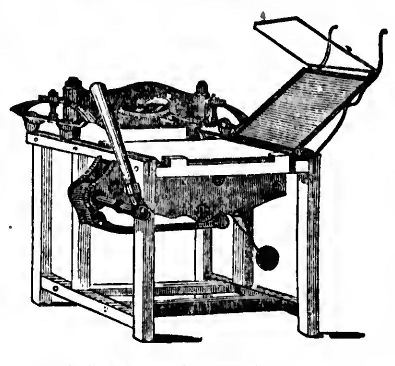


operates upon the upper end of a slider fitted into a dove-tail groove formed between the two vertical bars of the frame. The slider has the platten firmly attached to the lower end of it; and, being accurately fitted between the side guides, the platten must rise and fall parallel to itself when the screw is turned. The weight of the platten and slider is counterbalanced by a heavy weight behind the press, suspended by a lever which acts upon the slider to lift it up, and keep it always bearing against the point of the screw.

There are two projecting pieces cast with the main frame, to support the carriage when the pull is made: to these, rails are screwed, and placed exactly horizontal for the carriage to run upon, when it is carried under the press to receive the impression, or drawn out to remove the printed sheet. The carriage is moved by a rounce or handle, with leather girths, very similar to the wooden press. Upon the axle of this handle a wheel is fixed, round which leather belts are passed, one extending to the back of the carriage to draw it in, and two others which pass round the wheel in an opposite direction to draw it out. By this means, when the handle is turned one way, it draws out the carriage; and by reversing the motion, it is carried in. There is likewise a check strap which limits the motion of the wheel, and, consequently, the action of the carriage. The principal improvement of Earl Stanhope's press consists in the mode of giving motion to the main screw of it, which is not done simply by a lever attached to the screw, but by a second lever. The main screw has a short lever fixed on the upper end of it, and this communicates by an iron bar or link to another lever of rather shorter radius, which is fixed upon the upper end of a second spindle, and to this the handle or lever by which the press is worked is fixed. Now, when the workman pulls this handle, he turns round the spindle, and, by the connection of the rod, the main screw turns with it, and causes the platten to descend with it, and produce the pressure. But it is not simply this alone, for the power of the handle is transmitted to the screw in a ratio proportioned to the effect required at the different parts of the pull; thus, at first, when the pressman takes the handle, it lies in a direction parallel to the frame, or across the press: and the short lever (being nearly perpendicular thereto) is also nearly at right angles to the connecting rod; but the lever of the screw makes a considerable angle with the rod, which therefore acts upon a shorter radius to turn the screw; because the real power exerted by any action upon a lever is not to be considered as acting with the full length of the lever between its centres, but with the distance in a perpendicular, drawn from the line in which the action is applied to the centre of the lever.

The obvious excellence of the Stanhopian improvement in gaining power for the handle, led a number of printers to apply this species of lever power to the screw of the common press, but we believe not with marked success. The improvements of Lord Stanhope were speedily followed by the attempts of other individuals in Great Britain and America, to remedy the ancient defects in printing mechanism. So numerous, indeed, have these attempts been since the beginning of the present century, that it is quite out of our power to mention them in detail. With, we believe, one or two exceptions, all the modern improvers of the printing-press have confined their efforts chiefly to the process of communicating pressure to the platten, so as to modify labour, and procure greater rapidity of working. In these cases the screw has been generally dismissed, and power procured sometimes by the action of two or more inclined planes working against each other, in other instances by fulcrums and levers, and in others by the straightening of a joint. The latter is an exceedingly simple and beautiful form of power, and may easily be comprehended when we say, that it resembles the bending and straightening of the knee-joint: when the knee of the upright bar of the press is bent, the platten is drawn up; and when the knee is forced by a lever into a perpendicular position, the platten sinks, and the pressure is communicated. This may be considered the most efficient mode of compressing the platten yet discovered, and it would be difficult to rival it in the properties of simplicity and rapidity of execution. Nevertheless, such is the number and variety of improved presses in the present day, that it would not be easy to decide upon which has the best claims to the notice of printers. Among those which have gained a large share of approbation, may be mentioned the *Columbian press*, which is of American invention. This new press was brought to this country in 1818, by Mr. George Clymer of Philadelphia, and made the object of a patent. The pressing power in this instance is procured by a long bar or handle acting upon a combination of exceedingly powerful levers above the platten, and by many workmen this press is greatly preferred to any other.

The various improved presses which we have noticed, are, in most cases, made of at least three sizes, namely, *demy*, *royal*, and *super-royal*—that is, they are respectively able to print sheets of these sizes; and they accordingly vary in price from about £50 to £80 each. They are nearly all manufactured by the patentees in London. In the present day, the old wooden press of Blaew is entirely discarded from use in printing, and it is only to be seen occasionally in an obscure corner of the printing-office, reduced to the humble character of a proof-press.



The only instance worth mentioning, in which an improved press was made of quite a new construction, was in the case of the ingenious invention of Mr. John Ruthven of Edinburgh. This mechanician contrived a press in which the types stand upon a fixed frame or table, while the pressing part or platten is brought over the form by being hurled forward on wheels. On being brought over the form, a depending hook or notch at each end of the platten is caught and pulled down by the combined action of levers beneath the table, and operated upon by the left hand of the pressman. This was an exceedingly meritorious invention, and many presses on this plan were manufactured and sold, but experience has evinced that the contrivance is only valuable when applied to small presses, not larger than foolscap size, and chiefly useful for executing jobs. Mr. Ruthven makes his presses as small as quarto size; and as they stand on a table, and can be easily wrought by any gentleman, no better press could be recommended to the notice of the amateur printer. The above cut presents a correct representation of Mr. Ruthven's press, which it will be perceived is of an exceedingly compact and portable form.

THE CHAPEL.

It is worth while to remark, that till the present day the phraseology used in relation to the mechanical details of the printer, possesses certain traces of the early connection of the art with men of learning. A number of the technical terms, as may be seen from the description we have given, are a corruption of Latin words. We may instance *tympan*, from tympanum, a drum, and *stet*, (let it stand), which is used as a mark in correcting proof-sheets. The name *brevier*, applied to a certain size of type, originated, as has been already mentioned, in that letter being first used in printing the Breviaries of the Romish church. An exceedingly old practice prevails among printers of calling their office a *Chapel*, and under this title the compositors, pressmen, and all others engaged in the office, have been in the habit of meeting together, and forming a species of lodge, in order to settle affairs connected with the internal arrangements of the office, or any disputes which may occur among members. The general improvement in every thing connected with printing establishments, and the advance of manners, have greatly modified the spirit which used to prevail in those confederacies; nevertheless, the appellation of *the chapel* remains, and is of traditionary interest. It has been supposed by many writers that the title of Chapel originated in Caxton's exercising the profession of a printer in one of the chapels in Westminster Abbey; and it is exceedingly probable that it has an origin of this nature, for printing was at first carried on in many places in England in connection with religious houses. Hence, in M'Creery's poem, entitled "The Press," the author has the following lines:

> "Our art was hail'd from kingdoms far abroad,
> And cherish'd in the hallow'd house of God;
> From which we learn the homage it received,
> And how our sires its heavenly birth believed.
> Each printer hence, howe'er unblest his walls,
> E'en to this day his house a CHAPEL calls."

LAWS AFFECTING PRINTERS.

The proprietors and printers of newspapers are subject to various laws, enforcing the mode of publication, the use of stamps, and payment of advertisement duties; but printers of books, or any common species of work, are practically left at liberty to carry on their business in any manner or way that seems suitable to themselves. Each printer, however, by the act 2 V., c. 12, is required to print upon the front of any sheet, if printed on one side only, or upon the first or last leaf of every book consisting of more than one leaf, his name, place of abode, and business; penalty for omission £5, and the like penalty for dispersing any such publication without the imprint. But no actions for penalties can be instituted except in the name of the Attorney or Solicitor General for England, or the Queen's Advocate in Scotland. The queen enjoys the prerogative of printing the authorized versions of the Bible, Book of Common Prayer, Acts of Parliament and other state papers.

PRINTING BY MACHINES.

After all the ingenuity of Lord Stanhope and that of his successors had been lavished on the press, still the process of printing could not be executed but with considerable fatigue, and at a rate of speed seldom greater than that of throwing off 250 impressions, or 125 complete sheets, in an hour. It must appear evident that this was a state of things quite incompatible with the advancement of knowledge and the necessity for producing a large quantity of impressions in a short space of time, particularly as regarded newspapers. It became apparent that an entire revolution was required in the structure of the press; that the flat printing surface should be discarded, and cylinders brought into use. We have now to describe how this great new invention, applied to printing-machines, came to be adopted.

In 1790, Mr. Nicholson, the editor of the Philosophical Journal, procured a patent for certain improvements in printing, which patent imbodies almost every principle since so successfully applied to printing-machines; and although he did not carry his views into practical effect, little has been left for subsequent engineers to do, but to apply, in the most judicious manner, the principles he laid down in his patent. He may therefore be justly considered as the originator of the great modern improvements in printing machinery; for with him originated the idea of taking the impressions from types by means of cylinders, and of inking the forms with rollers instead of balls, which constitute the two essential parts of all effective modern printing-machines.

Whether Mr. Nicholson's ideas were known to Mr. König, a German, is now uncertain; but to him is due the distinguished merit of carrying steam printing first into effect. Mr. König, conceiving it possible to apply steam-power to produce accelerated speed with the common press, after various unavailing efforts to obtain assistance from the printers on the Continent, came to England. Arriving in London about 1804, he submitted his scheme to several printers there with no better success, until introduced to Mr. Bensley, senior, who, attracted by Mr. König's plans, entered into arrangements with him. After persevering for some time in various attempts to accelerate the speed of the common press, and at the same time render the attendance of the man who inks the types unnecessary, his exertions resulted, to use his own words, "in discovering that they were only employing a horse to do what had been before done by a man." He in consequence gave up all idea of his projected improvements of the common press, and turned his attention to CYLINDRICAL PRINTING.

After continued experiments for some years, a small machine was made, in which the two leading features of Nicholson's invention were embraced (the cylinders and the inking-rollers), which he exhibited to Mr. Walter, proprietor of the Times newspaper; and on shewing what further improvements were contemplated, an agreement was entered into for the erection of two machines for printing that journal. Accordingly, on the 28th November, 1814, the public were apprized that the number of the Times of that date was the first ever printed by machinery, steam-propelled. At this period but few persons knew of any attempts going on for the attainment of this object; whilst, among those connected with printing, it had often been talked of, but treated as chimerical.

After the utility of cylindrical printing had been thus proved, it was thought highly desirable that the principle should be applied to printing fine book-work, where accurate register is indispensable. This was, to a certain extent, attained, by using two large cylinders, the sheet of paper being conveyed from the bottom of the first cylinder (where it had received the first impression) by means of tapes, leading in a diagonal direction to the top of the second cylinder, round which the sheet was carried till the second side was printed. The first machine of this description was erected at Mr. Bensley's office, where it continued at work for some years, till more modern machines superseded it.

So sanguine were the patentees (Mr. König, Mr. Bensley, and Mr. R. Taylor) that no further improvement could be effected, that in March, 1817, they issued a prospectus, offering three kinds of machines at high prices, and requiring a considerable annual premium; but we believe these offers were not embraced.

In the course of 1818, Mr. Napier, and Messrs. Applegath and Cowper, took out patents for improvements in cylindrical printing machinery. Mr. Napier's invention consisted chiefly in using grippers instead of tapes, as in König's, for seizing hold of and leading the sheet of paper round the cylinders. Ingeniously as this machine was constructed, the principles upon which it worked caused it to give way in general estimation to those of Applegath and Cowper. These mechanicians' patent which expired in 1832, referred principally to the application of two drums placed betwixt the cylinders to ensure accuracy in the register, over and under which the sheet was conveyed in its progress from one cylinder to the other, instead of being carried, as in König's machine, in a straight line from the one cylinder to the other; and the mode of distributing the ink upon tables instead of rollers—two principles which have secured to machines of this construction a decided preference for fine work. Machines of this construction were made by Applegath and Cowper for the principal printing establishments in London, Paris, Edinburgh, and many other cities; and it is nearly upon the model of their machines that other manufacturers now construct their steam-presses for the execution of book-work.

Printing-machines are now made of various kinds, adapted to the peculiar descriptions of work for which they are required. These descriptions of work may be classed under two distinct heads, namely, the printing of newspapers, one side at a time, and the printing of a better kind of sheets, or book-work, both sides at a time. There can be nothing more easy than to make a machine capable of first printing one side of a sheet of paper, and afterwards the second, by the removal of one form and the introduction of another; but this process will not produce *register:* the second side may or may not be on the back of the first, and the work is therefore of a very inferior appearance, though suitable enough for newspapers, in the working of which despatch is chiefly required. This kind of press is therefore the best adapted to gain that end; for the first side of the paper may be printed deliberately, and the second side be made up to the last moment of time, and then thrown off. To produce a machine to print both sides at a time, and with perfect register, no small degree of mathematical accuracy, and no small share of ingenuity in the mechanician, are required. The great and important object to be attained in this kind of machine, is to cause the sheet, after it has received its first impression, to travel along the sides of the cylinders and drums at such a rate as to meet the types of the second side at the exact point which will cause the second side to fall with perfect accuracy upon the back of the first. To accomplish this exceedingly desirable end, the cylinders and drums must revolve at precisely the same speed as the carriage underneath; and therefore any inaccuracy in the turning of the axles, the cutting of the teeth of the wheels, or any other deficiency, however slight, will produce ill-registered sheets, and create an enormous degree of vexation to the printer. With these explanatory remarks, we pass on to a notice of four different machines, calculated to produce register and non-register sheets, under various modifications and rates of speed.

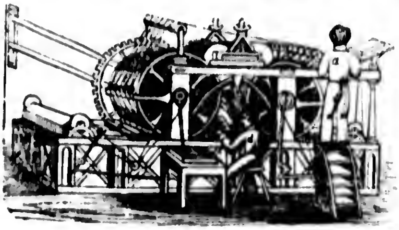
1. A machine with one cylinder, called a single machine, generally used for printing newspapers; it throws off from 900 to 1200 an hour on one side, requiring two boys, one to lay on the paper, and another to receive it when printed.

2. A machine with two cylinders, called a double machine, but only printing from one form of types at the rate of from 1600 to 2200 an hour, requiring two boys to lay on the sheets, and two to take them off, exclusively used for newspapers. It consists of two small cylinders, about ten inches in diameter, placed about five inches apart, and suspended from a beam at each end. A camb or eccentric causes the beams to vibrate, and with them the cylinders to rise and fall about one half of an inch. The cylinders turn in opposite directions, and as the machine only prints one form at a time, that cylinder only which is turning in the same direction as the types is permitted to rest upon the form, and take the impression, so that a sheet is printed by each cylinder alternately every time the type-carriage goes backwards or forwards. Two boys feed the paper into the machine, at two drums placed about three feet above the carriage, and the sheet is led down to the cylinders by tapes, which also convey it, after being printed, to the end of the machine, where two boys receive the sheets and lay them straight in a heap, ready to be again put through the machine when the second form is placed on the type-carriage to print the other side. There is a distinct and complete apparatus for inking the types at each end, similar in principle to that which is mentioned in the account of the book machine. Many of the largest sized and best newspapers are printed by machines of this construction. They are generally moved by manual labour, two men turning a winch, which operates upon the mechanism and fly-wheel.

3. A machine, similar to that used by the Times, with four printing cylinders, requiring the attendance of eight boys, and throwing off about 4000 impressions an hour. To attempt to describe this machine without diagrams, is difficult, but a general idea may be conveyed of its principle, by its being considered as two double machines placed in contact. There are four printing cylinders, about nine inches in diameter each, placed close together in pairs, but with a space of about seven inches between the centre ones, in which space there are two inking-rollers. Each pair of cylinders are secured to the ends of two strong beams, by means of adjustable connecting rods; to these beams a slight vibrating motion is given, by means of cambs, so as to cause the alternate cylinders to rise and fall about one-fourth of an inch. The type-carriage and inking-tables have a reciprocating motion, and the movements are so adjusted that those two alternate cylinders shall be depressed and press upon the types, whose motion coincides with the carriage, and, of course, the other two alternate cylinders are by the same means raised sufficiently to permit the types to pass free under them, till the carriage changes the direction of its motion, when the position of the cylinders is reversed, and the pair which formerly took the impression from the types are in their turn raised. Thus, every time the form of types moves backwards or forwards, two sheets of paper are printed. The paper is fed into the machine over four drums, placed in pairs over each other, at a considerable height above the machine, by four boys. The sheets are led down from the drums to their respective cylinders by means of broad tapes, and by other tapes they are conducted out to the ends of the machine, where they are received by four other boys, when printed, ready to be again passed through the machine, to receive the impression on the second side.

This ingenious machine has only two inking apparatuses, one situated at each end. There are three pairs of inking-rollers, one pair at each end, close to the two outer cylinders, the remaining pair being placed between the two centre cylinders. The inking-tables are about three feet wide, and the motion of the carriage is sufficiently long to bring each table not only under its respective pair of inking-rollers, but also to enable each table alternately to ink the centre pair. Thus, the form is first inked by one of the outer pairs of rollers; the first cylinder is raised; in passing under the second, an impression is given, and, of course, the ink is taken from the form, but it immediately becomes inked anew by the centre pair of rollers; the third cylinder is raised; the form passes to the fourth cylinder, where another impression is taken; and the motion of the form being continued a little farther, it gets again inked from the outer pair of rollers at the opposite end of the machine from whence it started. In its return, the two cylinders which had just taken the impression are raised; the other two now print in their turn, the inking process going on as before; and two sheets are again thrown off. Machines of this complex description are only used where extraordinary despatch, in the production of a large number of copies, is required. Few, besides that employed by the Times, and other London daily papers, are in use. The only one in Scotland, as far as we know, is that used in Edinburgh, for printing the North British Advertiser of Messrs. Gray, and which was made by Morton and Son, machine-makers, Leith Walk.

4. The fourth kind of machine is called a book or perfecting machine, printing both sides of the sheet in register before it leaves the machine. The machine from which the annexed engraving is taken, is one of this description, and bears a resemblance to that of Applegath and Cowper. It is about fifteen feet long by five



broad, and consists of a very strong cast-iron framework, secured together by two ends and several cross bars. To this frame all parts of the machine are fixed. In external figure, as seen in the cut, it is a large apparatus, of imposing appearance. On approaching it when at work, we perceive two cylinders, as large as hogsheads, revolving on upright supports; two smaller cylinders or drums revolving above them; and beneath, within the framework, a table on which lie the types at both ends, going constantly backward and forward. A belt from a steam-engine, acting upon a shaft in the frame, gives motion to the whole apparatus. It will further be observed that a boy marked *a* in the cut, is standing on the top of some steps feeding in sheets of paper, each of which, on being delivered, is swept round the first cylinder *b* (being held on by tapes), gets its impression below from the types, is carried over and betwixt the drums above, and then brought round on the second cylinder *c*; now it gets its second side printed, and issuing into the space between the cylinders, is seized by the boy *d*, who lays it on a table completely printed. The whole operation is accompanied with a loud noise, from the revolving of the cylinders, the working of the notched wheels, and the driving of the table to and fro by a rack beneath, but without any strain on the mechanism, or risk of injury to the attendants. On minutely examining the parts, we observe that at each end there is an apparatus of rollers taking ink from a ductor or reservoir of that material, and placing it upon a portion of the moving table beneath; here other rollers distribute it, while others take it off and roll it upon the pages of types, ready for each impression.

The two printing cylinders are nearly nine feet in circumference each, and are placed about two feet apart. They are accurately turned, so that the surfaces of the type-carriages and the cylinders may be perfectly parallel. The axis of each cylinder works in brass bearings in the upright framework, where, by means of screws, the degree of pressure with which the cylinders are allowed to rest upon the types may be regulated to any degree of nicety. Over about two feet of the circumference of each cylinder which forms the printing surface, two folds of cloth, called blankets, are stretched by means of rollers placed inside the cylinder. The lower blanket is seldom changed, but the upper one, on the second cylinder (which stands in the stead of what are called slip-sheets in hand-press printing) must be shifted as soon as the ink which it has absorbed from the printing on the first side of the sheet begins to set off, or soil the paper when receiving the second impression. This shifting is speedily effected, by unrolling a sufficient quantity of the cloth off one roller, and winding it up on the other, to present a clean portion to the printing surface.

The cylinders have a continuous rotatory motion towards each other, given by two large toothed wheels, whilst the type-carriages move backwards and forwards under them. The movements are so contrived that the type-carriages shall have gone and returned to the same point during the period that the cylinders have made one entire revolution; consequently, each successive impression is taken from the types by the same part of each cylinder; and thus, in order to bring the impression level, the same facility for patching or overlaying is afforded, as at the hand-press. The two drums placed between the cylinders are for the purpose of causing the sheet of paper to pass smoothly and accurately from one printing cylinder to the other.

To preserve the sheet in its proper place on the cylinders, and carry it forward through the different parts of its journey from the hand of the one boy to that of the other, there is an extensive apparatus of tapes, some of which are observable in the cut. These tapes are half an inch broad, and are formed into series of endless bands, arranged at certain distances apart, so as to fall into the interstices and margins of the forms, and therefore escape being crushed between the types and cylinders. The machine may be stopped at any instant, by turning the handle of a lever, which shifts the belt from the fast to a loose pulley, without stopping the engine.

To produce an impression with a flat surface from a large form, requires a force of about from forty to fifty tons; and even with a cylinder, where a line only is impressed at a time, the pressure is little short of a ton. But, in the machine, to prevent any undue pressure of the cylinders upon the forms, there are wooden bearers, of the same height as the types, screwed upon the sides of the carriages under the ends of the cylinders; thus effectually shielding the types from the enormous and injurious pressure which a cylinder might, through accident or otherwise, be caused to exert.

Four machines such as has been described are constantly employed printing the works of Messrs. Chambers at Edinburgh, the whole, together with a flat-pressure machine, being moved by a steam-engine of four-horse power. At the large printing establishment of Messrs. Clowes & Son, in London, we believe at least twenty machines of this kind are to be seen daily at work.

Besides those various descriptions of machines above alluded to, as being principally in use, there are others calculated to execute work of a more peculiar nature. Perhaps the most wonderful of these ingenious pieces of mechanism is a machine which has been made to print two colours by only one impression—a lower form charged with one colour being caused to rise through and come upon a level with another form, so that both may be printed at once. Hitherto the work which has been executed by this machine has consisted chiefly of the stamp-duty marks for the Excise, and for bank-notes, fancy labels for druggists, and other similar jobs.

A machine for printing newspapers (on one side at a time) has also come into use, constructed by Carr and Smith of Belper, on the plan of an advancing and retiring cylinder, while the table for the types is stationary. It is more easily turned than the other kinds of newspaper machines, and is said to be exceedingly suitable for printing newspapers of a limited number of impressions, such as are issued in many country towns.

The only other cylinder machine which we may here notice, is one invented by Mr. Cowper, intended to print from convex stereotype plates. The plates, instead of being fixed flat upon blocks, as will shortly be described, are fastened upon the cylinders, so as to give them a bent form, and the printing is effected with the face of the plate or type surface downwards; wherefore the paper is placed undermost instead of uppermost, as in all other printing. We have never heard what are the peculiar advantages of this fanciful contrivance.

We have now described the advantages of cylinder printing, and it is but proper that we should mention certain drawbacks to its universal use. The pressure by a round or cylindrical surface is less perfect than that given by an even surface. The cylinder has the effect of pressing partly on the edge of the type, both in coming up to the impression and in leaving it; therefore, the impression, in technical language, is not clean; it has a slight blurring, or wants that degree of sharpness and fairness that is required in fine book-work. Cylinder printing, from the same cause, wears down types much more quickly than flat presses. A fully more important defect is the time required to prepare a sheet of types, or forms, for the machine. A sheet, such as the present, seldom requires less than three hours to make ready, and a sheet of stereotype plates an hour longer. The pressure of the cylinders is so searching, that the smallest defect in the levelness of the forms or of the blanket and printing surface, is observable, and must be remedied by putting patches beneath the outer blanket. So much time is thus consumed in preparing a sheet for the cylinder machine, that it would be a positive loss to print any thing at it, unless a great number of copies were wanted. In other words, cylinder machines are only suitable for long impressions, and where a moderate fineness of work is sufficient.

These deficiencies of the cylinder machine have led to numerous and expensive attempts to apply steam power to machines with flat printing surfaces. The most successful of these attempts has been one by an American, and another by a gentleman in London, whose machines have been working for some years in Mr. Spottiswoode's printing-office. The latter is by far the best, and is now coming into general use. It consists of an upright frame and printing platten, resembling the common hand-press, with a type carriage at each side. The type carriages go below the platten alternately; so that, in point of fact, the apparatus is two presses with one printing surface to serve both. The movements to and fro of the type carriages, and the pull downwards of the platten, are effected by machinery beneath. The forms are also inked by an apparatus for the purpose. This machine requires a layer-on and taker-off of sheets at each end, besides a superintendent, and works about 700 sides per hour, or 350 complete sheets.*

By the introduction of the steam-presses, which we have now described, the profession of the printer has within these few years undergone a most extraordinary revolution; and although, perhaps, fewer hand-pressmen are now employed than formerly, the increase of employment to compositors, engineers, bookbinders, booksellers, &c., must be very great. The principal advance in the profession has been since the year 1832, when the printing of cheap literary sheets rose into importance, and by a fortunate coincidence the patents of various machines having about the same time expired, a new impulse was given to the trade. Hardly a newspaper is now anywhere printed with a hand-press, and few or no periodical publications. The making of printing-machines has in itself become a great business. One maker in London lately mentioned to us that he produced a machine regularly every three weeks upon an average all the year round, each at a price of about £400. Other manufacturers in London, and also now in Scotland, are similarly engaged; the machines being sent not only to all parts of Europe, but to America, Australia, and India. In a few years there will not be a civilized country of any consequence on the globe which does not possess these powerful distributors of human knowledge.

It will readily be supposed, that the introduction of a steam-press such as we have described, has caused a very extensive alteration, both in the dimensions of many printing-offices and in their organization. Printing is now a manufacture. The printing-office is a factory; and the interior of one of these concerns usually presents a remarkable spectacle of industry, animate and inanimate, which to a stranger leaves a lasting impression on the memory.

*Since the expiry of the patent, machines of this kind have been made by J. Brown and Co., engineers, Kirkaldy. The mechanism is very beautiful and effective.

ENGRAVING.

In the printing of letterpress or woodcuts, as has been already noticed, the impressions are effected by the raised faces of the letters, or marks, in the manner of a stamp. Printing from engraved plates is performed on a principle directly the reverse: in this case, the face of the metal, cleared of the ink daubed upon it, gives no representation—the printing is effected from the sunk lines. While wood-engravings may be printed along with type-matter, engravings on plates of metal require to be printed by themselves.

The discovery of the art of engraving on metal, for the purpose of making impressions on paper, is generally ascribed to Finiguerra, a goldsmith of Florence. He excelled in an art then much practised in Florence, called *niello*. It was the custom with jewellers, in those times, to engrave the outlines of Scripture subjects upon the vessels which they made for the use of the church. When this engraving was completed, they filled the lines with a black substance composed of a mixture of lead and silver, in solution with borax and sulphur; and impressions were taken from this in clay or sulphur. The black substance used was called *niello*, and hence the name of the art. The same process was also used when pieces of armour, household plate, and other articles, were engraved for the purpose of being inlaid with metals, wood, or ivory.

German writers claim the honour of the invention for a citizen of Antwerp, Martin Schoengauer, asserting that he practised the art before Finiguerra. It seems probable that it appeared nearly simultaneously in both countries. The earliest distinguished engravers, after the discovery of the art, however, were Italians.

It does not appear that Finiguerra pursued his invention any further than to take impressions on paper instead of clay. A contemporary, of the same profession and city, Baccio Baldini, improved upon the invention by engraving on plates for the express purpose of taking impressions on paper. He was greatly assisted by a distinguished painter, Antonio Pollajuolo, who furnished him with designs for his engravings, and also by another artist, Sandro Botticelli, who made a set of drawings, from which Baldini engraved plates for an edition of Dante, published in 1488, and supposed to be the first book ever embellished with copperplate engravings; though this notion has been proved false by a German writer. The works of Baldini attracted the attention of a Roman engraver, Andrea Mantegna, who had already become distinguished as one of the most successful of the *niellatori*. This artist not only assisted Baldini with original designs, but also turned his own efforts to the promotion of the newly discovered art, in which he soon became proficient.

