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BARBER & BROTHERS' STRAW PAPER MANUFACTORY AT GEORGETOWN.

In several numbers of this journal we have alluded to the history, manufacture, and general importance of paper, as a material necessary for the diffusion of knowledge, and one which has grown into an actual necessity of life in one form or another. For more than half a century the attention of manufacturers in all countries has been directed to the discovery of some cheap substitute for rags as a paper material, but hitherto without success, although it is now alleged, as will be seen by reference to page 228 of this journal, that paper made from maize or Indian corn stalks, after the process of extracting the so-called maize-flax has been effected, promises to become of considerable importance in those countries where maize is grown as an article of food. In England, the United States, and more recently in Canada, paper from wheat straw, with a small admixture of rags, is largely manufactured; and as a portion of the newspaper press of Canada is supplied with so-called straw paper, consisting of 70 to 75 per cent. of straw, and 25 to 30 per cent. of rags or manilla, the processes employed in the manufacture, acquire a general interest, the more especially as there still remains room for improvement in the production of cheap and good paper from wheat straw, both in respect of cost and quality.

Straw paper is no novelty, indeed it may be said that there is no common vegetable substance of a fibrous character which has not been tried as a paper material. Straw, and especially wheat straw, appears to answer the purpose better than any other known product, as far as cheapness goes; but there are not wanting many sanguine inventors even in Canada who think that they have discovered in other vegetables the raw material which shall afford the rising generation cheap and good paper for all useful purposes, and especially suitable for the printing press.

We may remind enthusiasts in paper materials—and their name is legion—that all vegetable substances whose fibre has a corrugated edge, are suitable for the manufacture of paper. The extent to which such material can be applied is altogether a question of cost, and depends upon the chemical nature and quantity of the impurities to be removed. With rags, many of the impurities have been already abstracted by the different processes to which the cotton or linen fibre has been subjected, so that the work is already half done, and the discovery of a cheap paper material would at once lessen the price of rags, which are continually accumulating, without the general introduction of woollen clothing should largely supersede the use of cotton and flax in temperate climates, a contingency which is certainly not likely to happen to such an extent as of itself seriously to affect the price of rags. The problem, however, is an attractive one, and promises well, if due attention is given to the cost of preparing the raw material, and the strength, beauty, finish and durability of the manufactured article, for as yet no one has succeeded in making, from any other fibre, paper equal in all or in many respects to that produced from "rags and tatters."

In order to reduce straw to a suitable consistency for paper-making, it is first cut into lengths, and then winnowed to separate the knots. The coarse part is reserved for brown wrapping paper, the finer portions of the straw are introduced with an alkaline mixture into a strong boiler, where it is subjected for a period of five hours to a boiling process, under a pressure of steam varying from 100 to 120, and sometimes in England to 150 lbs. to the square inch.

The alkaline liquor is composed of about 7 parts carbonate of soda, and 8 parts of lime, mixed with water; the effect of these agents is to dissolve the flint or silica of the straw under a high temperature, and convert it into an alkaline soluble silicate, which, when withdrawn from the fibre, leaves the vegetable or organic portion in such a soft condition that it may be easily reduced to pulp after being subjected to the action of the beating engine, when it is ready to be bleached. The abstraction of the silica causes the straw to lose one-half in weight, whereas rags lose only one third, by the process to which they are subjected. If the silica be not removed, the paper is so brittle as to unfit it for printing purposes, and the readiness with which some varieties of coarse straw paper tear in any direction is due to the presence of the silica, which the alkali, under great pressure and consequently heat, ought to have converted into a soluble condition, so as to ensure its subsequent removal by washing with pure water. The knots and fragments of weeds which are not removed by the winnowing process, frequently escape disintegration, even after prolonged action in the boiler, and if they are not separated by an after-filtering process, to be presently described, they render the paper spotty and detract from its appearance and value.

Should the alkaline solvent be too strong, the vegetable fibre is destroyed, and, instead of pulp, a thick liquid, in which no trace of fibre can be discovered, is the result, and the boiling is spoiled. If the temperature in the boiler be not sufficiently high (the temperature being dependent on the pressure), or the alkaline liquor not sufficiently strong, a five hour's boiling will not suffice to abstract all the silica, and the paper will be brittle and consequently fragile. It will occur to the reader that however careful the manipulators may be in testing the strength of their alkaline liquor, and in the temperature or pressure to which they submit the comminuted straw in the boiling process, yet the samples of paper produced under apparently the same conditions, will differ very widely in their properties, some being more brittle than others; this arises from the character of the straw employed, and it is a point to which we think too little attention is given. Wheat straw grown upon different soils varies very considerably in the amount of silica it contains, and it would, we think, be a matter of true economy, if the manufacturer would make a point of keeping separate the straw obtained from different localities where soils vary. It is clear that the same process which succeeds in converting into available pulp a straw poor in silica, will produce a brittle and comparatively worthless paper from straw rich in that element. It may be that some apparently inexplicable failures in particular "boilings" have resulted from a want of attention to the siliceous character of the straw. A little practice would soon enable a manipulator to determine whether a straw was rich or poor in silica, and the time during which it is submitted to the boiling process, and the strength of the alkali, should depend upon the relative quantity of silica in the material operated upon.

After the pulp has been well washed to withdraw all the soluble alkaline silicates, it is submitted to the bleaching process. The bleaching agent being the common chloride of lime or bleaching powder.

In practice it is found that notwithstanding the winnowing process, knots and fragments of weeds are found mingled with the pulp, which resist not only the boiling in alkali—the action of the bleach—but also that of the beating or grinding machine, through which the pulp is subsequently passed. These impurities, although unsightly, do not materially affect the sale of the straw paper for newspaper purposes, but if a superior article for books or writing paper is required, they constitute an insuperable objection. This difficulty may be in a great measure remedied by filtering the pulp through a sieve composed of fine slits, and so adjusted that the air beneath may be exhausted; the thin pulp passes through the slits, but leaves the impurities behind. This process is used in the best machines, and is found effective. The pulp being obtained by the manipulations described, is passed through the ordinary paper-making machine, calendered, and then cut to the requisite size. Pearl hardening is not used, as far as we are aware, in this establishment.

In the neighbourhood of Messrs. Barber's paper mills there may now be seen five immense stacks, each of which contains about eighty tons, or in the aggregate four hundred tons of wheat straw. It is well worth notice and reflection that, by the energy and intelligence of these gentlemen, the crude mass which so many passing eyes look upon without speculation in them, will probably, by the spring of next year, have circulated throughout the length and breadth of Canada, in the form of printed paper, thus becoming the means of convey-intelligence from day to day to millions of thinking creatures. Some of it will have been distributed in narrow streams throughout the United States, other portions will cross the Atlantic, and may meet the eye of "the Thunderer,' who will learn his lessons on Canadian politics, and endeavour to see which way the wind blows by gazing at a few straws properly manipulated from Messrs. Barber's huge stacks of eighty tons each.

We do not doubt that paper can be manufactured from straw so as to present as even and uniform a surface as the paper made from rags. But it would perhaps be necessary to adopt the tinting processes and pearl-hardening now so common in Europe, and which cover such a multitude of imperfections. Any one who examines the "Illustrated London News" paper will see that it is delicately tinted. The introduction of certain colours into the pulp possesses many advantages, as far as the appearance of the paper is concerned, and there can be no doubt that by a proper exhausting filtering