In our notice of the early days of the art, we must not omit mentioning Albert Durer, one of the earliest Dutch engravers. Some knowledge of the art seems to have been previously possessed in Holland by Martin Schoengauer, who is thought by some German writers, as we have seen, to have invented it, and who was certainly a contemporary of Finiguerra. The works of Martin, and his disciple Wolgemuth, inspired the genius of Albert Durer, who did much for the improvement of the art, excelling equally on copper and on wood.* Marc-Antonio Raimondi, an Italian artist, having seen Durer's prints, improved upon them, and became at Rome a master in the art. Thus the profession was spread simultaneously over Holland and Italy. Although there have been various improvements in the profession of the engraver since this early period of its history, the mode of etching the plates remains substantially the same.

At present there are several kinds of engraving, each effected in a different manner, and of these we shall offer a short account.

Line-Engraving.—This is the principal as well as the most ancient species of engraving; it is employed for all elegant pictorial embellishments, and is more expensive than any other. This, as well as every other kind of copperplate engraving, is commenced by a process called *etching.* The plate is made perfectly clean on its polished surface, and heated sufficiently to melt a composition of asphaltum and Burgundy pitch, called etching-ground, which is rubbed upon it, and rendered equal all over by dabbing with a ball of wool covered with silk. The plate is then held up for the surface to receive the smoke of a wax taper, until it is rendered black and glossy, into which state it comes on not being suffered to cool during the process. These preparations being effected, and the plate becoming cold, the etching-ground, which is not thicker than a coat of varnish, is found to be of a hard consistence, and ready to receive the tracing of the subject intended to be etched. The previous preparation of the subject is a very important step in the process. The subject is drawn upon transparent paper with a black-lead pencil, and being laid with the face downwards on the etching-ground, the lines or marks of the drawing are pressed upon it with such force that they are left on the ground on removing the paper. This is called transferring; and, of course, the excellence of the representation to be produced, depends on the excellence of the drawing. Engravers, therefore, in copying paintings, require to possess a degree of skill in the art of delineation hardly inferior to that of the original artist. The drawing being transferred in the manner described, the engraver applies his tool, or etching needle, over the lines, carefully removing the ground, at the same time pressing sufficiently hard to scratch the surface of the copper. A wall of wax is now placed round the margin of the plate, and into the enclosure so formed, aquafortis is poured, to the depth of half an inch. This aquafortis decomposes or bites into the copper where the etching-ground has been removed. During this process, globules of air arise from the decomposition, and these are carefully removed with a feather, to allow free scope to the biting liquid. The length of time employed in biting the plate is regulated by the depth required, also by the state of the atmosphere; in ordinary cases, the operation may be performed in about an hour. When it is ascertained that the plate is properly acted upon, the aquafortis is poured off, the wall of wax removed, and the ground cleared with spirits of turpentine. The plate is now said to be etched, and when printed from in this state, exhibits the appearance of a pen and ink sketch. To this state of etching, but regulated by the nature of the subject, professional engravers bring the plates to be finished in the *line* manner. Different gradations of power are given by the aquafortis, and parts are rebitten to the depth required; after which, the light parts are put in with a sharp needle. Other parts are then cut with gravers of various sizes and forms, suited to the lines which will best express the respective objects. The engraver, in thus finishing his work, rests the plate on a small cushion, so that it may be conveniently turned with the left hand, while the incisions are cut with the graving tool by the right. These lines are re-entered, crossed in various directions, or cut in the spaces between the diagonal crossings, until the desired effect is produced. Landscapes and architecture are generally executed with the needle and aquafortis: portraits and historical subjects are chiefly cut with the graver.

Dotting is a style of engraving, in which dots of various sizes and depths in the copper, instead of lines, express the form and shades of the subject. They are first carefully made in the etching-ground, then bitten, and some parts stopped out, to prevent the further action of the aquafortis on them; while other parts receive additional bitings, till the subject has the power required. After this, the plate is cleaned, dotted up with the needle, stippled with the graver, or rebitten, until all the gradations of force are communicated. This style is generally used for portraits.

Mezzotinto engraving is in a great measure a reversal of those styles already described; being the reducing of a darkened surface of copper to one that is light. The operation is generally commenced by grounding or puncturing the plate with a circular-faced tool, on the edge of which are a number of points; this instrument by being rocked regularly over the surface of the copper in every direction, covers it so completely with marks or spots, that, if it were printed from, the impression would be perfectly black. On this dark ground the subject is traced, directing where the various gradations of light and half-tint are to be scraped out; which operation is performed with tools shaped like a surgeon's lancet, while the highest lights are burnished with a polished steel instrument, until the proper effect is produced. This style of engraving is used chiefly for portraits and historical subjects. It has a pleasing soft appearance, but it is understood that the copper soon fails in producing strong impressions, and it is therefore not well adapted for subjects of which great numbers are required.

Aquatinto engraving is an exceedingly complicated style of producing pictorial effect; but being executed at a lower price than that of the kinds previously mentioned, it is commonly resorted to for embellishing books of travels or other works requiring illustrations of a simple nature. In appearance, it resembles tinting with Indian ink, and the prints are susceptible of being finished with water-colours. In commencing the process of aquatint engraving, the plate must be cleaned with an oil rubber, which is a strip of woollen cloth rolled up hard, to about two inches in diameter; this, with a little impalpable crocus and sweet oil, will give to the copperplate, when perfectly cleansed from the oil, a proper surface to receive the ground, which is made with pulverized sifted rosin and spirits of wine, incorporated by gentle heat, till it appears like a varnish. This composition is poured over the plate while placed in a slanting position, so as to permit the superfluous liquid to run off. The operation must be so managed as to preserve an equal surface. As soon as the granulation, or drying of the grain, appears, the plate must be placed horizontally, when the spirit will evaporate, and the particles of rosin will adhere to the copper. When dry, the surface appears evenly covered, as with a diminutive honey-comb, and perfectly smooth. On this the subject is traced, and the highest lights painted out with a sable pencil in a mixture of turpentine-varnish and lamp-black, so as to prevent the aquafortis acting on those parts. The margin is also covered, and on it a wall of wax is fixed, with a spout at one corner. The aquafortis is regulated in its strength by the temperature of the weather and the hardness of the copper. Being poured on the plate, it remains until the first gradation of tint is bitten—the aquafortis having acted on the copper between the particles of rosin which adhered to the plate. The aquafortis is then taken off, the plate dried, and this first degree of tint stopped out or covered

* North American Review.

over with the blackened varnish. When hard, the aquafortis is again poured on, to bite the second degree of tint; and so on until all the tints have in succession been bitten in. The copper must then be cleansed, and a proof taken and compared with the original. A similar or re-biting grain must then be laid on the plate as before: when cold, a composition of treacle and lamp-black, well mixed, must be used to paint the projections of foliage on lights, or other touches which the masses of tint may require. When these are dry, the whole of the plate must be washed over with a thin coat of varnish reduced with turpentine, which will adhere to the untouched parts of the work. The wall of wax must then be replaced, and clean water poured on; in a short time the water will mix with the treacle touches, and loosen them. When all appear to be removed, the water is taken off, and aquafortis poured on, and allowed to remain until a sufficient degree of power is given to the touches, and the subject completed. Latterly, aquatint engraving has been in many cases superseded by lithography.

Plate-Printing.—Copperplates, engraved in any of the above styles, are ready for press as soon as they are finished by the engraver. The method of printing from these is very simple. Their engraved surface is daubed over with a thick oleaginous ink, so that the lines are effectually filled. As this dirties the whole face of the plate, it is necessary to clean it, which is done by the workman wiping it first with a piece of canvas and then with the palms of his hands rubbed on fine whiting. It may be calculated that a hundred times more ink is thus removed than actually remains in the indentations; however, such is necessary. The plate being thoroughly cleansed, it is laid on a press, with a piece of damped paper over it, and being wound beneath a roller covered with blanket stuff, it is forced to yield an impression on the paper. The plate requires to be kept at a moderate warmth during the operation. The frequent rubbing of the plate with the hand to clean it, as may be supposed, tends greatly to wear it down; and such is the wear chiefly from this cause, that few copperplates will yield more than a few thousands of impressions in good order. The earliest, called *proofs*, are always the best and most highly prized. In consequence of this defect in copper, the practice of engraving steel plates, for all subjects requiring long numbers, has now become very common.

Seal Engraving.—This is a branch of the profession altogether distinct from that of the engraver of plates. While the hardest metals are susceptible of being cut by a tool wielded by the hand of the artist, the different kinds of stone required to be operated upon by the seal-engraver are so extremely hard, that a much more powerful instrument than the hand has to be resorted to. The cutting tool is fixed into a turning machine or lathe, and is made to operate while in a rapid rotatory motion. The lathe is of a light and miniature construction, erected on an elevated bench or table in front of the artist, and is moved by a foot-board beneath. The engraver of metal plates sits while at his work, but the seal-engraver in general stands, in order to have greater command over his operations. He likewise requires to be exceedingly steady in the hand, for the slightest error would perhaps be irremediable; therefore, with both his elbows resting on cushions on the bench, and the palm of his left hand leaning on the top of an erect roundish-shaped bolt or pillar, his fingers of both hands are busy in pressing the stone to the edge of the whirling tool, or guiding it so that it may receive the appropriate indentations. One tool, however, cannot execute all parts of the device. The cutter possesses from one to two hundred tools, varying from a large to a small size. It is also necessary to explain, that the cutting part of each tool is shaped so as to present to the stone a sharp thin edge like the rim of a wheel. (By sticking a small wafer on the point of a pin, and conceiving the edge of the wafer, when turning round, to be the cutting part, a good idea may be obtained of this curious instrument.) As the tool projects horizontally, the artist, by holding the stone beneath it, with its surface to be cut uppermost, is thus enabled to watch the progress of his operation from beginning to end. Sharp as the cutting tools of the seal-engraver are, they would entirely fail in perforating the gems to which they are applied by the lathe, unless they were given an additional sharpness, by means of a foreign material occasionally applied to them while in rapid motion. This material is diamond dust. The diamond is so expensive an article, that the particles used by the seal-engraver are those which have been rejected as waste by the lapidary. These being placed in a hollow steel tube, having a tight-fitting rammer of the same material, a few smart blows on the upper extremity of the rammer reduce the particles to powder. A small portion of this dust is then mixed with a little highly refined oil, and being held to the tool in a state of motion, it is attached to or forced into the metal. If a powerful magnifying glass were taken to examine the tool after its absorption of the diamond dust, its edge would be observed to resemble a rasp or saw, the particles being partly imbedded and fixed in the steel; hence, properly speaking, it is not the tool, but the diamond dust upon it, which cuts the surface of the stone.

To cut an elaborate device, such as a bust or a coat of arms, upon the surface of a cornelian or other gem, a vast deal of care is necessary on the part of the artist. The precise depth of every turn and indentation is matter of serious study, and a momentary heedlessness might have the effect of ruining the work of several days. The operator, however, exercises caution in his ingenious labour. The stone being dimmed by friction, is drawn upon with a brass point to show the subject; the artist first traces the outlines of his figures, next opens them with the bolder tools, and gradually proceeds to the details with finer and finer instruments, frequently stopping to take impressions on wax, to see the effect which has been produced, before he gives the finishing stroke to his workmanship; lastly, the surface is repolished, and the seal completed.

Engraving, in all its branches, is a species of labour which requires payment higher than almost any other department of art; for not only must there be great ability brought to the task, but a degree of patience and perseverance beyond what is required in most other employments.

LITHOGRAPHY.

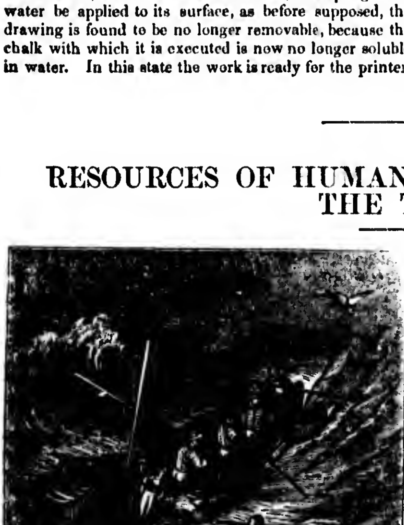
Lithography (from *lithos*, a stone, in Greek) is the art of printing from a peculiar kind of stone, and generally in a style which resembles the more ordinary kinds of engravings. It was invented at Munich, in Bavaria, between the years 1795 and 1798, by Alois Senefelder a person of literary ability, who, being too poor to pay for the printing of books in the usual manner, endeavoured to fall on a method of executing his productions from the surface of various metals and also of stone. Proceeding in his ingenious attempts, he was at length successful in discovering that drawing made on the surface of stone will form a sufficient type to yield inked impressions on paper. From Munich, the invention shortly spread over Germany; it was also introduced into France and England; and finally, after encountering the usual quantity of derision, lithography took its place alongside the more ancient arts of letterpress and copper-plate printing.

The stone employed for lithography is of a calco argillaceous nature (lime and clay), resembling in appearance a smooth yellow hone, and is found in quarries in Bavaria; it is likewise found in England but no stones are so good as those from Germany, and their importation is a considerable object of commerce. The stone, when prepared, usually varies in thickness from an inch and a half to two inches and a half; those which are large requiring the greatest thickness, in order to endure the severe pressure to which they are exposed. Of whatever dimensions, the stone requires to be perfectly flat, and highly polished on the upper surface. The ink to be employed in making the drawings for the stone varies in composition according to the precise nature of the work, and whether the drawing is made direct on the stone or transferred to it from paper. One kind, of a good quality, consists of dried tallow soap, mastic, subcarbonate of potash, Chinese or table varnish, and lamp-black, the varnish being the principal ingredient. The materials are incorporated in a close vessel over a fire, and when prepared are cast into moulds. The substance taken from the moulds forms a chalk, which may be pointed like a pencil, or it may be dissolved in water to form an ink.

The drawing is made on the stone either by the pencil or chalk, or by the ink and a fine pen or camel-hair pencil. "To render the lithographic process intelligible, let it be supposed that the artist now completes a drawing with the chemical chalk just described, upon a grained stone. If, while in this state, a sponge filled with water were passed over the face of the stone, the drawing would wash out, the chalk with which it is made being, as we have seen, soluble in water, by reason of the soap which it contains. Before, therefore, it is capable of yielding impressions, a weak solution of nitrous acid is poured over it, which unites with and neutralizes the alkali or soap contained in the chalk, and renders it insoluble in water. After this, the usual course is to float a solution of gum over the whole face of the stone, and when this is removed, if a sponge and water be applied to its surface, as before supposed, the drawing is found to be no longer removable, because the chalk with which it is executed is now no longer soluble in water. In this state the work is ready for the printer, who obtains impressions by the following process:— Having thrown with the ends of his fingers a few drops of water on the stone, and spread them with a sponge, so as to wet, or rather damp, the whole surface equally the printer finds that the water has been imbibed by the stone only on those parts not occupied by the drawing, which, being greasy, repels the water and remains dry. A roller properly covered with printing-ink is now passed over the whole stone, which will not even be soiled where it is wet, from the antipathy of oil and water. But the parts occupied by the drawing being, as we have seen, dry and greasy, have an affinity for the printing-ink, which therefore passes from the roller and attaches itself to the drawing. In this state it is said to be charged, or rolled in. Damped paper is then put over it, and the whole being passed through a press, the printing-ink is transferred from the stone to the paper, and this constitutes the impression. By repeating in this manner the operations of damping the stone and rolling in the drawing, an almost unlimited number of impressions may be obtained. Now, as we have said, the modes of lithography are various, but the illustration just given will explain the principle of them all. It consists in the mutual antipathy of oil and water, and the affinity which the stone has for both, that is, in its power of imbibing either with equal avidity."—*Penny Cyclopædia.*

The art, in whichever way pursued, requires great delicacy and dexterity. In drawing on the stone, the slightest mark of the hand will fasten on the surface and appear in the impression. The execution of the impression in an equally clear and dark manner is evidently a matter of difficult accomplishment, there being nothing more common than to see lithographic impressions light at one part and dark at the other. The process of printing differs from that of letterpress or copper-plates. The stone, properly [illegible] and with paper over it, lies in a box on the table of the press, covered by a piece of leather, and is drawn beneath a hard edge or scraper, the mechanism being assisted by a lever power.

RESOURCES OF HUMANITY—USEFUL RECEIPTS—THE TOILET.



RESOURCES OF HUMANITY.

Under this head may be appropriately included those inventions which have reference to the preservation of life from accidents by water, fire, and other agents of personal injury.

ESCAPES FROM DROWNING.

Life-boats.—The attention of the public has been called at an early period to the perils and fatalities of shipwrecks. Several boats for preserving lives in such cases were invented, and among others, one by Mr. Lukin in 1785. But an accident which occurred on the Herd Sands of South Shields, in September, 1789, led to material improvements in the art of constructing these vessels. The Adventure, a merchant-ship of considerable bulk, was wrecked within three hundred yards of the shore, in presence of an immense number of spectators; and almost every man of the unhappy band of mariners perished, without the possibility of receiving assistance from the shore. The consequence was, that the people of South Shields met soon afterwards, and offered a reward to any one who should invent a boat capable of being launched from the shore to the aid of ships in distress. Mr. Greathead gained the premium; and in 1790 a life-boat, constructed upon the plan proposed by him, was effectually used in saving the crew of a vessel stranded under circumstances similar to those of the Adventure. Several other trials of the life-boat proved its utility so fully, that in 1802 the Society of Arts presented the inventor with their gold medal and fifty guineas; and Parliament also decreed to Mr. Greathead a reward of £1200. The Trinity House followed the example; and the Committee of Lloyd's devoted £2000 to the purpose of building boats on the same principle. By these and other means, the dangerous parts of our coasts have been very generally furnished with these life-preservers.

The form of Mr. Greathead's life-boat is one well adapted to give it buoyancy, and keep it afloat in any sea. It is usually "made about thirty feet in length, ten in breadth, and three feet three inches deep at midships; both extremities are made precisely of the same form, so that it goes through the water with either end foremost; and its shape lengthwise is a curve, so formed that in a line drawn from the top of one stem to that of the other would be two feet and a half above the gunwale at midships. In this boat there are five thwarts, or seats for rowers, double-banked, so that it must be manned with ten oars. It is cased and lined with cork, which gives it such buoyancy that it will float and be serviceable, though so damaged by hard knocks as to be almost in pieces; and this the softness and elasticity of the cork is well calculated to prevent. The cork on the outside is four inches thick, and it reaches the whole length of the shear, or side of the boat; on the inside it is thicker, and the whole quantity is about seven hundred weight. It is firmly secured with slips or plates of copper, and fastened with copper nails. The advantages of this boat are stated to be, that its curvature gives it great facility in turning, a single stroke of the steering oars, of which there is one at each end, moving it as though on a centre; that the covering of cork, being immediately under the gunwale, gives great liveliness or disposition to recover its balance after being suddenly canted aside by a heavy wave; and that its capability of going with either end forwards increases its manageability." A view of the life-boat in action is presented at the head of our article.

The life-boat is kept in a boat-house, and placed on wheels, in order that it may be moved at an instant's notice. Where the road to the sea is smooth, this simple mode of moving the boat does well enough; but it has been found better in many cases to suspend the boat under the axis of the wheels, so that the shaking may be less injurious. At most of the life-boat stations, the boat is under the charge of a committee, and twenty or twenty-four men, composing two crews, are alternately employed in its navigation. A reward is given to these men in cases of shipwreck, and the vessel receiving aid is expected to contribute to this end. Of course the life-boat men are picked persons, of steady habits and active frames; and the individual in command requires to possess peculiar skill and knowledge of the coasts and currents.

It has been observed, that the occupation of the life-boat men gives a sort of dignity to their character, and elevates their tone of thought. Many noble actions have been performed by them, which no money could compensate. Of their general usefulness some idea may be gathered from the fact, that, between the date of Mr. Greathead's invention and 1804, *three hundred lives* had been saved at the entrance of Tynemouth haven alone.

Mr. Greathead recommends the life-boat to be painted white on the outside, as a colour that most readily catches the eye. He also advises the steersman to keep the head of the boat to the sea, and to give her an accelerated velocity to meet the wave. The strong reflux of the waves renders it necessary to approach a wreck with great caution, and the leeside is usually the safest of access. Of course the first object is to convey the wrecked crews on the shore, which, if they are numerous, must be done by degrees. Many lives have been lost by the impatience of crews, in attempting to go on shore in their own boats. This is always an act of folly where a life-boat is on the scene.

Captain Manby's inventions.—Since the date of its discovery, some improvements have been made on the common life-boat of Mr. Greathead; but the most important subsequent inventions for the humane end of saving lives at sea have been those of Captain Manby. This philanthropic gentleman was in the corps of engineers, and held the situation of barrack-master at Yarmouth, on the Norfolk coast, in the year 1807. That coast, it is well known, is full of shoals, and many vessels have gone to pieces within a hundred yards of the shore, in sight of multitudes of people, without any chance of giving relief. Life-boats could not be stationed at all points of an extensive coast, and perhaps could not be always used if they were present. The lamentable case of the Snipe, where sixty persons lost their lives near Yarmouth, made so deep an impression on Captain Manby, that he resolved to devote his mind and his life to the discovery of some means of relieving similar cases of distress. It appeared evident to him that the desired end was the discovery of *some means of throwing a rope from the shore to the ship, or from the ship to the shore.* Boats with the crews would obviously be thus drawn ashore in almost any circumstances.

"The active and philanthropic mind of Captain Manby was not tardy in pointing out a probable method. It struck him that a cannon shot affixed to a rope, and projected from a piece of ordnance over a stranded vessel, was a practicable mode of establishing the communication. But to reduce it to practice was found to be attended with much greater difficulty than the simplicity of the object seemed at first sight to promise. In the first place, the folding or manner of laying the rope, so as to unfold itself with the rapidity equal to the flight of a shell from a mortar, without breaking by sudden jerks at each returning fold, and without entanglement from the effect of uneven ground and boisterous winds, was no easy task. But it was at length attained by adopting what is called a French faking, in folds of the length of two yards; and by laying the rope in a flat basket always kept ready, with the rope in order, in a secure place, so that it could be transported at a moment's notice to the situation required, and laid upon rocks and uneven ground even in the most boisterous weather, without fear of disarrangement.

"The next difficulty consisted in the means of connecting the rope with a shot, so as to resist the inflammation of gunpowder in that part of it which must necessarily occupy the interior of the mortar. Chains in every variety of form and strength universally broke from the sudden jerks or play to which they were liable, which proved that not only an elastic, but a more connected body was necessary. 'At length,' says Captain Manby, 'some stout plaited hide, woven extremely close to the eye of the shot, to prevent the slightest play, extending about two feet beyond the muzzle of the piece, and with a loop at the end to receive the rope, happily effected it.'

"This apparatus, projected from a small howitzer over a vessel stranded on a lee-shore, so light as to be easily conveyed from one part of the coast to another, affords a certain means of saving the lives of the crew in the day-time, and when from cold and fatigue they are not disabled from seizing and fastening the rope, and in other respects joining their own exertions to those of their friends on shore. The following extract, from an account of experiments made before some colonels and field-officers of artillery, shows the celerity with which the service may be performed:—

"'A person is completely equipped with every necessary apparatus to effect communication with a vessel driven on a lee-shore. A man mounted on horseback was exhibited, accoutred with a deal frame, containing 200 yards of log line ready coiled for service, which was slung as a knapsack, with a brass howitzer of a three-pounder bore on its carriage, and two rounds of ammunition, the whole weighing sixty-two pounds, strapped on the fore part of the saddle. The person thus equipped is supposed to be enabled to travel with expedition to the aid of ships in danger of being wrecked on parts of the coast intermediate to the mortar stations; and with this small apparatus the log-line is to be projected over the vessel in distress, from which a rope should be attached to it to haul the crew on shore. Captain Manby caused the howitzer to be dismounted from the horse, and in a few minutes fired it, when the shot was thrown, with the line attached, to the distance of 143 yards. At a subsequent trial, the horseman, fully equipped, travelled a mile and a third; the howitzer was dismounted, and the line projected 153 yards in six minutes.'

"Such is the simple but efficacious nature of Captain Manby's first invention; and a few practical experiments soon ascertained the allowance to be made in pointing the mortar to the windward of the object over which the rope is to fall, in order to obviate the effect of a strong wind, which would of course carry it considerably to leeward. Experience also proved that the mortar should be laid at a low elevation, in order to insure the certainty of the rope's falling on the weathermost part of the rigging.

"This original invention, however, was obviously capable of many improvements. The first of these was to afford assistance to vessels whose crews, either from their being lashed to the rigging, or from extreme cold and fatigue, are incapable of assisting to secure the rope to the wreck when projected over it from the mortar. This was attained by adding a quadruple barb to the shot—that is, making four hooks project from the ball—by means of which, when the rope is hauled tight by the people on shore, one end is firmly secured on some part of the rigging or wreck, and a boat can of course be hauled to the relief of the crew, without any assistance on their part."

But in order to make this invention effective in the darkest night as well as by the light of day, the ingenious philanthropist had yet much to do and discover. He attained his end, difficult as the task was. "The requisite objects were—First, to devise the means of discovering precisely where the distressed vessel lies, when the crew are not able to make their exact situation known by luminous signals. Secondly, to discover a method of laying the mortar for the object with as much accuracy as in the light. Thirdly, to render the flight of the rope perfectly distinguishable to those who project it, and to the crew on board the vessel, so that they cannot fail of seeing on what part of the rigging it lodges, and consequently may have no difficulty in securing it.

To attain the first object, a fire-ball is used, such as is often thrown up in the attack and defence of fortified places to discover the situation of an enemy by night. It consists of a hollow ball of pasteboard, having a hole at top containing a fusee, and filled with about fifty luminous balls of star composition, and a sufficient quantity of gunpowder to burst the ball and inflame the stars. The fusee is [illegible]lated so as to set fire to the bursting powder at the height of 300 yards. On the stars being released, they continue their splendour while falling for nearly one minute, and strongly illumine every surrounding object: ample time is therefore allowed to discover the situation of the distressed vessel.

"During the period of the light, a board, with two upright sticks at each end (painted white to render them more discernible in the dark), is pointed towards the vessel, so that the two white sticks shall meet in a direct line with it, the wreck being a fixed object. This will obviously afford an undeviating rule by which to lay the mortar, making an allowance, as by daylight, for wind, &c. Thus the second object is attained.

"For the third, a shell (instead of a shot) is affixed to the rope, having four holes in it to receive fusees, and the body of the shell is filled with the fiercest and most glaring composition, which, when inflamed, displays so splendid an illumination of the rope that its flight cannot be mistaken."

Such are the most prominent features in the scheme of Captain Manby for the relief of ships in distress. The number of persons saved by these inventions has been very great. Almost immediately after turning his mind to the subject, Captain Manby had the gratification of rescuing ninety persons from a grave in the deep. The whole expense of his apparatus did not exceed £10. Captain Manby was deemed worthy of a parliamentary reward.

Floats and buoys.—In addition to such a flat boat as that recommended by Captain Manby, with rods and ropes furnished with hooks for grappling, humane societies usually possess floaters, consisting of short bars of wood, with buoys or masses of cork at each end. One of these being thrown out with a rope, a party in danger may grasp the bar, and be readily borne up till pulled ashore. Another provision of late invention consists of hollow girdles of cloth, air and water-proof, which being sustained by straps from the shoulders, can be filled with air from the mouth, and when the pipe is closed, will sustain the wearer perfectly in water.

Safety cape.—This is of later invention than the above-mentioned float-belts, which it is likely to supersede, inasmuch as it combines an article of dress with its principle of life preservation. It is the invention of a member of the Skating Club of Edinburgh, and is furnished by the Albion Cloth Company of that city. The cape, which is suited to lie easily round the neck and shoulders, is formed of Macintosh cloth, which may be partially inflated with air at pleasure, by means of a small mouth-piece hid from external observation. The cape we saw is outwardly a grayish serge (it may, however, be made of any material), and hangs down all round as low as the elbows. A tape from the inner part of the back, to be tied round the body, keeps the cape down, in the event of immersion in water. When blown up, the cape swells to about an inch in thickness, which presents nothing unsightly; however, it need not be inflated till the wearer goes into a condition of danger—into a boat on a sailing excursion, for instance, or upon unsafe ice. As a piece of dress, it may be worn by ladies as well as gentlemen.

With respect to the buoyant powers of the apparatus, they have been the subject of a critical experiment by the Edinburgh and Leith Humane Society, which is mentioned in nearly the following terms in the newspapers of the day:—"The use of a large cast-iron tank or tun having been obligingly placed at the service of the directors by a brewer in Edinburgh, it was filled with warm water to the depth of six feet two inches. A stout man, a sailor, five feet six inches in height, and about ten to eleven stone weight, went into the water with his clothes on, wearing the safety-cape, and, to the satisfaction of all present, floated vertically at his ease, with his head, neck, and part of his shoulders above water. Wishing to ascertain what degree of buoyancy he had to spare, weights were given to him, which he held in his hands. Seven pounds sank him to the throat, and four more to the lip, proving that he could have sustained another person in the water. The man came out repeatedly, and again plunged into the water, always declaring it difficult to immerse his head even for an instant. On this fact, the directors of the society found that, in the event of the ice giving way under a skater, the reaction will effectually protect him till relieved from his perilous situation."

After this satisfactory testimony, nothing more need be said on the subject. It is quite clear to us, that if people would but be persuaded to wear one of these safety-capes, they need be under no apprehension whatever of immediate drowning in the case of sudden mersion in water; and it is well known that, except in shipwrecks at a great distance from land, a power of buoyency for only a few minutes would save almost every life. The deplorable deaths from boat accidents on rivers, for lack of some such simple means of preservation, who can either number or sufficiently lament?

Dangers upon ice.—The preservation of lives endangered by the breaking of ice also arrested the attention of Captain Manby. In ordinary cases, ropes and a ladder are used for the purpose of relieving persons so situated, but Captain Manby's suggestions have reference to all possible circumstances of difficulty and danger. He recommends as one instrument a rope with a floating noose, distended by whalebone, with an egg-shaped piece of wood or cork at a convenient distance, to be easily grasped by the hand. The evident purpose of this rope is to be thrown to and grasped by the person in the water, who for a time usually sustains himself by holding the edges of the ice. Another machine for saving persons in similar cases, recommended by Captain Manby, is a boat of wicker or wood, made very flat and light, and placed upon wheels. The wicker boat may be rendered buoyant by tin boxes enclosing air. Such a boat is pushed over the ice by means of sprits or pikes, with sharp iron points, and may be rapidly taken to the scene of danger in almost every case. Where the person in peril has sunk, a grappling rod with hooks, two, three, or four in number, is used for the purpose of raising him, or dragging him from below the ice; and the points are guarded, so that no injury may be done to the body. The body will always be easily moved in the water. A ladder, with a considerable balancing weight at one end, forms another instrument of value, either for approaching a broken portion of *weak* ice, so that ropes may be thrown to a party in the water, or for communicating between the boat and safe ice, or between the boat and the shore.

Boat accidents.—If upset in a boat, or in any other way precipitated into the water without being able to swim, draw in the breath, keep your mouth as well shut as possible, and do not throw about with your arms. Endeavouring to hold your head up, yield yourself to the buoyant powers of the water, and stretch out your hands—but only below, not above, the surface. Remember that the less you expose above the surface the better are you buoyed up. Many persons are drowned merely from struggling and throwing up their hands.

Treatment of persons apparently drowned.—The treatment of persons taken from the water in an apparently lifeless condition is a question of the highest consequence to humanity. It was formerly supposed that the deluging of the lungs with water, was the direct and immediate cause of death in cases of submersion in that element; but, in reality, it has been ascertained that only a very small quantity of water enters the lungs in such circumstances. The deprivation of air is now understood to be the true cause of death. On being submerged for the space of three-quarters of a minute, a violent effort is made to inspire and expand the lungs, but no air, of course, can enter. Air, however, is expelled, and as the same effort at inspiration is repeated again and again, the expiration also is renewed, making obvious bubbles at the surface, until the lungs are completely exhausted. In the meanwhile, the blood, from want of oxygenating air, becomes rapidly changed from its arterial or red condition to a venous or dark state, and being then incapable of maintaining the vital action of the brain and other organs, as well as of supporting the animal heat, sensation, voluntary motion, and bodily warmth, are gradually extinguished, and death ensues. A convulsive cough keeps out water from the lungs in a great measure, and the small quantity that does enter is wrought up into a sort of froth. Little water is found to enter even the stomach. It is the collapse of the lungs from want of air which weighs down the body, and causes it to rest below the surface, till the formation of gases of putrefaction again lighten and raise it.

The phenomena attending the extinction or cessation of life by submersion in water, are of importance as regulating the attempts that may be made to restore the vital spark. It is impossible to say at what distance of time after submersion these attempts will be fruitless. A person has been found irrecoverable after being four minutes in water, and many have been restored after submersion for twenty minutes, and even for half an hour. Much depends on the treatment applied. Misled by the notion that the body was in all cases gorged with water, people were wont to hold up the drowned by the heels, roll them about, and use other means calculated only to destroy all chances of recovery. This fatal error is even yet too often practised. The true remedies in such cases are few and simple. The first object is the restoration of the animal heat. For this purpose, the wet clothes are to be removed without delay, and the body, after being well dried, is to be surrounded with warm air, for which purpose every humane society should have a portable warm-air bath. The heat should at first be moderate, and gently increased. In absence of the warm-air bath, the body should be laid in a well heated bed or blankets, and bottles of hot water laid to the feet and arm-pits. A warming-pan or heated bricks should be passed over the body, or gentle friction exercised with other warm substances. Meanwhile, by means of a pipe or bellows, continual though gentle attempts should be made to excite respiration artificially; and, if the apparatus be at hand, slight shocks of electricity should be kept up at the same time. If there be any signs of returning life, such as sighing or convulsive twitching, a vein may be opened. The throat may be tickled to excite a propensity to vomit, and a tea-spoonful of warm water administered to test the power of swallowing. If it exist, a table-spoonful of warm diluted wine or brandy may be given.

Even if no vestige of returning animation be discovered, these means of recovery should be persisted in for three or four hours. In a late remarkable case, mentioned in a note below, a person who had been under water for ten minutes was restored to life at the end of *four hours.**

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* One of the most extraordinary cases of restoring animation to a human being after it had been suspended for nearly four hours, was mentioned to Mr. Baker, the coroner, at an inquest held before that gentleman, and the following particulars relative to it will not only be read with interest, but will instruct and shew the necessity, in all cases of immersion in the water, for diligence and perseverance to be used by the medical men called on to assist:—A few evenings since, a young gentleman, named Henry Stanhope, was amusing himself by angling in one of the basins of the West India Dock, when, by some means, he fell into the water, and immediately sank. A cry was raised of "a man overboard," and the drags were soon in requisition; but ten minutes elapsed before the body was recovered, life appearing quite extinct. Mr. Bloomfield, of High Street, Poplar, surgeon, was fetched on the first alarm, and was in attendance when the body was recovered. He immediately had it conveyed to the receiving-house on the docks, and placed in a warm bath. It was then taken out, wrapped in blankets, and bottles of hot water applied to the chest and soles of the feet. Several of the dock labourers were then called in, and were ordered to rub the body. This they did for about a quarter of an hour, when it appeared to get colder and more livid about the face. By their pressure and rubbing a great quantity of mud began to ooze from the mouth, upon seeing which Mr. Bloomfield ordered them to continue their exertions. In half an hour the muscles began to lose their rigidity, and a slight vibration of them was observed. This stimulated them to continue their exertions, and after four hours' indefatigable exertion, animation was so far restored that the person was able to articulate. Mr. Bloomfield applied a dozen leeches to his temples, and four hours after bled him. Stimulants were afterwards applied, and he was restored, but remains in a very weak state. The coroner, after paying a compliment to Mr. Bloomfield for his praiseworthy exertion, said the case was one of the most extraordinary he had ever known but thought the best things to be used in cases of drowning were vapour baths. —*Times, June*, 1842.

ESCAPES FROM BURNING.

Precautions as to Fire.—Houses are said to take fire by accidents, but these accidents are in general only acts of carelessness, and could with a reasonable degree of prudence be avoided. As prevention is better than cure, we offer the following precautionary advices:—

Never leave a candle burning at your bedside, or on a table when you go to bed, except it be a rush, wax, or floating light, burning in a basin at a considerable distance from the bed or window-curtains. The best place for setting the light is on the hearth.

Never put hot cinders or ashes into a bucket to set aside in a closet.

If you light candles with pieces of paper, take care that the burning paper is completely trampled out after being used. It is always safest to light candles and lamps with a small wax taper, which can be at once blown out. In large manufactories, where there are many lamps or gas-burners to light, let the lighting apparatus be a small hand-lamp, which shall be in charge of a particular person in the premises.

Never blow gas lights out; always turn them off; and turn off the gas at the main stop-cock at the door. Should the gas, from any cause, have escaped, and the smell be suddenly and offensively felt, at once turn off the supply at the meter or stop-cock, and open the windows to allow the entrance of fresh air. Be careful not to take a lighted candle into the apartment where the escape has taken place.

Cause the chimneys to be swept once in three months, or oftener if necessary, so as to prevent the accumulated soot from catching fire. Sometimes houses are set on fire from beams which encroach upon the chimneys. House builders ought to be particularly cautious in preventing any part of the woodwork from touching the flues.

The following are advices how to act when the catastrophe of fire actually takes place:—

Chimney on fire.—To extinguish speedily the fire in a chimney, it is only necessary to hang over the fireplace a piece of wet carpet or blanket: some handfuls of salt thrown into the fire at the same time will greatly aid the extinction. Unless to prevent the chance of timbers in the walls catching fire, it would be generally preferable to allow the burning in the chimney to exhaust itself.

Clothes catching fire.—The moment you see that your clothes are on fire, remain still and collected; do not, on any account, run away in a fright. If there be a loose rug, carpet, or table-cover at hand, snatch it up and roll it tightly about you. If you can get this done smartly, the flames will immediately be extinguished. Should no cloth of any kind be at hand, and no one be present to give assistance, lay yourself down on the floor, and try to extinguish the flames by rolling yourself about, always taking care to keep the garments as close together as possible. If a man be present, let him take off his coat and wrap it round you; and if a woman, her shawl will answer the same purpose. By one or other means, such as are here pointed out, the fire will be stifled, and perhaps the only personal injury will be some slight scorching of the hands, which must not be regarded in averting an infinitely greater evil.

House on fire.—In making way through a burning house, we ought not, if it be full of smoke, to walk upright, for then we shall run the risk of suffocation. It is best to creep along on hands and knees, the freest air being to be had close to the floor. On being awakened by an alarm of fire during the night, it is particularly important to preserve presence of mind, and not to act till a moment has been given for reflection. Preservation may depend on the choice we make of going *up* or *down* stairs, or on some selection of movements equally unimportant in ordinary circumstances.

Fire escapes.—The escape from a house v... on fire is sometimes prevented by the stairs being of wood, and either burning or already destroyed. In such an emergency, there are only two means of escape—issuing by the sky-light, and so reaching the next house, or going over the window. On this account, every house with wooden stairs should have a sky-light, accessible from the upper floors, and also some kind of apparatus for getting safely from the windows to the ground. The apparatus which meets with most general approbation is a rope-ladder, and this may be made in different forms. Captain Manby recommends "a rope with nooses distended by flat rests for the feet at convenient distances for stepping from one to another. In cases of danger, this might be instantly fastened by one end to a table or bed-post, while the other is thrown out of the window, thus furnishing a ready escape when perhaps there is no other possible means near those who are in momentary dread of being burned to death." Such a ladder may be serviceably kept by private parties; and we should advise that at all events every house with wooden stairs ought to be provided with one or more pieces of knotted rope, and these be deposited in the bed-rooms, for use when suddenly required. Where, from carelessness, no fire escape of this kind has been provided, two or more sheets or blankets taken from the bed may be tied to each other by the corners, and thus a rope of sheet be formed. There is no instance on record of a person being burnt to death in Edinburgh by fires in dwelling-houses, although the buildings are more than usually high; the reason of which is, that there the stairs are all of stone.

Every fire-establishment in towns, besides fire-engines, and buckets, should possess several long ladders, ready at all times to be applied to windows; also cords, which may be brought to bear wherever they are required.

Burns and Scalds.—When you receive a burn or scald, instantly plunge the part affected into cold water, or cover it with some cold moist substance. This will prevent the skin from rising in a blister, and the part will be easily healed. If you delay applying the cold water or cold substance, even for a few seconds, the skin will rise, and the application will have no good effect. If stockings or other coverings are upon a part at the time of its being burnt, they should be taken off immediately, as delay will only render their removal more difficult. One of the best applications to a burnt part that can be used is cotton or cotton-wad, an article generally abundant in every family. In many cases it is applied perfectly dry to the part, and in others it is wetted, on the side next the sore, with a mixture of lime-water and linseed oil. A rag wetted with some mixture may be used, where cotton cannot be had.

Cuts.—Almost any common cut may be cured by simply closing the edges of the wound, and holding them together so as to keep the air out. This may be done by sticking a piece of plaster on the closed wound, and keeping that plaster on till the part is completely well. The plaster has no healing property in itself—its entire use is to hold the edges of the cut together. A piece of linen rag may serve the same purpose, but the tying of it is apt to stop the circulation of the blood. If any dirt or foul substance has got into the cut, it must be carefully removed, otherwise the wound will fester, and not heal till it has been drawn and cleaned by a poultice.

Preservation against lightning.—When persons happen to be overtaken by a thunder-storm in the open air, it is customary for them to fly for shelter to any tree which may be at hand. They expose themselves to increased danger by so doing, particularly if the tree be a prominent one and standing alone, because it thus becomes a peculiar mark for the electrical fluid. But it is better to be placed at a short distance from such a tree or large object, than to be far from any thing of the kind. On an open bare moor, a single human body does not run any great risk, yet it is the most prominent mark if lightning be near the spot; whereas a large tree at a short distance would be the most attractive body. The human person is more secure when wet than when dry—another reason for refraining to seek the shelter of trees. All metallic bodies should be avoided when the atmosphere is charged with lightning. People in a house are rendered most secure by sitting quietly in the centre of their apartments; and it is even important to keep the mind as calm as possible.

Large buildings or establishments may be almost completely secured against the effects of lightning by means of metallic rods, rising from the earth to a height greater than that of the edifice to be protected. The lightning, if it does alight on the building, is conducted by the rod to the earth, and is there diffused or dispersed without noise or shock.

MISCELLANEOUS.

Ventilation and fumigation.—It is essential to health that the habitations occupied by us should be free of impure air and all noxious vapours. The first step towards this end is to effect and maintain a liberal circulation of fresh air, either by ventilators or by regularly opening the windows for stated daily periods. The kindling of fires also promotes the circulation of atmospheric currents. Noxious effluvia may be most effectually removed by occasional sprinklings of a solution of chloride of lime upon the floors and walls, the windows being kept open the while. It is always proper, also, that an infected house should be white-washed. We have seen recommendations to purify the air of rooms by closing them, and burning salt and oil of vitriol in a dish placed on the floor. In unskilful hands such plans are highly dangerous; and we strongly advise every one to confine the fumigating process to sprinkling with chloride of lime, and to ventilate by opening all outlets to the air. Lives are sometimes lost by sleeping in a close room in which charcoal is burning, the person in this case being stifled with noxious gas. We advise that every sleeping apartment should be airy, and that no one should go to bed with charcoal burning in the grate or stove. Bedrooms are always best without fires of any kind.

Hanging, or suspension by the neck.—In cases where a body is found in a suspended state, and life is seemingly extinct, the chief remedy consists in cupping the temples or opening the jugular vein, and so relieving the head of the blood which accumulates in its superficial veins in consequence of the ligature. Where the body is cold, from having been long suspended, friction, and the other means used for restoring animal heat in drowned persons, should be likewise resorted to. Electricity or galvanism may also be of service.

Poison.—When you have reason to know that you have accidentally swallowed a poisonous substance, and proper medical advice is not at hand, take an emetic. This may be done almost instantaneously by swallowing a cupful of warm-water mixed with a teaspoonful of mustard. If you have not dry mustard in the house, you are almost sure to have a mustard-pot, and a quantity from that put into the water will very quickly empty the stomach. As mustard may thus prove of so much use, it should never be wanting in any house; but even should there be no mustard at hand, warm water by itself forms a tolerably efficacious emetic.

Coach accidents.—Should the horses run off, in defiance of any restraint, while you are in a coach, sit perfectly still, and in anticipation of the possible overturn, keep your legs and arms from straggling. Sit easily and compactly, so that, when upset, you will gently roll over in the direction you are thrown. We have seen ladies in these circumstances scream wildly, and throw their arms out of the windows, thus exposing themselves to the chance of broken limbs. If run away with in a gig, either sit still collectedly, or drop out at the back, so as to fall on your hands. Never jump from a rapidly moving vehicle, unless (supposing it impossible to slip down behind) you see a precipice in front, in which case any risk of personal damage is preferable to remaining still. The Duke of Orleans lost his life by neglecting these simple precautions.

Alarms in churches and theatres.—Alarms, whether with reference to fire or the falling of galleries, often take place in these and similar places of resort. In general, they are raised without due cause, often from a circumstance of the most trifling nature, and perhaps occasionally from a deliberate spirit of mischief. However originating, they almost invariably generate a panic, and occasion much damage, which a little reflection would have enabled those present to avoid. The newspapers teem with accounts of incidents of this nature. In most instances, the whole mischief is caused by *yielding too much to alarm.* We anxiously recommend every one to cultivate the power of suppressing such idle emotions. When a cry of fire, or of the falling of galleries, is raised in church, *sit still*, and remain tranquil till the assemblage is allowed to disperse in the usual way. On no account yield to alarm. Granting that there is a real cause of danger, you are infinitely more safe sitting still than trying to rush wildly to the door.

Attacks of madmen.—A person in a house may become suddenly insane, and make a violent and deadly attack on those within reach. The best way to avert any serious calamity in cases of such attack is to remain calm and collected, and, if necessary, humour the madman till assistance be procured. A lady of our acquaintance kept a boarding-house; and one day a boarder entered the room in which she was sitting, armed with a carving knife, and with great coolness said he had taken a fancy to cut off her head. The lady was alone. She saw her extreme danger, but did not scream or appear alarmed, for that would have precipitated the catastrophe. She humoured the madman, and proposed that she should go and fetch a cloth to lay on the floor, so as to prevent the blood from damaging the carpet. This bait took, and she got safely out of the room, and into her bed-chamber, in which there was a key in the door in the inside. She instantly locked the door, and flying to the window, cried for help to the passengers in the street. The madman was speedily secured. This lady clearly owed her life to presence of mind.

We would add, *let every door in a house have its key*, and let the key remain in it both night and day. Every night, on going to bed, isolate each room, by locking it, and lock your own door in the inside. Always look beneath the bed and into any cupboards in the room before going to rest.

USEFUL ADVICES AND RECEIPTS.

Under this head we propose to offer a few advices connected with housekeeping, and certain operations in reference to the cleaning of dwellings, furniture, apparel, extirpation of vermin, removal of stains, &c.

HOUSE FURNISHING AND MANAGING.

Choice of a house.—There are certain important points on which you should obtain satisfactory information in making choice of a house. First, take care that it is not damp. Dampness may arise from several causes, but imperfect drainage, and a too close contact of the floors with the ground, are the principal. When a house is damp in any part, no matter from what cause, we advise you by all means to avoid it, for it may produce the most pernicious effects on the health of your family. Second, see that the house has a free open exposure for fresh air, and, if all other circumstances suit, prefer that which has an exposure to the south, and possesses the beneficial influence of the sun's rays. A house with a pleasant southern exposure enjoys a climate several degrees warmer than a house which is not so favourably situated. In general, too little attention is paid to this circumstance. Third, ascertain if there be a plentiful supply of good water in the premises, and if there be proper means at hand for drying and bleaching clothes. Fourth, learn whether the vents go well, and do not smoke. The inquiries you may make in reference to freedom from vermin and other particulars are left to your own judgment.

Furnishing.—When you design to furnish a house, take care to set out on a right principle in the selection of articles. It is essential, for the sake of neatness, and for pleasing effect to the eye, that there should be a harmony of colours, and also a similarity of style in the main articles of furniture. Therefore, if you do not exercise a little taste and judgment in your *first* selections, you may find that you have committed a blunder which will cost you much subsequent annoyance. For example, let the tints of the carpet, of the paper or paint of the walls, and of the window curtains, be all in harmony in each room—that is, either possess a general resemblance of colour, or various colours in pleasing contrast and harmony with each other. If the colour of your curtains be scarlet, and the colour of your walls or carpet blue, a most inharmonious and unpleasing effect will be produced; but brown and green, or green and gold, will be in harmony, and may therefore be placed together. Carpets being the most expensive articles, it is safest to buy them first, and then to let their colour lead the tone and style of curtains, paper-hangings, chair-covers, hearth-rugs, and all other articles. It is also a good economical plan to buy carpets for the same pattern for several rooms, because, in the event of removal to a house with different sized apartments, a piece of one carpet may be taken to eke out another.

Tables, chairs, &c.—When you are bargaining for tables, chairs, and other wooden articles of a fine quality, take care to specify that they must be of a solid fabric, and not veneered. Veneering is only tolerable in a few articles which are not to be subjected to much tear and wear; nevertheless, a practice has begun of veneering articles in daily use, such as chairs and tables, and consequently they are soon destroyed. This practice, we are sorry to say, is done in cases where the highest price is paid for solid articles, and we mention the circumstance to put you on your guard. Examine closely the back and seat-frames of every mahogany chair, and reject it if it be veneered. In ordering sofas, you should also take care to bargain for genuine hair stuffing, for in many instances the stuffing is composed of what is technically called *pob*, or a composition of tow, wool, and other kinds of rubbish. Likewise, the hair should be well baked or prepared. We have seen a hair sofa, for which the highest price was paid, swarming with a species of louse, shortly after being sent home from the upholsterer's, in consequence of the animal substance about the hair not having been properly dried by baking.

Earthenware and China.—In purchasing sets of earthenware articles for the table, also take care to set out on a right plan. Select that set which, in case of breakage, can at all times and in all places be easily matched. If you buy a set of table ware which is peculiar or rare in its pattern, and afterwards break several pieces, you may be put to a very great degree of trouble, or even find it impossible, to restore them. Thus, a peculiar set of earthenware or china, however beautiful and cheap, may ultimately prove a source of vexation and considerable expense.

Plate.—Whatever silver articles you require, buy them of a genuine kind, or of sterling silver plate, which always keeps its value, however old and worn it may become. Avoid all plated goods, for the plaiting is not long in wearing off, and then the article is valueless. A tarnished plate fork, spoon, or salver, has an excessively mean appearance. If you find it inconvenient to purchase sterling silver plate, your most economical plan, consistent with elegance of appearance, will be to purchase a few articles of German silver. This is properly the metal called *nickel*, and closely resembles sterling silver in texture and colour: it is not just so white as sterling silver, but the difference is not noticed unless a close comparison be made. In hardness and durability, it is much superior to sterling silver, and its price is in some cases only about a tenth of what genuine plate would cost. German silver is now manufactured to a large extent in England, and is made into spoons, forks, ladles, tea-pots, salvers, dish-covers, and all other articles for the table. It is not probable that German silver will ever be purchased to a large extent in order to supersede the sterling article, because it possesses no intrinsic value like bullion, but it forms a great stretch in advance of plated or Britannia metal goods, and is likely to come into extensive use. The articles in Britannia metal were once of a durable fabric, but they are so no longer; their good character is gone, and they should on no account be purchased by an economical house-wife. A tea-pot, for instance, of that metal, for common use, and costing seven or eight shillings, will probably not last twelve months, while a tea-pot of German silver, costing about three pounds, will last for fifty years. Thus the German silver article is by far the cheaper of the two, independent of all considerations as to elegance of appearance.

Fire-grates.—In choosing fire-grates or stoves for your rooms, do not buy those which have burnished steel fronts, as they require a considerable degree of care in cleaning, and are very liable to rust during summer when not in use. The best and neatest, as well as the cheapest, grates, are those which are made of cast-iron, and of an ornamental pattern. Let the grates which you select be small or of moderate size in the fireplace. Wide, open grates, by admitting cold air into the chimney, are exceedingly liable to smoke.

Gilding.—Order all the gilding of your picture frames and other articles to be done in oil. Oil gilding is not susceptible of flatting and burnishing like water-gilding, but it is infinitely more durable. You may wash an oil-gilt frame without injuring it, whereas one that is water-gilt cannot be cleaned, and is soon tarnished. We never knew a gilder who would gild in oil unless it was expressly insisted upon.

Baths and foot warmers.—Few houses possess the convenience of baths, but every one may command the use of small movable bathing vessels for the feet, or for infants. The best kind of foot and leg bath is a deep wooden pail; those of earthenware are exceedingly liable to break, and, besides, are very expensive. There are various kinds of close vessels for holding warm water, which are used for producing warmth in bed. The best article of this nature which we have seen is a vessel made of sheet tin. It measures twelve inches in length and six inches in diameter, being round like a bottle, with bulged out rounded ends. At one end there is a small brass screw cap, placed over an orifice at which the water is admitted. This cap being well screwed down, and a small leather washer being used to assist in the tightening, not a drop of water will ooze out when the vessel is laid in bed. With this simple apparatus, tied in a flannel bag, the feet or any part of the body will be effectually warmed, either during illness or in the cold of winter.

Housekeeping.—Every good housewife is expected to keep a regular and continuous account of her income and expenditure. This is, indeed, perhaps the most essential in the routine of domestic duties, and she must possess an ill-regulated mind, or have had an insufficient education, who neglects it. When properly set about and methodically managed, there is little or no trouble in keeping the household accounts. Some housewives have one method, and some have another. Always presuming that we are addressing young housewives in the middle ranks of society, with whom frugality is an object, we beg to suggest the following simple plan of keeping house accounts:—Procure a small slate-book—that is, a little book composed of three slates, bound in a plain cover. This, which you write upon with a slate pencil, is your *day-book*; it is always at hand for you to scroll down any note of outlay, and will keep several days' or a week's accounts at a time. At any leisure moment, you carry the entries of outlay from the slates to a small ruled paper book, which is your *ledger*. One page of this is devoted to money received, and the opposite page to money paid out. By doing this regularly, and comparing the entries of sums received with the entries of sums expended, so as to see that they square with each other, you will find that you possess a complete record of family expenses, satisfactorily alike to yourself and to your husband, should he make any inquiry into the subject. The keeping of an account of receipts and disbursements, in this or any other convenient manner, is calculated to have the most salutary and agreeable effects. The tendency to over-expenditure, or living beyond the means, is constantly checked, or at least you are not deceived upon the subject, and in all likelihood much future distress in circumstances is avoided.

In referring to housekeeping accounts, we must put you on your guard against the very mischievous practice of buying on credit, and running up bills with tradesmen. If you can at all avoid taking credit, do so. By paying for every article with ready money, you will possess two decided advantages—you get every thing cheaper as you want it, and you can go anywhere to seek out the best markets. Housewives who run up bills become the slaves of tradesmen, and can possess no proper independence of principle or self-respect.

Servants.—The old practice of hiring domestic servants for six months at once is rapidly declining. Both mistresses and servants find, by experience, that a bargain for such a length of time very often produces disagreements. It is best for all parties that the term hired for should be only one month at a time, with one month's notice for separation. By this plan, a servant can leave a place which does not please her without any lengthened delay; and in the same way a mistress can give a servant warning to quit at a short notice, should it be found that she is unsuitable. In this manner there is no vexatious obligation to keep together, and a separation can always take place amicably. All servants and mistresses who try this plan, find it so agreeable that they never like to change it. Many servants remain years in a place, though hired on the understanding that it is only from month to month, or, what is the same thing, hired for no fixed period, but just so long as both parties agree; and that, in the event of any dissatisfaction, there shall be a week or a month's warning given to leave. This practice has been long common in London, and the sooner it is universal the better.

It is a very old remark, that good mistresses make good servants; and though not strictly correct in all instances, there is, on the whole, much truth in it. A good mistress endeavours to seek out and attach a good servant to herself. She effects this attachment and good-will by simply laying before the servant what is to be her line of duties, or what is expected of her, and then leaving her undisturbed to execute these duties in a regular methodic manner. No servant likes to be interfered with in her work, or to be called away from one thing to do another; nevertheless, some mistresses are not happy unless they are going in and out of the kitchen, or bustling up and down the house, ordering and counter-ordering, or in some other way worrying the servant out of all patient endurance. Mistresses of this fidgetty turn can hardly expect to keep good servants, should they be so fortunate as to procure them. We advise the young housewife to commence on the wise plan of prescribing to her servants, in simple plain terms, the duties which she expects they will daily and regularly execute; and if the servants are unfit to take advantage of this friendly and liberal arrangement, and require to be continually urged and "spoken to," it is better for both that there should be a separation. Where two or more servants are engaged, it is absolutely necessary that the precise duties of each should be expressly defined, in order to prevent disputes between them, and that the work of the house may be duly performed.

CLEANING

The best way to clean a house is to *keep it clean* by a daily attention to small things, and not allow it to get into such a state of dirtiness and disorder as to require great and periodical cleanings. Some mistresses, and also some servants, seem to have an idea that a house should undergo "regular cleanings," or great washing and scrubbing matches, once every three or six months, on which occasions the house is turned almost inside out, and made most uncomfortable. All this is bad economy, and indicates general slovenliness of habits.

Wooden floors, if kept in order by daily sweeping and other small attentions, may be effectually cleaned by washing them with warm water and soap; but if spots of grease are to be removed, the spots must previously be taken out with fuller's earth. Ink spots may be discharged with spirits of salt. Some mistresses make a practice of ordering the floors of bed-rooms to be frequently washed. We wish to guard both mistresses and servants against this practice. It is most dangerous to the health of the person who occupies the bed-room to wash or scour it, unless the weather be very fine or warm, in order to allow the window to be opened for thoroughly drying the room before night. The utmost that should be done, except in favourable circumstances, is to pass a damp mop lightly over the floor.

Carpets.—Ordinary Kidderminster carpets can only be cleaned by shaking and beating; if cleaned by means of washing, they become so soft as to be speedily dirtied again, and their appearance is spoiled. Brussels carpets may be cleaned as follows:—Take them up and shake and beat them, so as to render them perfectly free from dust. Have the floor thoroughly scoured and dry, and nail the carpet firmly down upon it. Take a pailful of clean cold spring water, and put into it about three gills of oxgall. Take another pail with clean cold water only. Now, rub with a soft scrubbing brush some of the oxgall water on the carpet, which will raise a lather When a convenient sized portion is done, wash the lather off with a clean linen cloth dipped in the clean water. Let this water be changed frequently. When all the lather has disappeared, rub the part with a clean dry cloth. After all is done, open the window to allow the carpet to dry. A carpet treated in this manner will be greatly refreshed in colour, particularly the greens. It is very advisable, in laying down carpets at first, to cover the floor beneath them with large sheets of paper, so as to prevent dust from rising between the boards. A carpet lasts longer by adopting this precaution.

Oil-Cloths.—Oil or painted cloth should be laid only on dry floors; if the floor be in the least degree damp, the cloth will soon mildew and rot. Such cloths, laid even in the driest situation, should be wetted as little as possible. When to be cleaned, they should be wiped with a wet cloth, and rubbed gently till dry.

Marble hearths and chimney-pieces may be cleaned as follows:—Mix a gill of soap-lees, half a gill of turpentine, and a bullock's gall, and make them into a paste with pipe-clay, which lay upon the marble, and let it remain a day or two, then rub it off, and the stains will have disappeared, unless they are of long standing, when the paste must be again applied. Polished marble requires careful treatment, as any acid will destroy the polish. In general, warm water and soap will be found the safest thing for cleaning chimney-pieces.

Walls of houses.—The outer surfaces of walls, formed of brick or sandstone, sometimes imbibe moisture from the atmosphere, and this gives a dampness to the interior. If it be found unsuitable to plaster and whitewash the outside, the damp may be greatly prevented by painting the walls with a single coat of oil-paint, which, by being light in colour, will give a neat and clean effect.

Walls of rooms.—When walls of rooms or staircases are to be painted in oil, let the paint be of the best description. It is not unusual for inferior tradesmen to use whiting, instead of white lead, as a pigment: by this deception the paint will afterwards scarcely endure washing. Supposing, however, that the paint has been of the best kind, considerable care will be required in cleaning it. The safest and most simple plan is to take a pail of hot water and put into it as much common yellow or soft soap as will raise a lather or froth. Now wash the walls with a flannel cloth dipped in this water; then wash this soapy water off with clean flannel and clean warm water. Dry with a clean linen cloth. Do all this equally, so as not to leave smears or parts better washed or wiped than others.

Paper-hanging should be first dusted, and then cleaned by a stale loaf of bread, with the crumb surface cut smoothly, and gently rubbed, the dirty face of the bread being cut away from time to time. The imitative marble-paper, highly varnished, may be washed with cold water and soap. *Papier-mâché*, now much used for mouldings and ornaments in rooms, may be cleaned with soap and water.

Picture-frames of varnished or French-polished wood may be washed with soap and warm water, and sponge or flannel. As already mentioned, frames which are gilt in the ordinary manner, or "water-gilt," cannot endure washing or rubbing; but if "oil-gilt," they may be washed with cold water and a soft brush.

Ivory may be restored to its original whiteness by cleaning it with a paste of burnt pumice-stone and water, and then placing it under glasses in the sun's rays.

Brass inlaid work is best cleaned as follows:—Mix tripoli and linseed oil, and dip into a rubber of hat, with which polish the work. If the wood be ebony or rosewood, polish it with a little finely-powdered elder-ashes; or make a paste of rotten-stone, a little starch, sweet-oil, and oxalic acid, mixed with water. The ornaments of a French clock are, however, best cleaned with bread-crumb, carefully rubbed, so as not to spoil the wood-work. Ormolu candlesticks, lamps, and branches, may be cleaned with soap and water. They will bear more cleaning than lacquered articles, which are spoiled by frequent rubbing, or by acids, or strong alkalies.

Windows and looking-glasses.—Dip a moistened rag or flannel into indigo, fuller's earth, ashes, or rotten-stone, in impalpable powder, with which smear the glass, and wipe off with a dry soft cloth. Powder-blue or whitening, tied up in muslin, and dusted upon the glass, and cleaned off with chamois leather, also gives glass a fine polish. The spots in the silvering of old looking-glasses are caused by damp at the back. The Vauxhall plates are no longer prized, for the glass made in the present day is *whiter* and better. Window-panes may be made to resemble ground glass by daubing them with putty, or a brush with a little thin paste.

Brass and copper are best cleaned with sweet oil and tripoli, powdered bath-brick, rotten-stone, or red brick-dust, rubbed on with flannel and polished with leather. A strong solution of oxalic acid in water gives brass a fine colour. Vitriol and spirits of salts soon make brass and copper very bright, but they very soon tarnish, and consequently require more frequent cleaning. A strong ley of roche-alum and water will also improve brass.

Stove-grates are cleaned with black-lead mixed with turpentine, or with stale beer and yellow soap, and polished off. The finer lead is used dry, in lump or powder. The bronzed work of stoves should be only lightly brushed. Rottenstone, or fine emery and sweet oil, is used for the bright work of stoves and polished fire-irons; the higher the latter are polished, the less likely are they to rust. To prevent rust in articles not often used, rub them with sweet oil, and dust over them fine lime; or with the following mixture:—To a quart of cold water add half a pound of quicklime; let it stand until the top is clear, when pour off the liquid and stir up with it some olive oil, until it becomes of a pasty consistence, when it should be rubbed on the metal articles to be preserved. To fill cracks in stove-backs, make a paste of wood-ashes, salt and water. To remove rust, mix tripoli, sulphur, and sweet oil, and clean the articles with it; or mix boiled soft soap with emery No. 3, which will also discharge the fire marks from bright bars. Steel-work may also be kept from rust by varnishing it with turpentine in which is dissolved a small proportion of India rubber (caoutchouc). Polished fire-irons may be best preserved from rust by being closely wrapped up in strong brown paper.

Kitchen vessels.—The crust on boilers and kettles, arising from the hard water boiled in them, may be prevented by keeping in the vessel a marble, or a potato tied in a piece of linen. Tin plate vessels are cleanly and convenient, but unless dried after washing, will soon rust in holes. Iron coal-scopes are liable to rust from the damp of the coals. The tinning of copper saucepans must be kept perfectly clean and dry, in which case they may be used with safety. Copper pans, if put away damp, or a boiling-copper, if left wet, will become coated with poisonous crust, or verdigris. Untinned copper or brass vessels, even if scoured bright and clean, are always dangerous. If made dishes be allowed to cool and stand for some time in copper vessels, the articles will become poisonous. In the year 1837, a lady and her family, residing in Paris, were poisoned by partaking of a stew which had been allowed to stand and get cold in a copper pan. A German saucepan is best for boiling milk in. This is an iron saucepan, glazed with white earthenware instead of being tinned, the glaze preventing its tendency to burn. A stewpan made like it is also preferable to a copper pan, since simple washing keeps it sweet and clean. A method of glazing saucepans with earthenware has lately been the object of a patent in England. Zinc sieves are more easily kept clean than those made of hair, will last longer, and not rust.

Dish-covers are cleaned with fine whitening and sweet oil, and polished with dry whitening powder. Britannia metal teapots, &c., should be rubbed with sweet oil on flannel, then polished by the hand with rottenstone, and next washed with soap and hot water, and finished with wash-leather and whitening powder. Pewter is scoured with fine white sand and a ley made with wood-ashes, or soda and water.

Knives are best cleaned by rubbing on a flat board, on which is put finely powdered brick-dust. Some recommend leather to be put on the board; this may prevent the knives from wearing, but it deprives them of an edge fit for cutting. Never put knives in hot water, for that loosens the handles and spoils the temper of the steel. For simple cleaning after use, wipe them only with a damp and then with a dry cloth.

Lamps.—When lamps are foul inside, they should be cleaned with hot water and pearl-ashes, and well rinsed and set by the fire to dry before the oil is again put in. Spirit-lamps should be filled with great care, lest the spirits take fire; and unless the spirits of wine be pure, it will not burn. Naphtha, which is burnt in some lamps, is so inflammable as to be dangerous to use.

Lamp-glasses.—If the lamp-glasses be ground, burnt spots upon them cannot be removed, but they may be cleaned from the effects of smoke by washing with soap and water, and then rubbing with a dry cloth. The glasses should always be ground on the outside.

Furniture.—Mahogany furniture is always best cleaned by continual rubbing; and no ordinary stuff that may be applied will compensate the want of this requisite. Some furniture is what is called "French polished;" but this French polish is an unguent possessed and applied only by cabinet-makers, and cannot readily be had by housekeepers. In ordinary circumstances, therefore, the furniture must be well rubbed, and with some easily-procurable material. The following are the materials we suggest:—Take a gill and a half of unboiled linseed oil, one gill of turpentine, and a teaspoonful of pounded loaf-sugar. Shake all well together, and rub a portion on the furniture with a piece of flannel, and polish with a linen cloth.

An oil for darkening furniture may be made as follows: —Mix in one pint of linseed oil an ounce of powdered rose-pink, to which add one ounce of alkanet root, beaten in a metal mortar; let the mixture stand in a warm place for a few days, when the substances will have settled, and the oil, of a deep rich colour, may be poured off for use: or mix one ounce of alkanet root, four ounces of shell-lac varnish, two ounces of turpentine, and the same quantity of scraped bees'-wax, with a pint of linseed oil; and when they have stood a week, the mixture will be ready for use.

Furniture paste is made by scraping a quarter of a pound of bees'-wax into half a pint of turpentine, and letting it stand to dissolve. This will keep the wood light. If, however, a quarter of a pint of linseed oil be added to the above, the composition will darken the wood. Another paste, useful for very light wood, is made as follows:—In a quart of hot water dissolve six ounces of pearl-ash, add a quarter of a pound of white wax, and simmer the whole for half an hour in a pipkin; take it off the fire, and when it has cooled, the wax will float upon the surface, and should be worked in a mortar, with a little hot water, into a soft paste. With this, furniture may be highly polished, as may also marble chimney-pieces. It is necessary to mention, that furniture cleaned with paste has the disadvantage of receiving heat-marks more readily than if polished with linseed oil, which, however, requires more time and labour. In any case, the furniture should be cleansed from grease and stains before polishing is attempted; and this may be done by washing the wood with hot beer, or with soap and water. The safest way to heat furniture paste or oil is to place the vessel containing it in another holding boiling water upon the fire.

A fine varnish for mahogany or other furniture may be thus made:—Put into a bottle two ounces of gum-sandrac, one ounce of shell-lac, half an ounce of mastic, half an ounce of gum-benjamin, one ounce of Venice turpentine, and a pint of spirits of wine. Colour red with dragon's blood, or yellow with saffron. Let it stand in a warm place until the gums are dissolved, when strain it for use.

Varnishing.—Before new furniture is varnished, it should have a coat of boiled oil (if wished to be darkened) or linseed oil, and be left a day or two to harden; or a thin size, made from isinglass or gum-tragacanth, dissolved in water, or very thin glue, is used; so that the pores of the wood be filled up, and both varnish and time be thus saved. A good varnish may be made by dissolving eight ounces of white wax and half an ounce of yellow rosin in a pint of spirits of turpentine.

Bottles.—Cut a raw potato into small pieces, and put them in the bottle along with a table-spoonful of salt, and two table-spoonfuls of water. Shake all well together in the bottle till every mark is removed, and rinse with clean water. This will remove stains of wine, green marks of vegetation, and other discolourations. Hard crust in bottles may be cleaned off by rincing with water and small shot. Take care to wash out all the shot before putting the bottles aside.

Plate.—Articles of plate, after being used, should be washed in hot water, or, if stained, they should be boiled, and rinsed and dried before you attempt to clean them. They should be carefully handled, else they may receive deep scratches, which are very difficult to remove. Besides, the object is not merely to clean the plate, but to polish it, so that it may appear almost as brilliant as when it was received new from the silversmith. For this purpose quicksilver was formerly much used in plate-powder, and it gives the silver great lustre, which soon, however, disappeared, and the article became tarnished and blackened.

The best plate-powder consists of dried and finely sifted whiting or chalk. The greater part of the whiting sold in the shops is coarse trash, unfit for rubbing upon plate, and great care must be taken to procure the finest London whiting, which will not scratch.

Brushes, hard and soft, sponge, and wash-leather, are requisite for cleaning plate; if the powder be mixed with spirits of wine laid on with a sponge, and rubbed off with wash-leather, all tarnish will be removed. Salt stains (blackish spots) and sulphur marks from eggs are more difficult to remove. It is a good plan to boil a soft fine old cloth in water with some prepared chalk dissolved in it, and to dry the cloth, and use it for polishing The soft brush is for the same purpose, the hard brush being for chased work, edges, and crests, so that no a portion of dry powder may remain in them. Plate should in all cases be finished with a fine dry wash leather.

Plated articles should be carefully wiped dry after washing them, else they will rust or canker at the edges, where the silver first wears off; and on this account, also, they should be cleaned as rarely as possible. German silver may be cleaned in the same manner as plate.

Embroidery and gold lace should be cleaned only with spirits of wine, or brushed with finely-powdered roche-alum and chalk. For gold chains, dissolve three ounces of sal-ammoniac in six ounces of water, in which boil the chain; then boil it in soft soap and water, wash it in cold water, rub it dry with flannel, and shake it in a bag with very dry bran.

Flannel or woollen articles.—Wash them quickly in warm water, with soap. Wring and shake them well, and hang them up to dry. Do not let them lie wet. The more quickly they are dried, the less likely are they to shrink.

Silks.—No silks look well after washing, however carefully it be done, and should therefore never be resorted to but from absolute necessity. We have seen it recommended to sponge faded silks with warm water and soap, then to rub them with a dry cloth on a flat board, after which to iron them on the inside with a smoothing iron. Sponging with spirits will also improve old black silks The ironing may be done on the right side, with thin paper spread over them to prevent glazing.

Bed feathers.—Put a manageable quantity into a pillow case or bag, which wash with warm water and soap Wring out the lather, and rinse them in clean water Wring them as dry as possible, and hang them up to dry Shake them frequently while drying. When quite dry beat them to free them from any dust. They may be now taken from the bag, and are ready for use.

Lace.—When lace has lost its colour, soap it well and put it in cold water, just enough to cover it. If much discoloured, change the water at the end of twenty-four hours. When steeped sufficiently, rinse it out; starch it a little; pick it out as evenly as possible; roll it in a towel, and when nearly dry, iron it. All kinds of lace veils may be treated in a similar manner.

Scarlet cloth.—Pour boiling water upon bran, strain it, and, while hot, wash the cloth in it, and rinse with hot water. Soap should not be used. Purple cloth may be washed in hot water and pure ley. Saxony or dark print dresses should be washed in two lathers, and in the second should be poured a little ox-gall, which will freshen reds, blacks, and greens; and a handful of salt added to the last rinsing-water will prevent the colours running.

Clear starching is practised as follows:—Rinse the articles in three waters, dry them, and dip them in a thick starch, previously strained through muslin; squeeze them, shake them gently, and again hang them up to dry; and when dry, dip them twice or thrice in clear water, squeeze them, spread them on a linen cloth, roll them up in it, and let them lie an hour before ironing them. Some persons put sugar into the starch to prevent it sticking while ironing, and others stir the starch with a candle to effect the same end; we object to these practices as injurious to the article starched, or as very nauseous. The best plan to prevent sticking is to make the starch well, and to have the irons quite clean and highly polished.

Stains.—Stains of fruit or wine may be generally removed from linen or cotton cloth by placing the articles over the top of a pail, and pouring boiling water through them till the marks disappear.

Ink marks or *iron moulds* may be removed by placing a plate (a pewter one is the best) on the top of a basinful of boiling water; then spread the articles on the plate; wet the spot, and rub it with a small quantity of the salts of lemon; as the article dries, the stain will disappear. If this fail, repeat the operation. A small box of salts of lemon will be found very useful in a household.

Paint or grease spots may be removed from woollen cloth by turpentine. Smith's scouring drops is a liquid sold in small bottles, which will also be found efficacious in removing oil or grease marks; it is more expensive than turpentine, but has a less offensive odour.

To extract grease from silk.—As soon after the discovery of the injury as possible, hold the part firmly, and with a clean soft white cloth, or an old cambric handkerchief, rub the spot briskly, changing the portions of the handkerchief frequently, and in a minute or two the spot will disappear. On silks which fray easily, this plan will be unsuitable.

MISCELLANEOUS.

To remove a tight stopper.—It frequently happens that the stopper of a glass bottle or decanter becomes fixed in its place so firmly, that the exertion of force sufficient to withdraw it would endanger the vessel. In this case, if a cloth be wetted with hot water, and applied to the neck of the bottle, the glass will expand, and the neck will be enlarged, so as to allow the stopper to be easily withdrawn.

Economical fuel.—In places where coal is scarce and dear, a tolerably good fuel may be made by mixing the culm or refuse dross of coal with clay, and moistening the whole with water—masses in the form of bricks or balls may be made, which, when dry, will burn with an intense heat. Where peat prevails, that article may be easily charred by burning in a covered pit or stove; and this charred peat will be found to give a great heat when used in an open fire. The Dutch make much use of their turf in this manner. Another economical fuel easily procurable where there are woods of Scotch firs consists of fir cones or tops, which contain a great quantity of solid woody matter in addition to the resinous, and are excellently adapted for domestic fires.

To light a fire, clear the ashes from the grate, leaving a few cinders for a foundation, upon which put a piece of dry crumpled brown paper, and lay on a few small sticks crosswise, then some of larger size, and on them a few pieces of coal, and next the large cinders; and when the flames have caught the coal, add a backing of small coal and cinders. When the fire has become low, stir it together, but do not turn the large cinders; clear the front of the lower bar to admit air, and pass the poker into the bottom of the fire to clear it of ashes; and then with tongs put on a few large pieces of coal towards the front of the fire, but not on the upper bar, else the fire will smoke. Coals should not be thrown on, but put on gently with a scoop or shovel; and even the smallest ashes may be burnt at the back of the fire, if they be covered with small coal. The best and quickest mode of restoring a neglected fire is to stir out the ashes, and with the tongs to fill up the spaces between the bars with cinders. If carefully done, it is surprising how soon this process will produce a glowing fire.

Ashes and small cinders mixed with water into a mass, and put on the back of a fire with a few coals, burn well, so that ashes may thus be entirely burnt up. In stoves under boilers, this mixture is very useful, as it lasts long with little addition.

Smoky chimneys.—The causes of smokiness in chimneys are various; but all are connected with the properties of air and heat, for the smoke is only particles of culm ascending through the agency of heated air. To make a chimney vent well, the column of heated air from the fire must not be entangled with cold air from beneath, nor retarded by cold air coming down the chimney. To effect these objects, the fireplace must not be much larger than the grate, and the chimney must be of a certain length and bend. The great leading cause of smokiness is cold air somehow or other mixing with the warm air about the mouth or throat of the chimney, and so causing a sluggishness in the ascent, or no ascent at all. Therefore, the nearer the air is made to pass the fire on all sides, the more rarefied it will be; and the less vacancy there is in the chimney-place, it will ascend with the greater rapidity. A proper contraction of the mouth of the chimney, at the same time allowing the fire to be fed freely with air, will be found in most instances to cure smoke. Of late, certain contrivances called dampers, by which the chimney throat can be narrowed, have been the means of effecting draughts, and so curing smoke. It should be noted, that in contracting chimney throats, the contraction should not be all at once, but at first gradual, and then straight upward, so as not to allow a volume of cold air to lurk in a hollow above. A chimney being wide at bottom, and gradually narrowing towards the next story, allows the coldish air to hang about the lower parts, by which, when a gust of wind comes, the smoke is driven back into the room. This kind of smokiness is the most teasing of all the forms of chimney diseases. Every little puff of wind sends a smaller or larger quantity of smoke into the apartment, and often when it is least expected. Perhaps this kind of smokiness is not in all cases caused by wrong construction, but arises from the situation of the house; and of this we shall immediately say a few words.

If a funnel of a chimney be made too narrow to afford an easy passage to the top, the smoke will then naturally be forced into the room to find some other passage; this defect is very common, and the remedy troublesome and difficult. The most effectual cure, if the situation will admit, is to build a small additional flue, and open a hole into it from the back of the chimney, near the level of the mantel-piece, slanting upwards in an easy direction; this supplemental flue must be carried to the top of the building to receive the surplus of the smoke, and will prove a certain cure. If the situation will not allow of this expedient, the fireplace may be contracted both in breadth and height, a smaller grate used, and the chimney heightened at the top; which will oblige the air to pass close over the fire, and carry up the smoke with greater rapidity, for the quicker the current, the less room it requires. Should the chimney still smoke, a blower, or front plate, to put on and take off at pleasure, will be of use. But if none of these prescriptions answer, then something must be done to improve the current of air towards the fire. This brings us to a consideration of the want of ventilation in the room.

If the chimney and fireplace be faultless, and yet smoke, it is almost certain that there is a want of ventilation. In ordinary circumstances, as much air is admitted by chinks in windows and doors as will feed a fire; but if the room be rendered very close by closing as many chinks as possible, how is the fire to receive air? According to the plan on which houses are generally built, ventilation is left to be a matter of chance. To ventilate an old house is therefore no easy task. The following plans are worth considering, for they have been found to answer:—Contrive to bring a small tube from the external air, or from a staircase or lobby, to a point beneath the grate, so as to cause a free current of air to reach the fire. If the mouth of the tube below the grate be topped with a cowl, the ashes will be prevented from falling into it. Some years ago, the rooms of a public office in Edinburgh were completely cured of smoke by this simple contrivance, after all other means had failed. Another plan consists in perforating small holes in the cornice or roof, for the air to gain admission, but, unfortunately, unless care be taken to prevent draughts, the cure is apt to be worse than the disease.

Cases are by no means uncommon of fire-places giving out a puff of smoke every time the door of the room is shut. The cause of this kind of smokiness is the want of ventilation in the room. In shutting the door, it pulls out a certain quantity of air, which cannot be afforded to be lost, or it causes such distraction of the current towards the fire, that the equilibrium that carries up the smoke is destroyed, and a puff downwards—in other words, a rush of air loaded with smoke from the chimney—is the consequence. It will be remarked, that this smokiness occurs most frequently when the door is on the same side of the room as the fireplace. We would therefore advise house-planners to avoid this bad arrangement. If possible, let the door be on a different side from that in which the fire is placed. Most houses in which the chimneys go up the middle walls instead of the gables, have the fault we mention. A remedy for this smokiness is to contract the mouth of the chimney, and, if possible, heighten the stalk; for if the chimney be pretty long, the heated air ascending it goes with such a force that the outer heavy air cannot get down, at least not to so great an extent as to cause a puff when the door is shutting. In some cases, the cause of the disease will be found to be air rushing up behind the grate, if a register, and then coming down to supply the fire, the action of the door disturbing the current. This is therefore an argument for always taking care to build register stoves quite close behind, not leaving the smallest crevice for air to steal up the chimney without first going through the fire.

In erecting chimneys, it should be a rule to carry them up a good way in a perpendicular direction, before making a turn, by which means the heated air gains a force in its primary vertical ascent, which carries it over future difficulties. In walls in which the fireplace of one story is immediately below the fireplace above, it is impossible to get a perfect straight for any great length; therefore this must be left to the judgment of the builder. It is also advantageous for all chimneys to have a bend in them before reaching the top, and a garret chimney should have two bends. For want of attention to this top bending, many cottage and small villa chimneys smoke. The use of bends is obvious. Strong, sudden, and accidental gusts of wind sometimes enter, and beat into the top of the chimney; a turning or bend, therefore, will break the force of the wind, and prevent it repelling the heated air downwards. But if the chimney is straight, and the gust meet with no interruption, it will stop the passage of the smoke for a while, and of course force what rises from the fire immediately into the chamber. It is to be observed, that the farther the wind gets down the funnel the greater strength will be required to repel it; therefore the nearer to the top the bend or winding is, the better. Also, if there is a storm of wind, with heavy showers of hail, snow, or rain, falling perpendicularly in great drops, the first bend of turning will, in part, stop their progress; but if the funnel is perpendicular all the way down, the great drops of hail, snow, and rain, will fall freely to the bottom, repelling the smoke into the room; and if the funnel is foul, great quantities of soot will be driven down. These reasons recommend a bend in some part of the funnel as absolutely necessary.

Garret chimneys are more liable to smoke than any other in the house, owing to the shortness of the funnel: for when the composition of rarefied air and smoke has made its way up a high funnel, it forms a strong column, and to repel it requires a proportionably great force; but in a garret chimney this strong column cannot be obtained; therefore, what cannot be had from nature must be aimed at by art. The fault in most garret chimneys is being carried up in a straight direction from bottom to top in a slovenly manner, and with funnels as large as any in the house; whereby the little internal rarefied air has the whole immediate pressure of the atmosphere to resist, which, in general, is too powerful for it. But a garret or cottage chimney carried up and executed in a proper manner, with due proportion in every part, according to the size of the room, and the funnel in an easy crooked direction, will draw and be as clear from smoke as any other.

When smokiness is produced by too short a chimney, it will be necessary to add to its length either by building the stalk higher, or inserting an earthenware pot or iron tube at the summit. The building of higher stalks is an infallible remedy, provided all be right below, but it is attended with danger to adjoining roofs. Pots or cans are useful both in adding to height and in causing a free disengagement and shooting of the smoke as soon as it enters the outer atmosphere.

Another very common cause of smokiness is fires overpowering one another. For instance, if there be two chimneys in one large room, and you make fires in both of them, the doors and windows close shut, you will find that the greater and stronger fire shall overpower the weaker, and draw air down its funnel to supply its own demand; which air descending in the weaker funnel, will drive down its smoke, and force it into the room. If, instead of being in one room, the two chimneys are in two different rooms, communicating by a door, the case is the same whenever that door is open. In a very tight house, it has been known that a kitchen chimney on the lowest floor, when it had a great fire in it, has overpowered any other chimney in the house, and drawn air and smoke into its room, as often as the door was opened communicating with the staircase. The remedy for this is, to take care that every room in a house has the means of supplying itself with what air it requires, so that it does not need to borrow air from other rooms. Back smoke is only cold air loaded with smoke coming down into a room from an adjoining chimney-top, in order to supply, in the readiest manner, air to that room.

Thus, fires in the lower part of a house will draw air even from a garret room, and this garret room will draw air to supply its deficiency, by taking it in a smoky condition from next house.

Smokiness is also produced when the tops of chimneys are commanded by higher buildings, or by a hill, so that the wind blowing over such eminences falls, like water over a dam, on the tops of chimneys that lie in its way, and beats down the smoke contained in them. Sometimes we have seen the droll phenomenon—though it is no laughing matter—of every particle of smoke all of a sudden pouring into the room, in consequence of a gust of wind blowing pertinaciously for several minutes down the chimney. Such a form of smokiness arises chiefly from the situation of the house, and the want of a bend in the chimney. The remedy to be applied is fixing on the top of the chimney a turning cap or cowl, which acts like a weather-cock, and keeps its closed side to the wind. These cowls, however, are creaking, noisy things; and being hence insufferable near sleeping rooms, are only to be resorted to when more simple means have failed.

Preserving meat.—To preserve meat for a few days fresh in warm weather, wash it lightly over with a brush or sponge, with a mixture composed of two thirds pyroligneous acid, and one third water. The acid, which is a kind of vinegar, gives it no flavour, and the meat requires no washing before being cooked.

Meat may be preserved fresh for any length of time by being put in tin cases secluded from the air. To do this effectually, put the meat in the case; then solder on the top or lid, but leaving in it a small hole the size of a pea; now plunge the case in a vessel full of steam, where let it remain a few minutes, by which the air will be expelled. The case is now to b taken out, and the small hole instantaneously closed by soldering a piece of tin the size of a wafer over it. By means such as this, meat, fish, and soup, may be preserved for years, and when used, they will be found quite fresh.

Salting and smoking meat.—The following method, which requires only forty-eight hours, may be adopted for salting and smoking meat:—A quantity of saltpetre, equal to the common salt that would be required for the meat in the usual way, must be dissolved in water. Into this the meat to be smoked must be put, and kept over a slow fire till all the water is evaporated. It must then be hung up in a thick smoke for twenty-four hours, when it will be found equal in flavour to the best Hamburgh smoked meat that has been kept several weeks in salt, as red throughout, and equally firm.

To purify water, put into a hogshead of it a large table-spoonful of powdered alum, stir it, and in a few hours the impurities will be sent to the bottom. A pailful of four gallons may be purified by a single teaspoonful of alum. Freshly-burnt charcoal is also an excellent sweetener of water.

To filter water.—Put into an earthen vessel (such as sugar-bakers use to form the loaves in, with a small hole at the bottom or pointed end) some pieces of sponge, and on them a sufficient number of small clean pebbles to quarter-fill the vessel. Hang this filter end downward, in a barrel with the head out, leaving a space of about two or three inches between the end of the filter and the bottom of the barrel. The upper part of the filter should be kept a little above the top of the barrel, which must always be kept full of water. The sediment of the water will remain at the bottom of the barrel, and the pure water will rise through the sponge and pebbles to the vacant part of the filter. It may be hung in a cistern, or water-butt if more convenient. The pebbles and sponge should be cleansed occasionally.

Another economical filter may be made by taking out the head of a cask, setting it upright, and at a distance of about one-third from the bottom putting in a shelf or partition pierced with small holes; this shelf being covered with pebbles, upon which is a layer of fresh charcoal made from bones; and over this lay fine sand, to the depth of an inch, covered with another layer of pebbles; and upon this should be placed another shelf, pierced with holes, to prevent the pebbles, sand, and charcoal being disturbed by the water which is poured or runs in at the top of the cask; and after passing through the filter, is drawn off by a crane placed at the bottom of the cask.

Drying flowers as specimens.—A writer in the "New Monthly Belle Assemblée" recommends the following plan:—"As pressure is necessary for drying flowers, the first thing requisite is to construct a press, which in this instance is composed of two of the thickest milled boards, each twenty inches in length and fourteen in width; also two leather straps with buckles, and holes at intervals, to allow for the varying bulk of the press; then procure two quires of coarse sugar paper, which can be purchased at a grocer's. After having selected the most perfect specimens of flowers, with their stems, lower leaves, and roots, when practicable—and carefully observe that the plants be free from dew or moisture—lay every portion out nicely on one of the coarse sheets, being careful, at the same time, that one part of the specimen does not interfere with another: the leaf should be filled. Allow several sheets to intervene before another sheet is occupied by specimens. If the flowers be delicate, their colour will be better preserved by placing blotting-paper between the folds, to absorb the moisture. The plants are now ready to be put into the press, the straps forming the pressure, which, however, must not be great at first. It is necessary to remove the flowers every day, and dry the papers at the fire. When the specimens are quite dry, they should be taken from the press, and each plant separately sewed or fastened with gum on to half sheets of foolscap (a very sufficient substitute for gum will be found in the margins of the penny stamps, when cut into narrow strips); they may then be arranged in their natural orders, with the Linnæan class and order, and their place of growth, appended in the lower corners of the paper. The sheets thus classed make up the Herbarium or *Hortus Siccus*, and are kept in trays, boxes, or in a cabinet constructed for the purpose, in a dry room, when they will be ready for future reference, which is the principal use to be derived from making a collection of plants."

Preserving flowers fresh.—In the "Gardeners' Chronicle," the following appears on this subject:—"It is now eighteen years ago since we first saw, in the drawing-room of a gentleman, in the hot dry weather of the dog-days, flowers preserved day after day in all their freshness by the following simple contrivance:—A flat dish of porcelain had water poured into it. In the water a vase of flowers was set; over the whole a bell-glass was placed with its rim in the water. This was a 'Ward's case' in principle, although different in its construction. The air that surrounded the flowers, being confined beneath the bell-glass, was constantly moist with the water that rose into it in the form of vapour. As fast as the water was condensed, it ran down the sides of the bell-glass back into the dish; and if means had been taken to enclose the water on the outside of the bell-glass, so as to prevent its evaporating into the air of the sitting-room, the atmosphere around the flowers would have remained continually damp. What is the explanation of this? Do the flowers feed on the viewless vapour that surrounds them? Perhaps they do; but the great cause of their preserving their freshness is to be sought in another fact. When flowers are brought into a sitting-room, they fade because of the dryness of the air. The air of a sitting-room is usually something drier than that of the garden, and always much more so than that of a good greenhouse or stove. Flowers, when gathered, are cut off from the supply of moisture collected for them by their roots, and their mutilated stems are far from having so great a power of sucking up fluids as the roots have. If, then, with diminished powers of feeding, they are exposed to augmented perspiration, as is the case in a dry sitting-room, it is evident that the balance of gain on the one hand by the roots, and of loss on the other hand by their whole surface, cannot be maintained. The result can only be their destruction. Now, to place them in a damp atmosphere is to restore this balance; because, if their power of sucking by their wounded ends is diminished, so is their power of perspiring; for a damp atmosphere will rob them of no water—hence they maintain their freshness. The only difference between plants in a 'Ward's case' and flowers in the little apparatus just described is this—that the former is intended for plants to grow in for a considerable space of time, while the latter is merely for their preservation for a few days; and that the air which surrounds the flowers is always charged with the same quantity of vapour, will vary with the circumstances, and at the will of him who has the management of it. We recommend those who love to see plenty of fresh flowers in their sitting-rooms in dry weather to procure it. The experiment can be tried by inserting a tumbler over a rose-bud in a saucer of water."

DESTROYING VERMIN.

The best plan for preventing the attacks of vermin in houses is to keep the house scrupulously clean; for where there is cleanliness and ordinary precautions, no vermin will generate or exist.

Rats and mice.—These might in most instances be completely prevented from encroaching in dwellings by giving a solid foundation to a house, cutting off the approach by grating the drains, but especially by filling up all open spaces beneath pavements and in walls and partitions. Mice might be effectually kept out by only filling up the spaces behind skirting boards in rooms. These vacant spaces are invariably the habitations of mice, and the first thing any person should do in entering into possession of a domicile, is to cause all the spaces behind the skirting-boards and wainscot to be filled with plaster. When mice and rats have gained a footing in a house, they should be taken off by a cat or trap, and when one kind of trap fails, another may be tried. All schemes for poisoning them with arsenic or other ingredients are dangerous, and cannot be recommended.

Bugs.—These pests exist only in dirty houses. A careful housewife or servant will soon completely destroy them. The surest method of destruction is to catch them individually when they attack the person in bed. When their bite is felt, instantly rise and light a candle and capture them. This may be troublesome, but if there be not a great number, a few nights will finish them. When there is a large number, and they have gained a lodgment in the timbers, take the bed in pieces, and fill in all the apertures and joints with a mixture of soft soap and Scotch snuff. A piece of wicker-work, called a bug-trap, placed at the head of the bed, forms a receptacle for them, and then they may be daily caught till no more are left. Fumigations are very dangerous, and rarely effectual, therefore attempt no such project. Oil-painting a wall is a sure means of excluding and destroying them.

Fleas.—There is no way of ridding a bed or house of these vermin but excessive cleanliness. Keep the floors well swept and washed, and if you have a dog, comb and wash it frequently. Fleas are bred in the ground, or among dust.

Lice are now almost unknown in England. Wherever they are found, there certainly also is found dirtiness. Ignorant people imagine that these nauseous vermin breed spontaneously; this is a gross error. By cleanliness they are completely prevented; and the more warm the climate, so is the necessity for cleanliness greater.

Beetles, Cockroaches, and Crickets.—These may be caught in traps. A simple trap for them is a glazed basin or pie-dish half-filled with sweetened beer or milk, and to the edge of which a piece of wood is laid from the floor as a gangway. Do not attempt poisoning or fumigation.

Flies.—It is difficult to rid a house of flies by any other plan than poisoning, and that is too dangerous to be recommended. A composition of milk, sugar, and pepper, will attract and kill them, and so will a decoction of quasia; but both cause them to make offensive marks on the walls and furniture before they die. Gilt frames and chandeliers should be shrouded in thin yellow gauze or paper, in situations where the flies are likely to spoil them. Trees about a house form a harbour for flies, as well as dirt of all kinds. Cleanliness and airiness are the best preventives.

Moths.—The best way to preserve furs or worsteds from moths is to sew them closely up in a bag of new unwashed linen; if this be not done, the next best is to take the articles frequently out and brush and air them. The odour of camphor, shavings of Russia leather, lavender, &c., are much less efficacious than they are supposed to be. Kill every flying moth which you see.

Slugs.—Take a quantity of cabbage leaves, and either put them into a warm oven, or hold them before a fire till they are quite soft; then rub them with unsalted butter, or any kind of fresh dripping, and lay them in the places infested with slugs. In a few hours the leaves will be found covered with snails and slugs, which may then be destroyed in any way you think fit.

SMALL DOMESTIC MANUFACTURES.

The attempt to make all sorts of articles for domestic use is now far from economical, as the time and expense bestowed upon them are often of greater amount than what would buy the things ready made from the shops. We therefore confine our directions to articles which may require to be manufactured in families at a great distance from towns, or for the families of emigrants in remote settlements.

Blacking for shoes.—There are many ways of making this article, the chief ingredients employed being ivory-black, vinegar or sour beer, sugar, a little sweet oil, and oil of vitriol. A good blacking may be made as follows:—Mix three ounces of ivory-black, two ounces of treacle, a table-spoonful of sweet oil, one ounce of vitriol, one ounce of gum-arabic dissolved in water, and a pint of vinegar.

For *blacking-balls*, mix one pound of ivory-black, one pound of lamp-black, a quarter of a pound of gum-arabic dissolved in water, six ounces of brown sugar, half an ounce of melted glue, and a quart of water; and make into balls. A fine blacking for dress-shoes may be made by well beating two eggs, and adding a table-spoonful of spirits of wine, a lump of sugar, and ivory-black to thicken. This blacking may also be used for restoring the black leather seats and backs of chairs, &c. It should be laid on and polished as other blacking, and then left a day to harden.

Boot-top liquid.—Dissolve in a quart of water, one ounce of oxalic acid, and the same of white vitriol; with which sponge the leather previously washed with water; then wash off the composition with water, and dry. This mixture is for *white* tops. For *brown*, mix one ounce of oxalic acid, one ounce of spirits of salts, a scruple of cochineal bruised, and a pint of boiling water, and use as above. These mixtures should be labelled "poison." For brown tops, also, mix with a pint of skimmed milk, half an ounce of spirits of salts, half an ounce of spirits of red lavender, one ounce of gum-arabic dissolved in water, and the juice of two lemons; keep the mixture closely corked, sponge the tops when dry, and polish them with a brush or piece of flannel.

Blacking for harness.—Melt two ounces of mutton suet with six ounces of bees'-wax; add six ounces of sugar-candy, and two ounces of soft soap dissolved in water, and one ounce of indigo finely powdered; and when melted and well mixed, add a gill of turpentine. Lay it on the harness with a sponge, and polish off with a brush.

Cement.—Various preparations are used for mending broken china, earthenware, and glass. The most successful are as follow:—Beat the white of an egg with quicklime, in impalpable powder, into a paste; to which is sometimes added a little whey, made by mixing vinegar and milk. A little isinglass, dissolved in mastic varnish, is another cement. Nature supplies some cements ready to our hands—as the juice of garlic, and the white slime of large snails; and it has been stated in a respectable scientific journal, that a broken flint has been joined so effectually with this snail cement, that when dashed upon a stone pavement, the flint broke elsewhere than at the cemented parts. In their anxiety to unite broken articles, persons generally defeat themselves by spreading the cement too thickly upon the edges of the article, whereas the least possible quantity should be used, so as to bring the edges almost close together; and this may be aided by heating the fragments to be joined.

Paste is useful in a house for papering walls, cupboards, boxes, labelling, &c. Dr. M'Culloch, of Edinburgh, employs paste made of flour in the usual way, but rather thick, with a proportion of brown sugar, and a small quantity of corrosive sublimate. The use of the sugar is to keep it flexible, so as to prevent its scaling off from smooth surfaces; and that of the corrosive sublimate—independently of preserving it from insects—as an effectual check against its fermentation. This salt does not, however, prevent the formation of mouldiness; but a drop or two of oil of lavender, peppermint, or aniseed, is a complete security against this.

Waterproof stuff for shoes.—In winter, or during wet weather, shoes may be rendered durable by applying to the soles and seams a composition made of the following materials:—Half a pint of unboiled linseed oil, two table-spoonfuls of turpentine, one ounce of bees' wax, and a quarter of an ounce of Burgundy pitch. Melt the whole together, and apply with a brush before the fire. Repeat the application till the soles will absorb no more. Neats'-foot oil, alone, will be found an excellent preservative of shoes in wet weather.

Ink.—An excellent ink suitable for writing with steel pens, which it does not corrode, may be made of the following articles:—Sixty grains of caustic soda, a pint of water, and as much Indian ink as you think fit for making a proper blackness.

Bottle wax.—A good kind of bottle wax or cement may be cheaply made as follows:—Put into an iron ladle half a pound of rosin, two ounces of bees' wax, and when melted over the fire, stir in Venetian red, lamp-black, or other colouring; and apply while hot. If kept for after use, melt with a candle as usual when applied.

Potato-starch.—Wash and peel a gallon of good potatoes, grate them into a pail of water, stir frequently, and then let them settle. On the following day the starch will be found at the bottom of the pail; when pour off the water, add fresh, stir as before, and let it subside a second time; when pour off the water, and dry the sediment in the sun or a slow oven. An excellent starch may also be made by setting in a cool place the water in which rice has been boiled (though not in a cloth), which will in twenty-four hours become a strong starch.

Potashes.—Settlers in the backwoods of America, or other woody regions, have an opportunity of manufacturing potashes, an article of great use and considerable value. A vast quantity of this substance is annually made in Canada, and exported to Great Britain. Potashes are made from the ashes of burnt trees. In burning timber to clear the land, the ashes are carefully preserved and put in barrels, or other vessels, with holes in the bottom; and water being poured over them, a liquid or alkali is run off; this ley being boiled in large boilers, the watery particles evaporate, and leave what is called black salts, a sort of residuum, which, when heated to a high degree, becomes fused, and finally, when cool, assumes the character of potash.

By these potashes the Canadians make their own soap; the ley of a barrel of ashes, boiled along with ten pounds of tallow, till it is of a proper consistence, produces about forty pounds of very good soft soap. It is related, that when the land has been covered with heavy timber of a hard nature, there is such a quantity of ashes produced that their value will pay for clearing the land.

Maple sugar.—In the woody districts of Canada, the inhabitants have it in their power to make sugar for domestic consumption as well as for exportation. This sugar is produced from the sap of the maple tree, one of the most valuable vegetable products of the American forests. An active farmer and his wife may make, it is said, about 700 lbs. of sugar annually, not inferior in quality to that of the West Indies, and worth about 4d. per pound. The manufacture of this native sugar greatly tends to lower the price of West India sugars, which would be otherwise as high as 1s. 6d. a pound. Talbot, in his "Five Years' Residence in the Canadas," writes with enthusiasm of the value and use of this manufacture, which it seems is far from being properly attended to by the settlers. "Maple sugar might be manufactured," says he, "by the rudest mountaineer in your country, as well in the first season after his arrival here, as by the most eminent sugar-refiner in Jamaica. The manufacture is generally commenced early in the month of April, when the sap of the tree is first put into motion at the return of spring, and when no other agricultural operation can be carried on to good purpose by the farmer, on account of the unpleasant weather which occurs at that period. A part of the estate is selected which contains the largest quantity of flourishing maple-trees nearly contiguous to each other, and a temporary hut is erected for the accommodation of the operators, but not more than two or three being required for the management of a hundred trees, from every one of which the sap is oozing out at the same time. In rainy weather, the trees yield their valuable juice rather tardily; and, during the whole month which is sometimes devoted to this employment, it often happens that only eight or nine days are propitious to this part of the settler's labours. The best weather for the purpose is that in which the night is frosty, and the day cheered by the rays of a warm sun. If the process of boiling were not continued both day and night, the sap would accumulate too rapidly in the reservoir, and soon evince symptoms of vinous fermentation, which would change its quality, and render it useless for the manufacture of sugar.

"The first thing necessary for commencing the manufacture of this article is a metal boiler, which costs in Upper Canada about £2 10s. sterling. This holds nearly thirty gallons, and, with a small cooking-pot, is sufficient, in a prosperous season, to boil down 500 lbs. One hundred and fifty troughs, eight reservoirs, and four hand-buckets, will be necessary for the regular supply of this boiler. The troughs cost about 16s. 3d. per hundred; the reservoirs, which are barrels without heads, about 4s. each; and the buckets 2s. 6d. each. These are the only utensils which an emigrant will need the troughs may be made by himself, if he has acquired any skill in the use of his axe during the preceding winter. An expert hand can make thirty or thirty-five troughs in a day, which, though formed only with the axe, will last for many years, if carefully placed under cover during summer. The t..es are tapped either by means of an incision made by an axe, or the perforation of an auger. But the latter mode is considered the less injurious to the growth of the tree, and is therefore the more approved plan. A small shoot about nine inches long is made the conductor of the sap from each incision to its respective trough, from which, when nearly full, it is conveyed in buckets to the reservoirs, and there allowed to subside. When the grosser particles of the sediment have been left to sink to the bottom, the sap is drawn off into the boilers, and reduced to molasses by the simple process of evaporation. The liquid in this purer state is then drawn from the boilers, and placed in the reservoirs or coolers, until it becomes nearly cold, when it is strained through a woollen cloth into a smaller boiler, and, after being clarified with eggs, milk, or bullock's blood, is boiled down to the consistency of sugar, and poured into moulds of the particular shape which it is intended to assume as a sort of candy; but if to be used as soft sugar, the syrup in its last stage of purification is left in a sugar-cask, which is perforated, to allow the moist particles, in the form of molasses, to ooze through the bottom. Many people neither clear nor strain the molasses, and consequently make very coarse and dirty sugar; but by a strict adherence to the simple directions which I have given, the most ignorant novice in the art might manufacture sugar equal to any that is imported into England. Some of it, indeed, has what is called 'a smack,' or peculiar taste, derived often from the kind of wood of which the troughs are made, and sometimes from being neglected while in the act of boiling, and suffered to burn. Every tree, on an average, will from a single wound yield about twenty gallons of sap, and a proportionate quantity from any number of incisions not exceeding four. Five gallons of sap contain at least one pound of sugar."

Dyes.—The most simple rule for dyeing is to put the dye into very hot water, and when well mixed, to pass the stuff through it until it sufficiently imbibes the colour, but on no account to squeeze it; it should then be hung up, and when cold, plunged twice into soft water, and then into hard water with a little alum dissolved in it; the stuff may then be again hung up, and when nearly dry, ironed or pressed. Most colours are made brighter by the addition of a little cream of tartar, and darker by pearl-ash. Dyes may be purchased ready prepared. We would recommend that all ordinary dyeing, and particularly when fancy or delicate colours are required, should be consigned to the hands of the professed dyer; and dyeing of a coarse kind only be done at home. In such cases, *brown* may be produced from a decoction of birch bark; and *black* from logwood with green copperas. (See article CHEMISTRY APPLIED TO THE ARTS.)

Temperance drinks.—The simplest beverage of a cooling and pleasing quality, which contains no intoxicating fluid, is *lemonade;* this may be very easily made by pouring boiling water on sliced lemons, and sweetening with sugar to taste. Lemons, however, are not always to be procured, and in such a case, citric acid, or cream of tartar, may be employed instead. Superior lemonade is made with lump sugar. *Ginger beer* may be made as follows:—Take of lump sugar 3 pounds, bruised ginger 2 ounces, cream of tartar 1 ounce, one or two lemons sliced, boiling water 4 gallons, and yeast 8 ounces. Let the whole stand to work in a cask for four days, and then bottle off for use.

Treacle beer is a cheap drink, which may be made as follows:—Boil as much water as will fill twelve common quart bottles; and to it add one pound of treacle, or more, according to taste. When the treacle is dissolved, take the pot from the fire, and let the solution cool. When lukewarm, put into it half a gill of yeast. As soon as it is cold, bottle it, but do not put in the corks till next morning, when the yeast will have wrought over the top of the bottles. Let it stand in a cool place for two or three days, when it will be fit for use. Unless care is taken as to the proportion of yeast and keeping cool, also to corking tightly, the bottles may burst, which is a serious loss to a poor family.

THE TOILET.

Personal cleaning and decoration are the proper duty at the toilet, which requires regular performance daily. We shall speak first of matters connected with the gentleman's toilet.

Shaving.—Some beards are more hard and difficult to shave than others. The usual plan is to soften them with soap lather, but this is not sufficient with beards which are somewhat stubborn. We recommend all to try the following plan: Rub the face or beard with a little soap and water with the hand over the basin, and when pretty well rubbed or softened, apply the lather. Raise the lather from warm water, and apply with a brush. The best kind of soap for shaving is Bandana, but Windsor is also generally liked. Although warm water is most agreeable and suitable for shaving with, it is advantageous for every one to accustom himself to shaving with cold water, as it will render him independent of assistance when travelling or in cases of emergency.

It is of no use going to great expense in purchasing razors. A razor of the best kind may be had for from five to eight shillings, and as their tempering is very much a matter of chance, sometimes a first-rate razor may be had for two or three shillings. Supposing a sharp and good razor to be procured, it may last a whole lifetime with ordinary care. We have used one for twenty years, and it is still as good as new. Some persons prefer keeping six or seven razors, and changing them daily, but in this there is no absolute utility. Razors become blunt more from bad management than fair work in shaving. When to be used, dip the razor in hot water, for this adds keenness to the edge; and before putting it away, wash the razor gently to remove all impurities. Do not wipe it with or upon paper, for that spoils the edge; w[illegible] it only with a fine rag. Before putting it away in its case, give it a turn or two on a strop. Several kinds of strops are [illegible] offered for sale; and all, very properly, are mounted [illegible]ard board. The best we have seen has several sides, [illegible]rent degrees of fineness; one being for use in taking out small bluntnesses or flattenings on the edge, called *setting*, and another for simple stropping. In any case, take care always to draw the razor smoothly and flatly *from heel to point* along the strop. Do not draw first one way and then push another. In general one or two turns will be enough. Never leave your razors in drawers or cases which are accessible to servants or children. By locking them up, you will keep them in better order than by all the other means you employ.

A cut in shaving.—The bleeding may be at once effectually stopped by placing on the wound a small portion of wool from a beaver hat. We have known cases in which bleeding from very serious wounds have been stopped by the application of hat stuff when all other means failed.

The teeth.—The cleaning and proper management of the teeth is the most difficult operation of the toilet. Whether arising from heat of the stomach or other caustitutional causes, the teeth of some persons are much more liable to become discoloured and decay than others. In general, even in the worst cases, much might be done in youth to prevent future deterioration of teeth; but children are ignorant, and parents are lamentably careless on this important matter of personal economy, and remedies often require to be applied when too late. Parents desirous of seeing their children grow up with good teeth, should cause them to be cleaned with scrupulous regularity daily, though only with a brush and tepid water. If the teeth appear crowded, so that there is a fear of one tooth shooting over another, a dentist ought by all means to be employed to thin the row, and allow all to grow straight.

The daily cleaning of the teeth should take place every morning after washing the face. Employ in preference tepid water and a moderately hard brush. Various dentifrices or powders are offered for sale, and which the opulent have opportunities of testing; but we know of none better than finely-powdered charcoal, that is, charred wood well ground in a mortar, and kept in a box secluded from the air. It may be purchased, ready for use, at a small price from perfumers. By putting a little of this on the wet brush, and rubbing the teeth with it, impurities and discolourations will be removed without injuring the enamel. Rinse well afterwards with clean water. A much more strong dentifrice consists of the powder of burnt tobacco; but it contains silica, or gritty particles of sand, and cannot be recommended for common use.

The nails.—Keeping the nails of the fingers in order is a proper duty of the toilet. They should be brushed with soap and water when washing the hands. While still wet, or when wiping the hands with the towel, push back the skin which is apt to grew over the nail, and thus keep the top of the nails neatly rounded. The points of the nails should be regularly pared once a week.

Stray hairs.—These sometimes grow in the nose and ears to an uncomfortable extent. Remove them smartly with a pair of tweezers.

Pomatum.—This is a soft unguent which is valuable for softening the hands, and preventing them chopping in cold dry weather, or for moistening the hair. It was originally named from its containing apple (*pomum*, Latin), and consisted of lard, rose-water, and the pulp of apples. It now consists of perfumed hog's-lard, the apple being omitted. The famed *sultana pomatum* is made as follows:—Melt together half a pound of beef suet, the same of bear's grease, an ounce of white-wax, and two ounces of olive oil; and add to it, tied up loosely in muslin, one ounce of bruised cloves, half an ounce of cinnamon, two bruised tonquin beans, and four grains of musk; strain and put into pots. The article called bear's grease, usually sold in the shops, is little else than perfumed beef-marrow; and the many oils offered for restoring and softening the hair are chiefly olive or almond oil, perfumed with different scents. In general, if the hair be well brushed, no such applications are necessary, and in most cases they create a scurf on the head which it requires considerable trouble to get rid of.

Pomade divine.—This is a soft and valuable unguent, possessing a fine aromatic odour. Dr. Biddoes recommends it to be made as follows:—Steep twelve ounces of beef-marrow in water ten days (changing the water occasionally), and then steep it in rose-water. Put it into a jar with half an ounce of flowers of benjamin, the same of storax and orris-root in powder, and two drachms each of cinnamon, nutmeg, and cloves, in powder. Cover the jar closely, set it in a vessel of water, and put it on the fire; and when the pomade is thus melted, strain it for use. As a very small quantity is ever used at a time, in general it will be found much more economical to buy a small bottle of it than to prepare the article.

Cold cream.—This is a simple and cooling ointment, exceedingly serviceable for rough or chopped hands in winter, or for keeping the skin soft. It is very easily made. Take half an ounce of white wax, and put it into a small basin, with two ounces of almond oil. Place the basin by the side of the fire till the wax is dissolved in the oil. When quite melted, add two ounces of rose-water. This must be done very slowly, little by little; and as you pour it in, beat the mixture smartly with a fork to make the water incorporate. When all is incorporated, the cold cream is complete, and you may pour it into jars for future use. This cold cream is much better than that which is usually sold in shops, and which is too frequently made of inferior ingredients.

Spermaceti ointment.—This is a cooling and healing ointment for wounds. Take a quarter of an ounce of white wax and half an ounce of spermaceti (which is a hard white material), and put them in a small basin with two ounces of almond oil. Place the basin by the side of the fire till the wax and spermaceti are dissolved. When cold, the ointment is ready for use. This is an article which it is also much better to make than to purchase. When you make it yourself, you will know that it has no irritating or inferior materials in it

The feet—corns.—To keep the feet in a proper condition, they should be frequently soaked and well washed. At these times, the nails of the toes should be pared and prevented from growing into the flesh. Corns are the most troublesome evils connected with the feet. They are of two kinds—soft and hard. The soft corns are those which grow between the toes. They may be easily removed by applying ivy leaf steeped in vinegar; if the corn be very painful, change the piece of ivy leaf every morning. The leaf may be steeped for one or two days before using. Hard corns, which grow on the outside of the toes, are caused by friction from the shoes, and we know of nothing so likely to prevent them as easy soft shoes and very frequent soaking of the feet in warm water. Every method of extracting corns seems but to afford temporary relief, and never will be attended with complete success unless attention is paid to the shoes. It is very dangerous to cut corns too deep, on account of the multiplicity of nerves running in every direction of the toes. The *bunion*, or swelling on the ball of the great toe, is produced by the same cause as the corn—pressure and irritation by friction. The treatment recommended for corns will succeed in cases of bunions; but in consequence of the greater extension of the disease, the cure of course is more tedious. When a bunion is commencing, it may be effectually stopped by poulticing, and then opening with a lancet; but this must be committed to the hands of a surgical attendant.

Cosmetics.—These consist of washes and pastes for improving the skin, and are in general highly objectionable; for the greater number contain poisonous ingredients, and while removing from the surface any discolouration, drive the disease inward, and therefore do much more harm than good. Lotions for pimples, freckle washes, milk of roses, rouge, and all such trash, we studiously discommend. The best purifier is water with a cloth; the best beautifiers are *health*, *exercise*, and GOOD TEMPER.

PROVERBS AND OLD SAYINGS.

SCRIPTURAL PROVERBS.

A FALSE balance is an abomination to the Lord; but a just weight is his delight.

A fool uttereth all his mind; but a wise man keepeth it till afterwards.

A fool's wrath is presently known; but a prudent man covereth shame.

A good name is rather to be chosen than great riches, and loving favour rather than silver and gold.

A man that has friends must show himself friendly; and there is a friend that sticketh closer than a brother.

A man of understanding holdeth his peace.

A man's pride shall bring him low; but honour shall uphold the humble in spirit.

A merry heart doeth good like a medicine; but a broken spirit drieth the bones.

A righteous man regardeth the life of his beast; but the tender mercies of the wicked are cruel.

A soft answer turneth away wrath; but grievous words stir up anger.

A virtuous woman is a crown to her husband; but she that maketh ashamed is as rottenness in his bones.

A wise son maketh a glad father; but a foolish son is the heaviness of his mother.

A word fitly spoken is like apples of gold in pictures of silver.

As a bird that wandereth from her nest, so is a man that wandereth from his place.

As a dog returneth to his vomit, so a fool returneth to his folly.

As a jewel of gold on a swine's snout, so is a fair woman who is without discretion.

As a madman who casteth firebrands, arrows, and death, so is the man that deceiveth his neighbour, and saith, Am not I in sport?

As the crackling of thorns under a pot, so is the laughter of a fool.

As the whirlwind passeth, so is the wicked no more; but the righteous is an everlasting foundation.

As vinegar to the teeth, and as smoke to the eyes, so is the sluggard to them that send him.

Be thou diligent to know the state of thy flocks, and look well to thy herds; for riches are not for ever.

Before honour is humility.

Better is a dry morsel and quietness therewith, than a house full of sacrifices with strife.

Better is a dinner of herbs where love is, than a stalled ox and hatred therewith.

Better is a little with righteousness, than great revenues without right.

Blessings are upon the head of the just; but violence covereth the mouth of the wicked.

Boast not thyself of to-morrow; for thou knowest not what a day may bring forth.

By much slothfulness the building decayeth; and through idleness of the hands, the house droppeth through.

By pride cometh contention.

Cast thy bread upon the waters, for thou shalt find it after many days.

Even a fool, when he holdeth his peace, is counted wise; and he that shutteth his lips is esteemed a man of understanding.

Faithful are the wounds of a friend; but the kisses of an enemy are deceitful.

Favour is deceitful, and beauty is vain; but a woman that feareth the Lord she shall be praised.

Fear God, and keep his commandments; for this is the whole duty of man

For men to search their own glory* is not glory

Go from the presence of a foolish man, when thou perceivest not in him the lips of knowledge.

Go to the ant, thou sluggard; consider her ways and be wise.

God hath made man upright, but they have sought out many inventions.

He becometh poor that dealeth with a slack hand; but the hand of the diligent maketh rich.

He that observeth the wind shall not sow, and he that regardeth the clouds shall not reap.

He that passeth by, and meddleth with strife belonging not to him, is like one that taketh a dog by the ears.

He that is slow to anger is better than the mighty, and he that ruleth his spirit than he that taketh a city.

He that loveth pleasure shall be a poor man: he that loveth wine and oil shall not be rich.

He that is greedy of gain troubleth his own house; but he that hateth gifts shall live.

He that is of a merry heart hath a continual feast.

He that is first in his own cause seemeth just; but his neighbour cometh and searcheth him.

He that hath pity upon the poor lendeth unto the Lord; and that which he hath given will he pay him again.

He that hideth hatred with lying lips, and he that uttereth a slander, is a fool.

He that spareth the rod hateth his son; but he that loveth him chasteneth betimes.

He that gathereth in summer is a wise son; but he that sleepeth in harvest is a son that causes shame.

He that walketh uprightly walketh surely; but he that perverteth his ways shall be known.

He that is surety for a stranger, shall smart for it; and he that hateth suretiship is sure.

He that keepeth [silent] his mouth, keepeth his life; but he that openeth wide his lips shall have destruction.

He that troubleth his own house shall inherit the wind; and the fool shall be servant of the wise of heart.

Heaviness in the heart of a man maketh it stoop; but a good word maketh it glad.

Hell and destruction are never full; so the eyes of man are never satisfied.

His own iniquities shall take the wicked himself, and he shall be holden with the cords of his own sins.

Hope deferred maketh the heart sick.

If sinners entice thee, consent thou not.

If the iron be blunt, and he do not whet the edge, then must he put to more strength; but wisdom is profitable to direct.†

If thine enemy be hungry, give him bread to eat; and if he be thirsty, give him water to drink: for thou shalt heap coals of fire upon his head, and the Lord shall reward thee.

If thou faint in the day of adversity, thy strength is small.

If ye cast pearls before swine, they will turn again and rend ye.

In all labour there is profit; but the talk of the lips tendeth only to penury.

Iron sharpeneth iron; so a man sharpeneth the countenance of his friend.

It is nought, it is nought, saith the buyer; but when he is gone his way, then he boasteth.

It is better to dwell in a corner of the house-top, than with a brawling woman in a wide house.

Let another man praise thee, and not thine own mouth; a stranger, and not thine own lips.

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* To talk of their own doings.
† Knowledge is power.—*Bacon.*

Love not sleep, lest thou come to poverty: open thine eyes, and thou shalt be satisfied with bread.

Much food is in the tillage of the poor; but there is that is destroyed for want of judgment.

Of making many books there is no end; and much study is a weariness of the flesh.

Pride goeth before destruction, and a haughty spirit before a fall.

Remove not the old land-mark; and enter not into the fields of the fatherless.

Reprove not a scorner lest he hate thee; rebuke a wise man and he will love thee.

Righteousness exalteth a nation; but sin is a reproach to any people.

Say not unto thy neighbour, Go, and come again, and to-morrow I will give, when thou hast it by thee.

Seest thou a man diligent in his business, he shall stand before kings; he shall not stand before mean men.*

Seest thou a man that is hasty in his words: there is more hope of a fool than of him.

Strive not with a man without cause, if he have done thee no harm.

The blessing of the Lord, it maketh rich, and he addeth no sorrow with it.

The curse causeless shall not come.

The drunkard and the glutton shall come to poverty: and drowsiness shall clothe a man with rags.

The hand of the diligent shall bear rule; but the slothful shall be under tribute.

The labour of the righteous tendeth to life, the fruit of the wicked to sin.

The memory of the just is blessed; but the name of the wicked shall rot.

The race is not to the swift, nor the battle to the strong.

The rich man is wise in his own conceit; but the poor that hath understanding searcheth him out.

The rich man's wealth is his strong city; the destruction of the poor is their poverty.

The rich ruleth over the poor; and the borrower is servant to the lender.

The simple believeth every word; but the prudent man looketh well to his going.

The sleep of the labouring man is sweet, whether he eat little or much; but the abundance of the rich will not suffer him to sleep.

The sluggard will not plough by reason of the cold; therefore shall he beg in harvest, and have nothing.

The slothful man saith, There is a lion without; I shall be slain in the streets.

The poor is hated even of his neighbour; but the rich hath many friends.

The profit of the earth is for all: the king himself is served by the field.

The upright shall dwell in the land, and the perfect shall remain in it. But the wicked shall be cut off from the earth, and the transgressors shall be rooted out of it.

The wicked flee when no man pursueth;† but the righteous are bold as a lion.

The wise shall inherit glory; but shame shall be the promotion of fools.

There is that maketh himself rich, yet hath nothing; there is that maketh himself poor, yet hath great riches.

There is that scattereth, and yet increaseth; and there is that withholdeth more than is meet, but it tendeth to poverty.

To all the living there [illegible]: a living dog is better than a dead lion.

Train up a child [illegible] he should go, and when he is old he will [illegible] from it.

* Anciently, in the [illegible] was an honour to be permitted to *stand* in the presence of king[illegible] it is to *sit* before them in our own country.

† Conscience makes cowards [illegible] all.—*Shakspeare.*

Treasures of wickedness profit nothing; but righteousness delivereth from death.

Wealth maketh many friends; but the poor is separated from his neighbour.

Whatsoever thy hand findeth to do, do it with thy might, for there is no work, nor device, nor knowledge, nor wisdom in the grave, whither thou goest.

When goods increase, they are increased that eat them, and what good is there to the owners thereof, saving the beholding of them with their eyes.

Where no counsel is, the people fall; but in the multitude of counsellors there is safety.

Where no wood is, then the fire goeth out; so where there is no tale-bearer, the strife ceaseth.

When pride cometh, then cometh shame; but with the lowly is wisdom.

Who can find a virtuous woman? for her price is far above rubies.

Whoso findeth a wife findeth a good thing, and obtaineth favour of the Lord.

Wine is a mocker, strong drink is raging; and whosoever is deceived thereby is not wise.

Withdraw thy foot from thy neighbour's house, lest he be weary of thee, and so hate thee.

Withhold not good from them to whom it is due, when it is in the power of thine hand to do it.

Yet a little sleep, a little slumber, a little folding of the hands to sleep: so shall thy poverty come as one that travelleth, and thy want as an armed man.

ENGLISH PROVERBS.

A bad workman quarrels with his tools.
A bird in the hand is worth two in a bush.
A happy heart makes a blooming visage.
Absence cools moderate passions, and inflames violent ones.
A burden which one chooses is not felt.
A cat may look at a king.
Aching teeth are ill tenants.
A chip of the old block.
A clear conscience fears no accusation.
A contented mind is a continual feast.
A creaking door hangs long on the hinges.
A day after the feast.
A drowning man will catch at a straw.
Adversity flattereth no man.
A fat kitchen makes a lean will.
A fault confessed is half redressed.
A fool and his money are soon parted.
A fool can make money; it requires a wise man to spend it.
A fool may give a wise man counsel.
A fool's bolt is soon shot.
After death the doctor.
After dinner sit a while, after supper walk a mile.
After meat, mustard.
A friend in need is a friend indeed.
A full purse never lacks friends.
A gentleman without a living is like a pudding without suet.
A good layer-up is a good layer-out.
A good maxim is never out of season.
A good name keeps its lustre in the dark.
A good servant [illegible] a good master.
A good word is [illegible] soon said as an ill one.
A goose cannot graze after him.
A great dowry is a bed full of troubles.
Agues come on horseback, but go away on foot.
A guilty conscience needs no accuser.
A hair of the dog that bit him.
A handful of good life is better than a bushel of learning.
A hungry man's an angry man.
A king's favour is no inheritance.
A libertine's life is not a life of liberty.

A lie has no legs, but scandal has wings.
A light-heeled mother makes a heavy-heeled daughter.
A light purse is a heavy curse.
A little body doth often harbour a great soul.
A little leak will sink a great ship.
A little pot is soon hot.
All are not friends that speak us fair.
All are not hunters that blow the horn.
All are not thieves that dogs bark at.
All feet tread not in one shoe.
All gone to sixes and sevens [confusion and ruin].
All is fish that comes to the net.
All is not gain that is got into the purse.
All is not gold that glitters.
All lay load on the willing horse.
All the honesty is in the parting.
All the fat's in the fire.
All things are soon prepared in a well-ordered house.
All work and no play makes Jack a dull boy.
Almost and very nigh, save many a lie.
Always put the saddle on the right horse.
A man forewarned is forearmed.
A man may buy gold too dear.
A man may cause his own dog to bite him.
A man may hold his tongue in an ill time.
A man may lose his goods for want of demanding them.
A man must ask his wife leave to thrive.
A man never surfeits of too much honesty.
A man without reason is a beast in season.
A miss is as good as a mile.
An apple, an egg, and a nut, you may eat after a slut.
An empty purse fills the face with wrinkles.
An evil lesson is soon learned.
Anger dieth quickly with a good man.
An honest man's word is as good as his bond.
An hour in the morning is worth two in the afternoon.
A nice wife and a backdoor often make a rich man poor.
An idle brain is the devil's workshop.
An oak is not felled with one blow.
An obedient wife commands her husband.
A nod from a lord is a breakfast for a fool.
An old knave is no babe.
An old sack asketh much patching.
An ounce of mother-wit is worth a pound of clergy.
Antiquity is not always a mark of verity.
An unlawful oath is better broke than kept.
Any thing for a quiet life.
A penny saved is a penny earned.
A pin a day is a groat a year.
A pitcher goes often to the well, but is broken at last.
A quiet conscience sleeps in thunder.
A quiet tongue shows a wise head.
A rolling stone gathers no moss.
A rotten apple injures its companions.
A rotten sheep infects the whole flock.
A single fact is worth a ship-load of argument.
A small pack becomes a small pedlar.
A small spark makes a great fire.
A smart reproof is better than smooth deceit.
A spur in the head is worth two in the heel.
As the bell is, so is the clapper.
As the crow is, the egg will be.
As the fool thinks, the bell clinks.
As the old cock crows, the young cock learns.
A stitch in time saves nine.
As welcome as flowers in May.
As you make your bed, so must you lie on it.
As you sow, so you shall reap.
A tree is known by its fruit.
A wager is a fool's argument.
A wilful man will have his way.
A willing mind makes a light foot.
A word before is worth two behind
Aye be as merry as you can.

Bachelors' wives and maids' children are always well taught.
Beauty is a blossom.
Beauty is no inheritance.
Before thou marry, be sure of a house wherein to tarry.
Beggars have no right to be choosers.
Be it for better, or be it for worse, be ruled by him that beareth the purse.
Be not too hasty to outbid another.
Be slow to promise, and quick to perform.
Better do it than wish it done.
Better go about than fall into the ditch.
Better known than trusted.
Better late than never.
Better ride on an ass that carries me, than a horse that throws me.
Better to be alone than in bad company.
Better to be beaten than to be in bad company.
Better to bend than to break.
Better to go to bed supperless than to rise in debt.
Between two stools we come to the ground.
Birds of a feather flock together.
Birth is much, but breeding is more.
Borrowed garments never fit well.
Brag is a good dog but Holdfast is better.
Bread at pleasure, drink by measure.
Brevity is the soul of wit.
Building and marrying of children are great wasters.
Burning the candle at both ends.
Business is the salt of life.
Buy at a market, but sell at home.
By others' faults wise men correct their own.
"Can do" is easily carried.
Care killed a cat.
Carrying coals to Newcastle.
Catch not at the shadow, and lose the substance.
Catch the bear before you sell his skin.
Change of fortune is the lot of life.
Charity begins at home, but does not end there.
Cheating play never thrives.
Children and chickens must be always picking.
Children are uncertain comforts.
Children suck the mother when they are young, and the father when they are old.
Climb not too high, lest the fall be the greater.
Confession of a fault makes half amends for it.
Confine your tongue, lest it confine you.
Conscience is never dilatory in her warnings.
Conscience is the chamber of justice.
Constant occupation prevents temptation.
Content is the true philosophers' stone.
Contentment to the mind is as light to the eye.
Conviviality should ever be free from intemperance.
Courtesy on one side never lasts long.
Covet not that which belongs to others.
Craft bringeth nothing home.
Custom is a second nature.
Cut and come again.
Cut your coat according to your cloth.
Daub yourself with honey, and you will have plenty of flies.
Death is deaf and hears no denial.
Death keeps no calendar.
Debt is the worst kind of poverty.
Deeds are fruits, words are but leaves.
Deep rivers move with silent majesty, shallow brooks are noisy.
Defer not till the evening what the morning may accomplish.
Delays are dangerous.
Deliberate slowly, execute promptly.
Depend not on fortune, but on conduct.
Dependence is a poor trade to follow.
Deride not any man's infirmities.

Desires are nourished by delays.
Deserve success, and you shall command it.
Despise none, despair of none.
Diligence is the mistress of success.
Diseases are the interests paid for pleasures.
Do as the most do, and fewest will speak evil of you.*
Do as you would be done by.
Dogs wag their tails not so much in love to you as to your bread.
Doing nothing is doing ill.
Do not burn daylight upon it.
Do not halloo till you are out of the wood.
Do not make fish of one and flesh of another.
Do not rip up old sores.
Do not spur a free horse.
Do not throw your opinions in everybody's teeth.
Don't be all your days trotting on a cabbage leaf.
Don't buy a pig in a poke.
Don't measure other people's corn by your bushel.
Don't neglect to feather your nest.
Don't run away with more than you can carry.
Don't value a gem by what it is set in.
Do what thou oughtest, and come what can.
Down with the dust [pay the money].
Drunkenness is a pair of spectacles to see the devil and all his works.
Drunkenness reduces a man below the standard of a brute.
Eagles fly alone, but sheep flock together.

Early to bed, and early to rise,
Makes a man healthy, wealthy and wise.

Eat what you like, but pocket nothing.
Empty vessels make the greatest sound.
Enough is as good as a feast.
Entertain honour with humility, and poverty with patience.
Evening oats are good morning's fodder.
Ever drunk ever dry.
Ever spare and ever have.
Every bean hath its black.
Every dog has his day.
Everybody's business is nobody's business.
Every couple is not a pair.
Every herring must hang by its own head.
Every Jack has his Jill.
Every man is the architect of his own fortune.
Every one for himself, and God for us all.
Every one puts his fault on the times.
Every one to their liking, as the old woman said when she kissed her cow.
Every path hath a puddle.
Every shoe fits not every foot.
Every thing hath an end, and a pudding hath two.
Every thing is good in its season.
Every thing is the worse for wearing.
Example teaches more than precept.
Experience is the mother of science.
Experience teaches fools.
Evil communications corrupt good manners.
Evil gotten evil spent.
Faint heart never won fair lady.
Fair and softly go far in a day.
Fair words make fools fain.
Fall not out with a friend for a trifle.
False friends are worse than open enemies.
Fancy may bolt bran and think it flour.
Far-fetched and dear-bought is good for ladies.
Fat paunches make lean pates.
Fat sorrow is better than lean sorrow.
Few take care to live well, but many to live long.
Fiddler's fare—meat, drink, and money.
Fine feathers make fine birds.
Fine words butter no parsnips.

* In most cases this would be a bad advice.

Fire and water are good servants, but bad masters.
Fire is not to be quenched with tow
First deserve and then desire.
Fly pleasure, and it will follow thee.
Fools make feasts, and wise men eat them.
Fools should never see half-done work.
Fools tie knots, and wise men loose them.
Fools will be meddling.
Forbearance is no acquittance.
Forgive and forget.
Forgive any sooner than thyself.
Fortune favours the brave.
Fortune has no power over discretion.
Fortune knocks once at least at every man's gate.
For want of company, welcome trumpery.
From fame to infamy is a beaten road.
Gather thistles, except prickles.
Gentry sent to market will not buy one bushel of corn.
Get thy spindle and distaff ready, and God will send flax.
Give a dog an ill name and hang him.
Give a rogue rope enough, and he will hang himself.
Give it plenty of elbow grease [hard rubbing].
Give the devil his due.
God help the rich, the poor can beg.
God helps those who help themselves.
God send you more wit, and me more money.
God tempers the wind to the shorn lamb.
Go farther and fare worse.
Good counsel is above all price.
Good harvests make men prodigal, bad ones provident.
Good to be merry at meat.
Good ware makes quick markets.
Good wine needs no bush.
Good words cost nothing, but are worth much.
Goods are not theirs who enjoy them.
Gossipping and lying go hand in hand.
Grasp all, lose all.
Great barkers are no biters.
Great cry and little wool.
Great gain and little pain make a man soon weary.
Half a loaf is better than no bread.
Handsome is that handsome does.
Happy is he whose friends were born before him.
Happy is he who knows his follies in his youth.
Happy is the wooing that is not long in doing.
Harm watch, harm catch.
Hasty resolutions seldom speed well.
Have not thy cloak to make when it begins to rain.
Hear twice before you speak once.
He dances well to whom fortune pipes.
He doubles his gift who gives in time.
He fights with his own shadow.
He giveth twice that gives in a trice.
He has a bee in his bonnet.
He has brought his noble to ninepence.
He has had a bite upon his bridle.
He is a wise man who speaks little.
He is proper that hath proper conditions.
He knows not a B from a bull's foot.
He knows not a hawk from a hand-saw.
He lacks most that longs most.
Hell is paved with good intentions.
Help the lame dog over the stile.
He liveth long that liveth well.
He'll find some hole to creep out at.
He loses nothing for the asking.
He loseth his thanks who [illegible]eth and delayeth.
He loseth nothing that [illegible] for his friend.
He loves roast meat well that [illegible] the spit.
He may well be contented who needs neither borrow nor flatter.
He must needs run whom the devil drives.
He must stoop that hath a low door.
He plays well that wins

He's a Jack in office.
He's gone upon a sleeveless errand.
He that always complains is never pitied.
He that blows in the dust fills his eyes.
He that falls in an evil cause, falls in the devil's frying-pan.
He that goes a-borrowing goes a-sorrowing.
He that has no shame has no conscience.
He that has no silver in his purse should have silver on his tongue.
He that hath a good harvest may be content with some thistles.
He that is angry is seldom at ease.
He that is warm thinks all are so.
He that lendeth loseth double. [Loses both his money and his friend.]
He that licks honey from thorns pays too dear for it.
He that lies down with dogs, must expect to rise with fleas.
He that lives not well one year sorrows for it seven.
He that liveth wickedly can hardly die honestly.
He that reckons without his host must reckon again.
He that runs fast will not run long.
He that runs in the night stumbles.
He that sows not corn plants thistles
He that stays in the valley will never get over the hill.
He that will not be saved needs no preacher.
He that will not be counselled cannot be helped.
He that will steal an egg will steal an ox.
He that would thrive must rise at five, he that has thriven may lie till seven.
He was born with a silver spoon in his mouth.
He who is hasty fishes in an empty pond.
He who knows himself best esteems himself least.
He who lies long in bed his estate feels it.
He who marrieth for wealth doth sell his liberty.
He who rises late never does a good day's work.
He who runs after a shadow has a wearisome race.
He who sows brambles must not go barefoot.
He who spends all he gets is in the highroad to beggary.
He who swims in sin will sink in sorrow.
He who would catch fish must not mind getting wet.
He who would reap well must sow well.
Hiders are good finders.
His bread is buttered on both sides.
His eye is bigger than his belly.
His tongue's no slander.
Home is home though it be ever so homely.
Hope is a good breakfast but a bad supper.
Hot love is soon cold.
Hot sup, hot swallow.
Humility is the foundation of all virtue.
Hunger is the best sauce.
Hungry dogs eat dirty puddings.
I can see as far into a millstone as the picker.
Idle folks have the most labour.
Idle folks have the least leisure.
Idleness is the greatest prodigality.
Idleness is the parent of want and shame.
Idleness is the root of all evil.
Idleness is the sepulchre of a living man.
If every one would mend one all would be amended.
If the brain sows not corn, it plants thistles.
If the cap fit, wear it.
If the mountain will not come to Mahomet, Mahomet must go to the mountain.
If things were to be done twice all would be wise.
If we subdue not our passions they will subdue us.
If wishes were horses, beggars would ride.
If you give an inch, he will take an ell.
If you have too many irons in the fire, some of them will burn.
If you would enjoy the fruit, pluck not the flower.
Ignorance is the parent of many injuries.
I have a crow to pluck with him.
I have lived too near a wood to be frightened by owls.
I have other fish to fry.
I'll trust him no farther than I can fling him.
Ill examples are like contagious diseases.
Ill gotten goods seldom prosper.
Ill news travel apace.
Ill wedding and ill wintering tame both man and beast.
Ill weeds grow apace.
In a calm sea every man is a pilot.
In at one ear and out at the other.
In vain he craves advice that will not follow it.
Inconstancy is the attendant of a weak mind.
It costs more to revenge injuries than to bear them.
It cuts both ways, like a two-edged sword.
It is a bad horse that refuses to carry his provender.
It is a long road that has no turning.
It is an ill wind that blows nobody good.
It is better to do well, than to say well.
It is good to begin well, but better to end well.
It is less painful to learn in youth than to be ignorant in age.
It is never too late to learn.
It is no small conquest to overcome yourself.
It is not the cowl that maketh the friar.
It's a bad cause that none dare speak in.
It's a bad sack will abide no clouting.
It's a good horse that never stumbles.
It's a poor sport that's not worth the candle.
It's a sad heart that never rejoices.
It's a wise child that knows its own father.
It's an ill procession where the devil holds the candle
It's easy to bowl down hill.
It's ill healing an old sore.
It's ill shaving against the wool.
It's merry in the hall when beards wag all.
It's more painful to do nothing than something.
It's not the gay coat makes the gentleman.
It's possible for a ram to kill a butcher.
It's wit to pick a lock and steal a horse, but wisdom to let them alone.
Jack Nokes and Tom Stiles.
Jack of all trades and master of none.
Jesting lies bring serious sorrows.
Judge not of a ship as she lies on the stocks.
Judge not of men or things at first sight.
Keep a thing seven years, and you will find a use for it.
Keep counsel thyself first.
Keep good men company, and you sh[illegible] of the number.
Keep no more cats than will catch mice.
Keep the bowels open, the head cool, and the feet warm and a fig for physicians.
Keep thy shop, and thy shop will keep thee.
Keep your tongue within your teeth.
Kill two birds with one stone.
Kindness is lost upon an ungrateful man.
Kindnesses, like grain, increase by sowing.
Kissing goes by favour.
Knavery may serve a turn, but honesty is best in the end.
Land was never lost for want of an heir.
Lazy folks take the most pains.
Least said is soonest mended.
Lend thy horse and thou mayest have back his skin.
Let every pedlar carry his own burden.
Let every tub stand on its own bottom.
Let not your tongue cut your throat.
Let sleeping dogs lie.
Let the cobbler stick to his last.
Let them laugh that win.
Life is half spent before we know what it is.
Life without a friend is death without a witness.
Light come, light go.
Lips however rosy must be fed.
Little and often fills the purse.

Little boats must keep near shore
Little pitchers have great ears.
Little sticks kindle the fire, but great ones put it out.
Live and let live.
Live not to eat, but eat to live.
Lowly set, richly worn.
Lock the stable door when the steed is stolen.
Long looked-for comes at last.
Look before you leap.
Look to the main chance.
Look twice ere you determine once.
Lookers-on see more than players.
Losers are always in the wrong.
Love asks faith, and faith asks firmness.
Love me, love my dog.
Lovers live by love as larks by leeks. [Ironical.]
Lucky men need little counsel.
Make a virtue of necessity.
Make hay while the sun shines.
Make not your sail too large for your ship.
Make the best of a bad bargain.
Making [illegible] a pleasure.
Man doth what he can, and God what he will.
Man proposes, God disposes.
Manners often make fortunes.
Many a slip betwixt the cup and the lip.
Many a true word is spoken in jest.
Many can pack the cards that cannot play.
Many go out for wool and come home shorn.
Many hands make light work.
Many words will not fill the bushel.
Marry in haste, and repent at leisure.
Marry your sons when you will, your daughters when you can.
Mills and wives are ever wanting.
Mischiefs come by the pound and go away by the ounce.
Misfortunes seldom come alone.
Misreckoning is no payment.
Modesty is the handmaid of virtue.
Money makes the mare to go.
Money will do more than my Lord's letter.
More afraid than hurt.
Much is expected where much is given.
Much water goes by the mill the miller knows not of.
Much would have more and lost all.
Muffled cats are bad mousers.
Murder will out.

My son is my son till he gets him a wife,
But my daughter's my daughter all the days of her life.

Necessity is the mother of invention.
Neither praise nor dispraise thyself; thine actions serve the turn.
Never carry two faces under one hood.
Never fall out with your bread and butter.
Never find any thing before it is lost.
Never fish in troubled waters.
Never light your candle at both ends.
Never look a gift horse in the mouth.
Never make a mountain of a mole-hill.
Never quit certainty for hope.
Never ride a free horse to death.
Never sound the trumpet of your own praise.
Never split against the grain.
Never tread on a sore toe.
Never trust to a broken staff.
Never venture out of your depth till you can swim.
Never wade in unknown waters.
New brooms sweep clean.
New lights often come through cracks in the tiling
New lords, new laws.
Next to love, quietness.
No alchemy is equal to saving.
No man can serve two masters.
No man should live like a toad under a harrow
No mill, no meal.
None are so deaf as those that will not hear.
None knows the weight of another's burden.
None so blind as those who will not see.
No pot is so ugly as not to find a cover.
No receiver, no thief.
No rose without a thorn.
Nothing comes out of the sack but what was in it.
Nothing dries sooner than tears.
Nothing down, nothing up.
Nothing is impossible to a willing mind.
Nothing venture, nothing win.
Of all studies, study your present condition.
Of all the crafts, to be an honest man is the master craft.
Of all prodigality, that of time is the worst.
Of two evils choose the least.
Old bees yield no honey.
Old birds are not to be caught with chaff.
Old friends and old wines are best.
Old friends to meet, old wine to drink, and old wood to burn.
Old reckonings breed new disputes.
One bad example spoils many good precepts.
One barber shaves not so close but another finds work
One eye-witness is better than ten hearsays.
One flower makes no garland.
One good turn deserves another.
One half the world knows not how the other half lives.
One hour's sleep before midnight is worth two after.
One is not so soon healed as hurt.
One man may steal a horse, when another may not look over the hedge.
One man's meat is another's poison.
One nail drives out another.
One never loses by doing a good turn.
One ounce of discretion is worth a pound of wit.
One scabbed sheep will mar a flock.
One swallow makes not a spring, nor one woodcock a winter.
One tale is good till another is told.
Open rebuke is better than secret hatred.
Opportunity makes the thief.
Opportunities neglected are irrecoverable.
Our own opinion is never wrong.
Out of debt, out of danger.
Out of sight, out of mind.
Out of the frying-pan into the fire.
Passion is a fever that leaves us weaker than it finds us.
Passion is ever the enemy of truth.
Patience and time run through the longest day.
Patience is a flower that grows not in every one's garden.
Patience is a plaster for all sores.
Pay as you go.
Penny wise and pound foolish.
People who live in glass houses should never throw stones.
Perfection is the point at which all should aim.
Petulent contentions engender malice.
Plain dealing's a jewel.
Positive men are most often in error.
Possession is nine points of the law.
Poverty makes a man acquainted with strange bedfellows.
Poverty parts friends.
Praise a fair day at night.
Praise the sea but keep on land.
Prevention is better than cure.
Prettiness dies quickly.
Pride of heart foreruns destruction.
Pride will have a fall.
Procrastination is the thief of time.
Promise little and do much.
Promises are too much like pie-crust.
Provide for the worst, the best will save itself.
Pry not into the affairs of others.

Pull hair and hair, and you'll make the carle bald.
Put no faith in tale-bearers.
Quick at meat quick at work.
Quick resentments are often fatal.
Quick returns make rich merchants.
Quit not certainty for hope.
Raise no more spirits than you can conjure down
Ratify promises by performances.
Ready money will away.
Reckless youth makes rueful age.
Remove an old tree and it will wither.
Rome was not built in a day.
Rule the appetite and temper the tongue.
Safe bind, safe find.
Sauce for the goose is sauce for the gander.
Saving at the spigot and spending at the bung.
Say no ill of the year till it be past.
Saying and doing are two things.
Search others for their virtues, thyself for their faults
See a beggar and catch a louse.
Seeing is believing.
Seek till you find, and you'll not lose your labour.
Seldom seen, soon forgotten.
Self-preservation is the first law of nature.
Set a thief to take a thief.
Shameless craving must have shameless way.
Sharp stomachs make short graces.
She shows many more airs than graces.
Show me a liar, and I will show you a thief.
Short reckonings make long friends.
Silence does seldom any harm.
Silks and satins put out the fire in the kitchen.
Sit in your place and none will make you rise.
Sleep without supper and wake without owing.
Sloth is the mother of poverty.
Soldiers in peace are like chimneys in summer.
Soon ripe, soon rotten.
Soon well, long ill.
Sooner said than done.
Sorrow will pay no debt.
Sour grapes, as the fox said when he could not reach them.
Spare well and spend well.
Spare when you are young, and spend when you are old.
Speak the truth and shame the devil.
Speech is the gift of all, but thought of few.
Stars are not seen by sunshine.
Stick your opinions on no person's sleeve.
Stretch your legs according to your coverlet.
Strike while the iron is hot.
Study to be worthy of your parents.
Such a welcome, such a farewell.
Such as the tree is such is the fruit.
Take care of the pence, and the pounds will take care of themselves.
Take heed of an ox before, an ass behind, and a knave on all sides.
Take heed will surely speed.
Take the will for the deed.
Take time by the forelock.
Talk of the devil and he'll appear.
Talking pays no toll.
Tell me the company you keep, and I'll tell you what you are.
Temperance is the best physic.
That is well spoken that is well taken.
That penny is well spent that saves a groat.
That's placing the cart before the horse.
That was laid on with a trowel.
The absent party is still faulty.
The ass that brays most eats least.
The best physicians are Dr. Diet, Dr. Quiet, and Dr Merryman.
The better day the better deed.
The blind man's wife needs no painting.
The cobbler's wife is the worst shod.
The comforter's head never aches.
The covetous man is his own tormentor
The crow thinks her own bird the fairest.
The devil is not as black as he is painted.
The devil was sick, the devil a monk would be;
The devil grew well, the devil a monk was he.
The end of a feast is better than the beginning of a fray.
The eye of the master does more work than both his hands.
The farthest way about is often the nearest way home.
The faulty stands on his guard.
The formost dog catches the hare.
The galled jade will wince.
The goodness of a pudding is known in the eating.
The gray mare is the better horse.
The greatest burdens are not the gainfullest.
The greatest strokes make not the best music.
The greatest wealth is contentment with little.
The groat is ill saved that shames the master.
The guilty mind needs no accuser.
The handsomest flower is not the sweetest.
The hasty hand catches frogs for fish.
The hastiest man that is must wait while his drink is drawing.
The highway is never about.
The highest branch is not the safest roost.
The hotter war the sooner peace.
The last drop makes the cup run over.
The last suitor wins the maid.
The lion's skin is never cheap.
The longest day must have an end.
The market is the best garden.
The married man must turn his staff into a stake.
The mill cannot grind with the water that is past.
The mob has many heads but no brains.
The more noble the more humble.
The more the merrier, the fewer the better cheer.
The more you heap, the worse you cheap.
The nearer the church the farther from God.
The offender never pardons.
The path of virtue is the path of peace.
The rat which has but one hole is soon caught.
The receiver is as bad as the thief.
The still sow sucks the most wash
The sweetest wine makes the sharpest vinegar.
There is a tide in the affairs of men, which taken at the flood leads on to fortune.
There is luck in leisure.
There is reason in roasting eggs.
There's a salve for every sore.
There's no compassion like the penny.
There's no fool like an old fool.
There's no general rule without an exception.
There's no joy without alloy.
The table robs more than the thief.
The truest jests sound worst in guilty ears.
The truth may be blamed but not shamed.
The weakest must go to the wall.
The wearer best knows where the shoe pinches him.
There would be no ill language if it were not ill taken.
There would not be great ones if there were no little.
They love too much that die for love.
They must hunger in frost, that will not work in heat.
They need much whom nothing will content.
Think of ease, but work on.
Those who live longest will see most.
Those who play with edge tools must expect to be cut.
Threatened folks live long.
Time and tide stay for no man
Time is a file that wears and makes no noise.
Timely blossom, timely fruit.
'Tis the second blow that makes the fray.
To a child all weather is cold.

To a crazy ship all winds are contrary.
To be hail fellow well met with one. [In good fellowship.]
To be in a merry pin.
To dine with Duke Humphry. [To go without dinner.]
To err is human, to forgive divine.
To find a mare's nest. [To discover something already well known.]
To give and keep there is need of wit.
To go through thick and thin. [Stick at nothing.]
To go to pot.
To have nothing but one's labour for one's pains.
To have the law in one's own hand.
To have two strings to one's bow.
To kill two birds with one stone.
To laugh in one's sleeve.
To leave a morsel for the Duke of Rutland. [That is—to leave it for the sake of *manners*, Manners being the family surname of the Duke of Rutland.]
Too many cooks spoil the broth.
Too much familiarity breeds contempt.
To play the dog in the manger. [Not to eat yourself nor let anybody else.]
To put one's nose out of joint.
To rob Peter to pay Paul.
To seek a needle in a bottle of hay.
To send one away with a flea in his ear. [In a state of trepidation and astonishment.]
To set up one's staff of rest. [To propose to abide in a place.]
To stand in one's own light.
To starve in a cook-shop.
To strain at a gnat and swallow a camel.
To take a wrong sow by the ear.
To tell tales out of school.
To throw the helve after the hatchet. [Giving up a thing in despair.]
To twist a rope of sand.
Trade is the mother of money.
Tread on a worm and it will turn.
Trim-tram—like master, like man.
True praise takes root and spreads.
Truth has always a fast bottom.
Two heads are better than one.
Two of a trade seldom agree.
Two swallows do not make a summer.
Unknown, unmissed.
Unminded, unmoved.
Use the means, and God will give the blessing.
Valour is worth little without discretion.
Valour that parleys is near yielding.
Venture a small fish to catch a great one.
Venture not all in one bottom.
War is death's feast.
Waste not, want not.
Wealth makes worship.
Welcome is the best cheer.
We must eat a peck of salt with a man before we know him.
We never know the worth of water till the well is dry.
What cannot be cured must be endured.
What is bred in the bone will not come out of the flesh.
What is got over the devil's back is spent under his belly.
What the eye sees not the heart rues not.
What the good wife spares the cat eats.
When a dog is drowning every one offers him water.
When all is consumed, repentance comes too late.
When fortune smiles on thee, take the advantage.
When many strike on an anvil, they strike by measure.
When poverty comes in at the door, love flies out at the window
When rogues fall out, honest men get their own.
When sorrow is asleep, wake it not.
When the cat's away the mice play.
When the goodman's from home the goodwife's table is soon spread.
When wine's in wit's out.
When two Sundays meet. [Never.]
When you are at Rome, do as they do at Rome.
When we have gold we are in fear, when we have none we are in danger.
When drink enters, wisdom departs.
Where much smoke is there must be some fire.
Where the carcass is, there the ravens will collect together.
Where the king is, there is the court.
Where the will is ready the feet are light.
Where there is a will there is always a way.
Write injuries in dust, but kindnesses in marble.
While the grass grows the cow starves.
While there's life there's hope.
Who dainties love shall beggars prove.
Who loseth his due getteth no thanks.
Who perisheth in needless danger is the devil's martyr.
Who spends more than he should, shall not have to spend when he would.
Who spits against the wind spits in his own face.
Wide will wear, but narrow will tear.
Wilful waste makes woful want.
Wise men care not for what they cannot have.
Wisely and slow: they stumble who run fast.
Wool sellers know wool buyers.
Words may pass, but blows fall heavy.
Wranglers never want words.
York—every man pay his share.
You are busy as a hen with one chick.
You come like a godfather after the christening.
You can look at teeth and not be bitten.
You can't see green cheese but your teeth must water.
You cannot catch old birds with chaff.
You cannot eat your cake and have it also.
You cannot have blood out of a stone
You cannot hide an eel in a sack.
You cannot kill a dog with a bone.
You cannot make a silk purse out of a sow's ear.
You cannot wash the blackamore white.
You need not grease a fat sow.
You taste the broth soon as the meat is put in.

SCOTS PROVERBS.

A begun turn is half ended.
A bit is often better gi'en than eaten.
A blate cat makes a proud mouse.
A black hen lays a white egg.
A borrowed len' should gae laughing hame.
A fidging mare should be weel girded.
Affront your friend in daffin', and tine him in earnest.
A fou man and a hungry horse aye mak haste hame.
A friend's dinner's soon dished.
Aft ettle, whiles hit.
After a storm comes a calm.
A gi'en horse shouldna be looked i' the mouth.
A gi'en piece is soon eaten.
A greedy e'e ne'er gat a gude pennyworth.
A green Yule maks a fat kirk-yard.
A gude cause maks a strong arm.
A handfu' o' trade is worth a gowpen o' gowd.
A hantle cry murder, yet are aye uppermost.
A hasty man never wanted wae.
A hunger and a burst.
A kiss and a drink o' water mak but a poor breakfast
A man's weel or wae as he thinks himsel sae.
Ane cannot wive and thrive baith in ae year.
Ane may be lo'e a haggis, that wadna hae the bag thrown in his teeth.
Ane ne'er tines by doing gude.
An ilka-day braw makes a sabbath-day daw
An ill shearer never got a gude heuk.

An ill wife and a new-kindled candle should hae their heads hadden down.
An inch o' gude fortune is worth a fathom o' forecast.
An inch o' a miss is as gude as a span.
A nod o' honest men is enough.
A pound o' care winna [illegible] ay an ounce o' debt.
A rough bane makes a fou wame.
As dark as a Yule midnight.
As gude fish in the sea as e'er came out o't.
As gude may haud the stirrup as he that loups on.
A Scotch mist will wet an Englishman to the skin.
A sillerless man gangs fast through the market
A sorrowfu' heart is aye dry.
A' Stewarts are no sib to the king.
A tale never tines in the telling.
A tarrowing hen was never fat.
A tocherless dame sits lang at hame.
At open doors dogs gae ben.
A wee mouse can creep under a great corn stack.
A wee thing puts your beard in a bleeze.
A wight man ne'er wanted a weapon.
A wilfu' man should be unco wise.
Auld men are twice bairns.
Auld sparrows are ill to tame.
Auld springs gie nae price.
Bairns speak in the field what they hear in the ha'.
Bargain is bargain.
Be a friend to yoursel, and others will.
Bear and forbear is gude philosophy.
Bear wealth weel, poortith will bear itsel.
Be aye the same thing you would be ca'd.
Be lang sick that ye may be soon hale.
Best to be off with the old love before we be on with the new.
Be thou weel, be thou wae, thou wilt not be aye sae.
Better a bit in the morning than fast a' day.
Better a finger off than aye wagging.
Better a tocher in her than on her.
Better a toom house than an ill tenant.
Better a wee bush than nae bield.
Better a wee fire to warm you than a big fire to burn you.
Better be blithe wi' little than sad wi' naething.
Better buy than borrow.
Better lang something than soon naething.
Better skaith saved than mends made.
Better sma' fish than nane.
Better to haud than draw.
Better wear shoon than wear sheets.
Blind men shouldna judge o' colours.
Bode for a silk gown and ye'll get a sleeve o't.
Broken bread makes hale bairns.
Burning a halfpenny candle seeking a farthing.
Burnt bairns dread the fire.
By chance a cripple may catch a hare.
Cadgers have aye mind of lade saddles.
Canny stretch, soon reach.
Carrying saut to Dysart.
Cast a bane in a deil's teeth.
Cast not a clout till May be out.
Castna out the dowed water till ye get the fresh.
Cauld cools the love that kindles ower het.
Change your friend ere you hae need.
Cheatery kythes.
Cleanliness is nae pride, dirt's nae honesty.
Come unca'd sits unserved.
Come wi' the wind and gang wi' the water.
Confess and be hanged.
Confess debt and crave days.
Corn him weel, he'll work the better
Count again is not forbidden.
Count siller after a' your kin.
Courtesy is cumbersome to him that kens it na.
Covetousness brings naething hame.
Craft maun hae claes, but truth gaes naked
Credit is better than ill luck.
Credit is better than ill-won gear.
Credit keeps the crown o' the causey.
Credit lost is like a broken glass.
Daffin and want o' [illegible] auld wives donart.
Dame, deem warily, [illegible] wha wytes yoursel.
Dauting and laving [illegible] sure fishing.
Daughters and dead fish [illegible] nae keeping ware.
Dawted bairns dow bear little.
Daylight will peep through a sma' hole.
Deal sma' an' serve a'.
Death and marriage break term-day.
Death at ae door and hardship at the other.
Deil be in the house that ye're beguiled in.
Deil stick pride, for my dog died o't.
Ding down the nest, and the rooks will flee away
Dinna cast awa' the cog when the cow flings.
Dirt bodes luck.
Dinna gut your fish till ye get them.
Do as the lasses do, say Na, an' tak it.
Dogs bark as they are bred.
Dogs an' bairns are aye fond o' fools.
Do not meddle wi' the deil an' the laird's bairns.
Do not touch him on the sair heel.
Dool an' ill life soon mak an auld wife.
Double drinks are aye gude for drowth.
Do weel an' doubt nae man, do ill an' doubt a' men.
Do weel an' hae weel.
Dows an' dominies leave aye a foul house.
Do your turn weel, an' nane will speer what time ye took
Draff he sought, but drink was his errand.
Dree out the inch when ye have tholed the span.
Drink an' drowth come nae aye thegither.
Drink little that ye may drink lang.
Drive a cow to the ha', she'll run to the byre.
Early birds catch the worms.
Early master, soon knave.
East or west, hame is best.
Easy learned, soon forgotten.
Easy learning the cat the road to the kirn.
Easy to that thy ain heart wills.
Easily working when will's at hame.
Eat in measure, an' defy the doctor.
Eat pe[illegible] wi' a prince, an' cherries wi' a chapman.
Eat-w[illegible] Drink-weel's brither.
Eating [illegible]ing only require a beginning.
Eat[illegible]ng puts awa the stamach.
E[illegible]le merchandise.
E[illegible] the soul and torture of the body.
[illegible] turn but when it means an ill ane.
[illegible]t day may you wear't.
[illegible]a
E[illegible] the dyke where it's laighest.
Every [illegible] trade, quoth the browster to the bishop.
Every bird thinks its ain nest best.
Every cock craws crousest on his ain midden head.
Every day [illegible] no Yule-day—cast the cat a castock.
Every fault has its fore.
Every flow has its ebb.
Every inch of joy has an ell ot annoy.
Every man bows to the bush he gets bield frae.
Every man buckles his belt his ain gate.
Every man can guide an ill wife weel but him that has hea
Every man can tout best on his ain horn.
Every man has his ain draff pock.
Every man's tale's gude till anither's be tauld.
Every May-be hath a May not be.
Every miller wad weise the water to his ain mill.
Every play maun be played, an' some maun be the players
Fair words break nae banes, foul words mony.
Fancy flees before the wind.
Far-awa fowls hae fair feathers.
Farther east the shorter west.
Fause folk should hae mony [illegible]

Fauschood makes ne'er a fair hinder-end.
Favour unused is favour abused.
Fill fu an haud fu', that makes a man stark.
Flaes an' a girning wife are waukrife bed-fellows.
Flee ne'er so fast, your fortune will be at your tail.
Fleeing a bird is not the way to grip it.
Fling-at-the-goad was ne'er a gude ox.
Flitting o' farms mak mailens dear.
Fools are aye fond o' flittin'.
Fools are aye seeing ferlies.
Fool's haste is nae speed.
Fools laugh at their ain sport.
Fools set far trysts.
Fools shouldna hae chappin'-sticks.
For fashion's sake, as dogs gang to the market.
For want of a steek a shoe may be tint.
Forbid a fool a thing, an' that he will do.
Frae saving comes having.
Fresh fish and poor friends grow soon ill-faured.
Friends are like fiddle-strings, they maunna be screwed ower tight.
Friends gree best at a distance.
Friendship canna stand aye on ae side.
Fry stanes wi' butter, and the broe will be gude.
Gathering gear is a pleasant pain.
Gaily wad be better.
Gear is easier gotten than guided.
Gentle partans hae lang taes.
Gentle servants are poor men's tinsel.
Get weel, keep weel.
Gie a bairn its will an' a whelp its fill, and neither will do weel.
Gie your tongue mair holidays than your head.
Giff-gaff maks gude friends.
Glasses and lasses are brittle ware.
Glowering's no gainsaying.
God ne'er sent the mouth, but he sent the meat wi't.
God send water to that well that folk think will ne'er rin dry.
God shapes the back for the burden.
Good wine makes a bad head and a lang story.
Gratitude is a heavy burden.
Great comfort is like ready gold in need.
Greedy folks hae lang arms.
Griening wives are aye greedy.
Guessed work's best if weel done.
Gude advice is ne'er out o' season.
Gude ale needs nae wisp.
Gude bairns are eith to lear.
Gude breeding and siller mak our sons gentlemen.
Gude claes open a' doors.
Gude company on a journey is worth a coach.
Gude gear's not to be gapped.
Gude fishing in drumly water.
Gude folk are scarce, tak care o' ane.
Gude forecast fathers the wark.
Gude health is better than wealth.
Gude kail is half meat.
Gude watch prevents harm.
Gude will ne'er wants time to show itsel.
Gude will should be ta'en in part payment.
Gudely cow, gawsy calf.
Hae, gars a deaf man hear.
Hand-in-use is father o' lear.
Hang a thief when he's young, an' he'll no steal when he's auld.
Hang hunger an' drown drouth.
Hankering an' hinging-on is a poor trade.
Happy the wife that's married to a motherless son.
He can hide his meat and seek mair.
He can say Jo, and think it no.
He can see an inch before his nose.
He cares na wha's bairns greet if his laugh.
He comes oftener wi' the rake than the shool.
He complains early that complains of his kail.
He doesna ken what end o' him's uppermost.
He doesna aye ride when he saddles.
He doesna like his wark that says *now* when its done.
He eats the calf i' the cow's wame.
He gangs awa in an ill time that ne'er comes again.
He gangs lang barefoot that wears dead men's shoon.
He girns like a sheep-head in a pair o' tangs.
He has a coup for a' corn.
He has a gude judgment that doesna lippen to his ain.
He has a hearty hand for gieing a hungry mealtith.
He has a slid grip that has an eel by the tail.
He has been rowed in his mither's sark tail.
He has brought his pocket to a braw market.
He has come to gude by misguiding.
He has coosten his cloak on his ither shoulder.
He has coupit the meikle pot into the little.
He has faut o' a wife that marries mam's pet.
He has feathered his nest, he may flee when he likes.
He has gotten the whip hand of him.
He has lain on his wrang side.
He has licked the butter off my bread.
He has mair wit in his little finger than ye hae in a' your bouk.
He has muckle prayer but little devotion.
He has some wit, but a fool has the grinding o't.
He has the best end of the string.
He has wit at will that wi' an angry heart can sit still.
He has't o' kind, he coft it not.
He hears wi' his heel, as geese do in harvest.
He kens his ain groats among ither folk's kail.
He kens whilk side his cake is buttered on.
He'll gie you the whistle o' your groat.
He'll have eneugh some day, when his mouth's fu' o' mools.
He'll mak an ill runner that canna gang.
He'll mend when he grows better, like sour ale in summer.
He'll neither dance nor haud the candle.
He'll no gie an inch o' his will for a span o' his thrift.
He'll no let grass grow at his heels.
He'll no sell his hen on a rainy day.
He'll soon be a beggar that canna say No.
He'll tell it to nae mair than he meets.
He lo'ed mutton weel that licked where the ewe lay.
He lo'es me for little that hates me for nought.
He looks like the far end of a French fiddle.
He maun be soon up that cheats the tod.
He maun hae leave to speak that canna haud his tongue.
He may find fault that canna mend.
He needs a long spoon that sups wi' the deil.
He ne'er did a gude darg that gaed grumbling about it.
He reads his sin in his punishment.
He rides sicker that never fa's.
He's a fool that forgets himsel.
He's a fool that marries at Yule; for when the bairn's to bear, the corn's to shear.
He's a hawk of a right nest.
He's a man of a wise mind, that of a foe can mak a friend.
He's a proud cook that maunna lick his ain fingers.
He's a proud fox that winna scrape his ain hole.
He's a silly chiel that can neither do nor say.
He's a worthless guidman that's no miss'd.
He's as welcome as water in a riven ship.
He's horn deaf on that side o' the head.
He should sit close that has riven breeks.
He sleeps as dogs do when wives sift meal.
He's like a flae in a blanket.
He's like the singet cat, better than he's likely.
He's no the best wright that casts maist spails.
He's no sae daft as he lets on.
He's ower soon up that's hanged e'er noon.
He's poor eneugh that's ill lo'ed.
He's sairest dung that's paid wi' his ain wand.
He starts at straes, and lets windlins gae.
He's the gear that winna traik.

He's unco fu' in his ain house that canna pick a bane in his neighbour's.
He's weel worthy o' sorrow that buys it.
He's weel boden there ben, that will neither borrow nor len'.
He's wise that's timely wary.
He's worth nae weel that can bide nae wae.
He that blaws best let him beat the horn.
He that buys nuts buys shells, but he that buys gude ale buys naething else.
He that canna mak sport should mar nane.
He that cheats me ance, shame fa' him; if he cheat me twice, shame fa' me.
He that counts a' costs will ne'er put plough i' the ground.
He that deals in dirt has aye foul fingers.
He that does you an ill turn will ne'er forgie you.
He that forecasts a' perils will win nae worship.
He that fa's a gutter, the langer he lies the dirtier he is.
He that fishes before the net, fishes lang or he fish get.
He that gets forgets, but he that wants thinks on.
He that gets gear before he gets wit, will die e'er he thrive.
He that has a mickle nose thinks ilk ane speaks o't.
He that has but ae e'e maun tent that weel.
He that has mickle wad aye hae mair.
He that has nae gear to tine may hae shins to pine.
He that has twa hoards will get a third.
He that keeks through a hole may see what will vex him.
He that lends his pot may seethe his kail in his loof.
He that looks to freets, freets will follow him.
He that rides or he be ready, wants aye some o' his graith.
He that's aught the cow gangs nearest the tail.
He that's ill to himsel will be gude to naebody.
He that seeks motes gets motes.
He that shows his purse bribes the thief.
He that speers all opinions comes ill speed.
He that steals can hide too.
He that tholes overcomes.
He that will cheat in play winna be honest in earnest.
He that will not tole maun flit mony a hole.
He that will to Cupar maun to Cupar.
He that winna when he may, shanna when he wad.
He that would eat the kirnel maun crack the nut.
He wad gang a mile to flit a sow.
He wad gar you trow that the moon's made o' green cheese.
He wad tine his lugs if they were not tacked to him.
He was mair fleyed than hurt.
He was scant o' news that tauld his father was hanged.
He was the bee that made the honey.
He winna send you awa' wi' a sair heart.
Highlanders—shoulder to shoulder.
I canna sel' the cow an' sup the milk.
I hae mair to do than a dish to wash.
I ken by my cog my cow's milked.
If ae sheep loup the dyke, a' the rest will follow.
If the deil be laird, ye'll be tenant.
If the deil find you idle, he'll set you to wark.
If the lift fa', the laverocks will be smoored.
If you win at that, you'll lose at naething.
If ye sell your purse to your wife, gie her your breeks to the bargain.
Ill bairns are aye best heard at hame.
Ill bairns aye get broken brows.
Ill beef ne'er made gude broe.
Ill comes upon waur's back.
Ill counsel will gar a man stick his ain mare.
Ill doers are aye ill dreaders.
Ill getting het water frae 'neath cauld ice.
Ill hearing maks wrang rehearsing.
Ill herds mak fat foxes.
Ill laying up maks mony thieves.
Ill payers are aye gude cravers.
Ill will ne'er spak weel.
Ill-won gear winna enrich the third heir.
Ill workers are aye gude onlookers.
I'll ne'er brew drink to treat drunkards.
I'll ne'er keep a cow when I can get milk sae cheap.
I'll ne'er keep a dog and bark mysel.
I'll ne'er lout sae laigh and lift sae little.
I'll ne'er put the rogue aboon the gentleman.
I'll rather strive wi' the lang rigg than the ill neighbour
I'll serve ye when ye hae least to do.
I'll tak the best first, as the priest did o' the plums
I might bring a better speaker frae hame than you.
I'm no every man's dog that whistles on me.
I'm no obliged to summer an' winter it wi' you.
I'm no sae blind as I'm bleer-eyed.
I'm no sae scant o' clean pipes as to blaw wi' a brunt cutty
I'm o'er auld a cat to draw a strae before.
I'm speaking o' hay and you o' horse corn.
I ne'er sat on your coat-tail.
I think mair o' your kindness than its a' worth.
It maun be true what a' folk says.
It's a far cry to Lochaw.
It's a hard task to be poor and leal.
It's a mean mouse that has but ae hole.
It's a nasty bird that files its ain nest.
It's a silly hen that canna scrape for ae bird.
It's an ill pack that's no worth the custom.
It's better to sup wi' a cutty than want a spoon.
It's by the head that the cow gies milk.
It's far to seek an' ill to find.
It's gude baking beside the meal.
It's gude sleeping in a hale skin.
It's gude to be sib to siller.
It's gude gear that pleases the merchant.
It's gude to be in your time, ye kenna how lang it may last.
It's gude to dread the warst, the best will be the welcomer.
It's hard both to have and want.
It's hard for a greedy e'e to hae a leal heart.
It's hard to sit in Rome an' strive wi' the pope.
It's ill bringing butt what's no ben.
It's ill speaking between a fu' man and a fasting.
It's ill wared that wasters want.
It's kittle for the cheeks when the hurlbarrow gaes o'er the brig o' the nose.
It's kittle shooting at corbies and clergy.
It's kittle to waken sleeping dogs.
It's lang before the diel be found dead at the dyke-side.
It's lang ere the deil dee.
It's nae laughing to girn in a widdy.
It's nae play when ane laughs and anither greets.
It's needless to pour water on a drowned mouse.
It's no lost what a friend gets.
It's not what is she but what has she.
It's ower far between the kitchen an' the ha'.
It's ower late to spare when the back's bare.
It's past jouking when the head's aff.
It's stinking praise comes out o' ane's ain mouth.
It's the best spoke in your wheel.
It's well that our faults are not written in our face.
It was never for naething that the gleg whistled.
It will be feathered out o' your wing.
It will be lang ere ye wear to the knee lids.
I wad be scant o' claith to sole my hose wi' dockens.
I would rather see't than hear tell o't.
I wadna be deaved wi' ye're keckling for a' your eggs.
I wadna ca' the king my cousin.
I wish you readier meat than a rinnin hare.
Joke at leisure, you kenna wha may jibe yoursel
Jouk and let the jaw gang by.
Keep out o' his company that cracks o' his cheatery
Keep something for a sore foot.
Keep the feast till the feast day.
Keep the staff in your ain hand.
Keep your ain fish guts to your ain sea-maws.

Keep your breath to cool your own porridge.
Keep your mouth shut and your e'en open.
Ken when to spend and when to spare, and ye needna be busy, and ye'll ne'er be bare.
Ken yoursel, and your neighbour winna misken you.
Kend folk's nae company.
Kings and bears aft worry their keepers.
Kings' chaff's worth other folk's corn.
Kings' cheese gaes half away in parings.
Kings hae lang hands.
Kindle a candle at baith ends, it will soon be done.
Kindness comes o' will, it canna be coft.
Kindness will creep where it canna gang.
Kiss a carle and clap a carle, that's the way to tine a carle.
Kythe in your ain colours, that folk may ken you.
Laith to bed and laith to rise.
Lang fasting gathers wind.
Lang fasting hains nae meat.
Lang standing and little offering maks a poor priest.
Lang straes are nae motes.
Laugh at leisure, ye may greet ere night.
Law's costly, tak a pint and gree.
Law makers shouldna be law breakers.
Lay the head o' the sow to the tail of the grice.
Lay your wame to your winning.
Leal heart never lied.
Learn the cat the road to the kirn, and she'll aye be lickin.
Learn you to an ill habit, and ye'll ca't custom.
Learn young, learn fair.
Let a' trades live, quoth the wife, when she brunt her besom.
Let alane, maks mony a loon.
Let byganes be byganes.
Let him cool in the skin he het in.
Let him tak a spring on his ain fiddle.
Let his ain wand ding him.
Let ilka ane soop before their ain door.
Let ilka sheep hang by its ain shank.
Let na the plough stand to kill a mouse.
Let the horns gang wi' the hide.
Let the mickle horse get the mickle windlin.
Let the tow gang wi' the bucket.
Let them care that come behind.
Let your meat dit your mouth.
Light burdens break nae banes.
Like a cow on an unco loan.
Like a sow playing on a trump.
Like butter in the black dog's hause.
Like hens, ye rin aye to the heap.
Like the bairns o' Falkirk, ye mind naething but mischief.
Like the cat, fain fish wad ye eat, but ye are laith to weet your feet.
Like the wife that aye took what she had, and never wanted.
Like the wife that ne'er cries for the ladle till the pot rins o'er.
Like the wife wi' the mony daughters, the best comes hindmost.
Like's an ill mark.
Lippen to me, but look to yoursel.
List to meat's gude kitchen.*
Little dogs hae lang tails.
Little folk are soon angry.
Little Jock gets the little dish, and that hauds him lang little.
Little kennel, the less cared for.
Little meddling maks fair parting.
Little wats the ill-willy wife what a dinner may haud in.
Little wit in the head maks mickle travel to the feet.
Little meuse to the cheeks to bite aff the nose.
Living at heck and manger.

* Hunger is the best sauce.

Lock your door, that you may keep your neighbours honest.
Lo'e me little, an' lo'e me lang.
Love and lairdships like nae marrows [equals].
Love is as warm among cottars as courtiers.
Love overlooks mony faults.
Maidens should be mild and meek, quick to hear and slow to speak.
Mair by luck than good guiding.
Mair haste the waur speed, quoth the tailor to the lang thread.
Mair than eneugh is ower mickle.
Mak a kirk an' a mill o't.
Mak nae toom ruse.
Malice is aye mindfu'.
Marriage and hanging go by destiny.
Marry a beggar, and get a louse for your tocher.
Marry aboon your match, and get a master.
Marry for love, and work for siller.
Master's will is gude wark.
Mastery maws the meadows down.
Maun-do is a fell fallow.
May-be's are no aye honey-bees.
Measure twice, cut but ance.
Meat feeds, claith cleads, but manners mak the man.
Mickle musing mars the memory.
Mickle power maks mony faes.
Mickle about ane, quoth the deil to the collier.
Mickle gifts mak beggars bauld.
Mickle head, little wit.
Mickle maun a gude heart thole.
Mickle meat, mony maladies.
Mess and meat ne'er hinder'd wark.
Mettle's dangerous in a blind mare.
Money is like the muck midden, it does nae gude till it be spread.
Money is welcome any way.
Money maks a man free ilka where.
Mony an honest man needs help that hasna the face to seek it.
Mony ane kisses the bairn for love o' the nurse.
Mony ane lacks what they would fain hae in their pack.
Mony ane serves a thankless master.
Mony ane speers the gate they ken fu' weel.
Mony ane's gear is mony ane's death.
Mony gude-nights is laith away.
Mony kinsfolk, but few friends.
Mony littles mak a mickle.
Mony purses haud friends lang thegither.
Mony ways to kill a dog, though ye dinna hang him.
Mony wyte their wife for their ain thriftless life.
Nae fleeing without wings.
Nae man can live langer in peace than his neighbours like
Nae man can mak his ain hap
Nae man has a tak o' his life.
Nae wonder to see wasters want.
Naething but fill and fetch mair.
Naething is a man's truly but what he comes by duly
Naething is got without pains but dirt and lang nails.
Naething is sae difficult but we may overcome by perseverance.
Naething sa bauld as a blind mare
Naething to be done in haste but gripping flaes.
Naething to do but draw in your stool and sit down.
Nane are sae weel but they hope to be better.
Nane can play the fool sae weel as a wise man.
Need maks greed.
Need will gar an auld wife trot, and a naked man rin.
Ne'er draw your dirk when a dunt will do.
Ne'er fash your thoom.
Ne'er let on, but laugh in your ain sleeve.
Ne'er lippen owre mickle to a new friend or an auld enemy.
Ne'er marry a widow unless her first man was hanged

Ne'er owre auld to learn.
Ne'er put a sword in a madman's hand.
Ne'er put the plough before the owsen.
Ne'er put your hand farther out than your sleeve will reach.
Ne'er rax aboon your reach.
Ne'er sca'd your lips in ither folk's kale.
Ne'er seek a wife till ye ken what to do wi' her.
Ne'er shaw me the meat but the man.
Ne'er shaw your teeth unless ye can bite.
Ne'er speak ill o' them whase bread ye eat.
Ne'er strive against the stream.
Ne'er tak a forehammer to break an egg.
Ne'er tell your fae when your foot sleeps.
Neither to haud nor to bind.
Neither sae sinfu' as to sink nor sae haly as to swim.
Next to nae wife, a gude wife is the best.
Nobility without ability is like a pudding without suet.
O' a' sorrow, a fu' sorrow's the best.
Owre braw a purse to put a plack in.
Owre reckless may repent.
Owre sicker, owre loose.
Owre strong meat for your weak stamach.
Of a' flatterers, self-love is the greatest.
Of ae ill comes mony.
Of ill debtors men get aiths.
Ony thing for you about an honest man's house but a day's wark.
Open confession is gude for the soul.
Our sins and debts are often mair than we think.
Out o' the peat pot into the gutter.
Owre mony grieves only hinder the wark.
Pay him in his ain coin.
Placks and bawbees grow pounds.
Play's good while it's play.
Please your kimmer, and you'll easily guide your gossip.
Plenty maks dainty.
Poor folk's friends soon misken them.
Poverty is the mother o' a' arts.
Pride and grace ne'er dwell in ae place.
Pride finds nae cauld.
Pride ne'er leaves its master till he get a fa'.
Pride that dines wi' vanity sups wi' contempt.
Provision in season makes a bien house.
Put a coward to his metal and he'll fight the deil.
Put on your spurs and be at your speed.
Put twa pennies in a purse and they'll keep thegither.
Put your finger in the fire, and say it was your fortune.
Put your hand twice to your bonnet for ance to your pouch.
Quality without quantity is little thought of.
Quey calves are dear veal.
Quick, for you'll ne'er be cleanly.
Quietness is best.
Rather spoil your joke than tine your friend.
Raw dads mak fat lads.
Raw leather raxes weel.
Reckon up your winning at your bed-stock.
Red wood maks good spindles.
Reputation is often got without merit and lost without crime.
Rich folk hae routh o' friends.
Rich mixture maks gude mortar.
Riches are got wi' pain, kept wi' care, and tint wi' grief.
Ride fair and jap nane.
Right wrangs nae man.
Rob Gib's contract—stark love and kindness.
Roose the fair day at e'en.
Rue and thyme grow baith in ae garden.
Rule youth weel, for eild will rule itsel.
Saut, quoth the souter, when he had eaten a cow a' but the tail.
Saw thin, shear thin.
Say still No, and ye'll ne'er be married.
Scanty cheeks mak a lang nose.
Scart-the-cog wad sup mair.
Send your gentle bluid to the market, and see what it will buy.
Serve yoursel till your bairns come of age.
Set a stout heart to a stey brae.
Shame fa' them that think shame to do themselves a gude turn.
She brak her elbow at the kirk door.
She hauds up her head like a hen drinking water.
She looks as if butter wadna melt in her mouth
She looks like a lady in a landward kirk.
She that gangs to the well wi' an ill will, either the pig breaks or the water will spill.
She'll keep her ain side o' the house, and gang up and down yours.
She'll wear like a horse-shoe, aye the langer the clearer.
She's better than she's bonny.
Show me the man, and I'll show you the law.
Sic as ye gie, sic will ye get.
Silence grips the mouse.
Slander leaves a sair behind.
Smooth waters run deep.
Soon eneugh if weel eneugh.
Soon eneugh to cry Chuck, when it's out o' the shell.
Sorrow and ill weather come unsent for.
Sorrow is soon eneugh when it comes.
Speak good of pipers, your father was a fiddler.
Spilt ale is waur than water.
Stay nae langer in a friend's house than you're welcome
Stuffing hauds out storming.
Tak a man by his word and a cow by her horn.
Tak the bit and the buffet wi't.
Tak time ere time be tint.
Tak wit wi' your anger.
Tak your ain will, and ye'll no die o' the pet.
Tak your thanks to feed your cat.
Tak your venture, as mony a gude ship has done.
That's Halkerston's cow.*
The black ox ne'er trod on his foot.†
The book o' maybes is very braid.
The cost owergangs the profit.
The deil aye drives his hogs to an ill market.
The deil doesna aye show his cloven cloots.
The deil gaes awa when he finds the door steekit against him.
The deil's bairns have aye their daddy's luck.
The deil's aye gude to his kin.
The deil's gane ower Jock Wabster.‡
The deil will tak little ere he want a'.
The deil's aye busy wi' his ain.
The first fuf o' a fat haggis is the bauldest.
The foot at the cradle and the hand at the reel, is a sign that a woman means to do weel.
The grace o' a gray bannock's in the baking o't.
The head for the washing.
The higher the hill the laigher the grass.
The hurt man writes wi' steel on marble stane.
The king may come in the cadger's gate.
The kirk's mickle, but you may say mass in the end o't.
The laird may be laird, and yet need his hind's help.
The master's foot's the best measure.
The o'ercome only fashes folk to keep.
There is an act in the Laird o' Grant's court, that no aboon eleven speak at ance.
There was a wife that kept her supper for her breakfast, and she was dead ere day.
There was ne'er a gude town but there was a dub at the end o't.
There was never a silly Jocky but there was as silly a Jenny.

* A story told the reverse of the real occurrence.
† Death never gave him sorrow.
‡ All things are gone wrong.

There was ne'er a thrifty wife wi' a sheet about her head.
There's a dub before every door.
There's a tough sinew in an auld wife's heel.
There's a whaup i' the raip.*
There's aye some water where the stirkie drowns.
There's beild aneath an auld man's beard.
There's steel in the needle point, though little o't.
There's the end o' an auld sang.
The simple man's the beggar's brither.
The smith's mare and the souter's wife are aye the warst shod.
The tod ne'er sped better than when he gaed his ain errand.
The thing that lies na in your gate breaks na your shins.
The thrift o' you and the woo o' a dog wad mak a braw web.
The worth o' a thing is best kenned by the want o't.
The wife's aye welcome that comes wi' a crooked oxter.†
They'll gree better when they gang in by different kirk doors.
They that board wi' cats maun count upon scarts.
They that burn you for a witch lose a' their coals.
They that gie you hinder you to buy.
They that lie down for love should rise up for hunger.
They that love maist speak least.
They were scant o' bairns that brought you up.
They are sad rents that come in wi' tears.
They hae need o' a canny cook that hae but ae egg to their dinner.
They may ken by your beard what has been on your board.
They ne'er saw great dainties that think a haggis a feast.
They should kiss the guidwife that wad win the guidman.
They speak o' my drinking, but ne'er think o' my drouth.
They that get a word o' soon rising may lie a' day.
They that see you a' day winna break the house for you at night.
Three can keep a secret when twa are away.
Thrift is a gude revenue.
Time tint is ne'er to be found.
Time and thinking tame the strongest grief.
Time tries a'.
Tine heart and a's gane.
Tine thimble, tine thrift.
Tit for tat's fair play.
To him that wills, ways are seldom wanting.
Toom stalls mak biting horses.
Truth will aye stand without a prop.
Try your friend ere you need him.
Twa words maun gang to that bargain.
Virtue never grows auld.
Waes the wife that wants the tongue, but weel's the man that gets her.
Want o' wit is waur than want o' wealth.
War maks thieves, and peace hangs them.
We are aye to learn as lang as we live.
We are bound to be honest and no to be rich.
Wealth has made mair men covetous than covetousness has made men wealthy.
Wealth maks wit waver.
Weans maun creep ere they gang.
We canna baith sup and blaw.
Wedding and ill wintering tame baith man and beast.
Weel kens the mouse when the cat's out o' the house.
Weel is that weel does.
We'll never ken the worth o' water till the well gae dry.
We maun live by the living and no by the dead.
Wha can haud what will be away.
Wha can help misluck.
Wha can help sickness, quoth the wife, when she lay in the gutter.
Wha comes oftener and brings you less.
Wha daur bell the cat.

* Something amiss.
† Bringing something under her arm.

Wha invited you to the feast.
Wha wad misca' a Gordon on the raws of Strathbogie.
What better's the house when the daw rises soon.
What may be done at ony time will be done at nae time.
What put that i' your head, that didna put the sturdy wi't.
What's my case the day may be yours the morn.
What's waur than ill luck.
What we first learn we best ken.
What winna do by might do by flight.
What ye do when your drunk ye may pay for when your dry.
What ye want up and down ye hae hither and yont.
When a' men speak, nae man hears.
When ae door steeks, anither ane opens.
When friends meet, hearts warm.
When he dies of age ye may quake for fear.
When ilka ane gets his ain, the thief will get the widdy.
When my head's down my house is theiked.
When petticoats woo, breeks come speed.
When the barn's fu' ye may thresh before the door.
When the cap's fu', carry't even.
When the cow's in the clout she soon runs out.
When the guidman drinks to the guidwife, a' wad be weel.
When the guidwife drinks to the guidman a's weel.
When the heart's fu' o' lust, the mouth's fu' o' leasing.
When the tod preaches, tak tent o' the lambs.
When the tod wins to the wood, he caresna how mony keeks at his tail.
When the wame's fu', the banes wad be at rest.
When the well's fu' it will rin owre.
When wine sinks, words swim.
When ye're gaun an' comin' the gate's no toom.
When ye are weel, haud yoursel sae.
When ye win at that, ye may lick aff a het girdle.
When you're served, a' the geese are watered.
When drums beat, laws are dumb.
Where the buck's bound there he maun bleet.
Wrang has nae warrant.
Ye're like auld maidens, ye look sae high.
Ye're like gude maut, ye're lang o' coming.
Ye're like Macfarlane's geese, ye hae mair mind o' your play than your meat.
Ye're like the chapman, ye're aye to handsel.
Ye're like the miller's dog, ye lick your lips ere the pock be opened.
Ye're like the cow's tail, ye grow backward.
Ye're like the tod, ye grow gray before ye grow gude.
Ye fand it where the Highlandman fand the tangs.
Ye hae fasted lang and worried on a midge.
Ye hae gotten the chapman's drowth.*
Ye hae gotten a ravelled hesp o't.
Ye hae ower foul feet to come sae far ben.
Ye hae put a toom spoon in my mouth.
Ye hae stayed lang and brought little wi' ye.
Ye hae taen the measure o' his foot.
Ye hae tint the tongue o' the trump.
Ye'll get nae mair o' the cat but the skin.
Ye'll hae baith your meat and your mense.†
Ye'll sit till ye sweat, and work till ye freeze.
Ye'll worry i' the band, like M'Ewan's calf.
Ye look as sharp as a Lochabar axe new come frae the grindstane.
Ye look like Let-me-be.
Yelping curs will raise mastiffs.
Ye maun have it simmered and wintered.
Ye're a gude seeker, but an ill finder.
Ye're best when ye're sleeping.
Ye're bonny enough to them that lo'e ye, and ower bonny to them that lo'e ye and canna get ye
Ye're busy seeking the thing that's no tint.

* Hunger.
† Offer a person a thing, and as he will not take it, you will at least have the credit of having made the offer.

Ye're come o' bluid, and sae's a pudding
Yer een's yer merchant.
Ye're feared for the day ye never saw.
Ye're gear will ne'er owergang ye.
Ye're never pleased, fu' nor fasting.
Ye're of sae mony minds, ye'll never be married.
Ye're sair fashed handing naething thegither.
Ye're teeth's langer than yer beard.
Ye shape shoon by your ain shachled feet.
Ye wad be a gude piper's dog, for smelling out bridals.
Ye wad be gude to fetch the deil a drink.
Ye wanta where a blessing may light.
Ye are a sweet nut, it ye were weel cracked.
Young folk *may* die, and auld folk *maun* die.
Your head will never fill your father's bonnet.
Your purse was steekit when that was paid for.
Your tongue rins aye before your wit

LATIN PROVERBS AND PHRASES.

Ab initio. From the beginning.
Ab uno disce omnes. From a single instance you may infer the whole.
Ad captandum vulgus. To catch the rabble.
Ad finem esto fidelis. Be faithful to the end.
Ad Græcas kalendas. Never.
Ad infinitum. To infinity.
A fortiori With stronger reason.
Alias. Otherwise; as, Allan *alias* Thompson.
Alibi. Elsewhere.
Alma mater. A benign mother; applied generally to the university.
A mensa et thoro. Divorced from bed and board.
Amor patriæ. The love of our country.
Animus conscius se remordet. A guilty mind punishes itself.
Anno Domini (A.D.). In the year of our Lord.
Anno Mundi (A.M.). In the year of the world.
A posteriori. From the effect to the cause.
A priori. From the cause to the effect.
Arbiter elegantiarum. Master of the ceremonies.
Argumentum ad hominem. An argument to the man.
Ars est celare artem. The perfection of art is to conceal art.
Audi alteram partem. Hear the other party.
Audito multa, sed loquere pauca. Hear much, but say little.
Auri sacra fames. The accursed appetite for gold.
Aut Cæsar aut nullus. He will either be Cæsar or nobody.
Basis virtutis constantia. Constancy is the foundation of virtue.
Beatus ille qui procul negotiis. Blessed are they who retire from toil.
Bona fide. In good faith; in reality.
Brutum fulmen. A harmless thunderbolt.
Cacoethes. An evil custom. Thus, cacoethes loquendi—scribendi. A rage for talking—scribbling.
Causus belli. The cause or reason for war.
Caput mortuum. The worthless remains.
Cede Deo. Submit to God.
Cede magnis. Give way to the powerful.
Cedant arma togæ. Let arms yield to eloquence.
Certum pete finem. Aim at a sure end.
Communia proprie dicere. To express common things with propriety.
Compos mentis. In a state of sane mind.
Concordia res parvæ crescunt. Small things increase by union.
Confide recte agens. Fear not while acting justly.
Contra bonos mores. Against good morals.
Corpus delicti. The body of the crime.
Credat Judæus apella. Let the circumcised Jew believe that.
Cui bono? To what good?
Currente calamo. With a running pen.
Data. Things given or granted.
De facto—de jure. From the fact—from the law.
Delectando pariterque monendo. By imparting at once pleasure and instruction.
Delenda est Carthago. Carthage must be destroyed. (The words of Cato.)
De mortuis nil nisi bonum. Let nothing be said of the dead but what is favourable.
Deo favente—juvante—volente. With God's favour—help—will.
Desideratum. The thing desired.
Desipere in loco To play the fool at the right time.
Desunt cætera. The remainder is wanting.
Deum cole, regem serva. Worship God, serve the king
Deus protector noster. God is our protector.
Dilige amicos. Love your friends.
Divide et impera. Divide and govern.
Dulce et decorum est pro patria mori. It is sweet and glorious to die for one's country.
Dum vivimus vivamus. Let us live while we live.
Est modus in rebus. There is a medium in all things.
Esto perpetua. Be thou perpetual.
Esto quod videris. Be what you seem to be.
Ex cathedra. From the chair; authoritatively.
Exempli gratia (E. g. and Ex. gr.) By the way of example.
Ex nihilo nihil fit. Nothing produces nothing.
Ex officio. By virtue of his office.
Ex parte. On one part.
Ex pede Herculem. Judge of the size of the statue of Hercules by the foot.
Experto crede. Believe an experienced man.
Extempore. Without premeditation.
Fac simile. Do the like: an engraved resemblance of handwriting.
Fama semper viret. A good name will shine for ever
Familias firmat pietas. Devotion strengthens families.
Fas est et ab hoste doceri. It is allowable to derive instruction even from an enemy.
Felo de se. A suicide.
Fiat justitia, ruat cœlum. Let justice be done, though the heavens should fall.
Fortuna favet fortibus. Fortune favours the bold.
Fruges consumere nati. Men born only to consume food.
Haud passibus æquis. With unequal steps.
Hinc illæ lachrymæ. Hence proceed these tears.
Id est (i. e.) That is.
Id genus omne. All persons of that description.
Imprimatur. Let it be printed.
Impromptu. Without study.
In forma pauperis. In the form of a poor man.
In propria persona. In person.
In re. In the matter of.
In terrorem. In terror.
In transitu. In passing.
Ipse dixit. He himself said it: dogmatism.
Judex damnatur cum nocens absolvitur. Guilt attaches to a judge when the guilty are suffered to escape.
Jure divino—humano. By divine—by human law.
Labor omnia vincit. Labour conquers every thing.
Lapsus linguæ. A slip of the tongue.
Lex talionis. The law of retaliation.
Locum tenens. A deputy or substitute.
Magna est veritas, et prævalebit. The truth is powerful, and will ultimately prevail.
Materiem superabat opus. The workmanship surpassed the materials.
Medio tutissimus ibis. A medium course will be the safest.
Memento mori. Remember death.
Mens sibi conscia recti. A mind conscious of rectitude

Mirabile dictu. Wonderful to tell.
Multum in parvo. Much in little.
Mutatis mutandis. After making the necessary changes.
Necessitas non habet leges. Necessity has no law.
Nem. con. An abbreviation of *nemine contradicente.* Without dissent or opposition.
Ne plus ultra. Nothing beyond—the utmost point.
Ne quid nimis. Too much of one thing is good for nothing.
Ne sutor ultra crepidam. Let not the shoemaker go beyond his last.
Nisi Dominus frustra. Unless the Lord assist you, all your efforts are in vain.
Noscitur ex sociis. He is known by his companions.
Nota Bene (N. B.) Mark well.
Obiter dictum. A thing said by the way or in passing.
Onus probandi. The weight of proof; the burden of proving.
O si sic omnia! Oh that he had always done, or spoken thus!
O tempora, O mores! Oh the times, oh the manners!
Otium cum dignitate. Ease with dignity.
Palmam qui meruit ferat. Let him who has won bear the palm.
Pari passu. By a similar gradation.
Par nobile fratrum. A noble pair of brothers.
Particeps criminis. An accomplice.
Passim. Everywhere.
Per fas et nefas. Through right and wrong.
Per se. By itself.
Poeta nascitur non fit. Nature, not study, must form a poet.
Primâ facie. On the first view, or appearance.
Primæ viæ. The first passages: the upper part of the intestinal canal.
Primum mobile. The main spring; the first impulse.
Principiis obsta. Oppose the first appearance of evil.
Pro aris et focis. For our altars and firesides.
Pro bono publico. For the public good.
Pro et con. For and against.
Pro re nata. For a special business.
Pro tempore. For the time.
Quid nunc? What now?—applied to a news-hunter.
Quid pro quo. What for what; tit for tat.
Quoad hoc. To this extent.
Quod erat demonstrandum. Which was meant to be shown.
Rara avis in terris, nigroque simillima cygno. A rare bird in the earth—very like a black swan.
Reductio ad absurdum. A reducing to an absurdity.
Re infecta. Without attaining his end.
Requiescat in pace. May he rest in peace.
Res angusta domi. Narrow circumstances at home
Respice finem. Look to the end.
Seriatim. In order.
Sic itur ad astra. Such is the way to immortality.
Sic passim. So everywhere.
Sic transit gloria mundi. Thus the glory of the world passes away.
Sine die. To an indefinite time.
Sine qua non. An indispensable condition.
Status quo antè bellum. The state in which both parties were before the war.
Suaviter in modo, fortiter in re. Gentle in the manner, but vigorous in the deed.
Sub silentio. In silence.
Summum bonum. The chief good.
Suum cuique. Let every man have his own.
Tabula rasa. A smoothed tablet.
Tempora mutantur, et nos mutamur in illis. The times change, and we change with them.
Toties quoties. As often as.
Ubi suprà. Where above mentioned.
Vade mecum. Go with me: a constant companion. (Usually applied to a pocket-book.)
Veluti in speculum. As if in a mirror.
Veni, vidi, vici. I came, I saw, I conquered.
Vis inertiæ. Force or property of inanimate matter.
Versus (v.) Against.
Vice versa. The terms or cases being changed.
Vi et armis. By main force.
Viva voce. By or with the living or loud voice.
Viz. (videlicet.) Namely.
Vox et præterea nihil. A voice and nothing more.
Vox populi, vox Dei. The voice of the people is the voice of God.

END OF THE FIRST VOLUME.

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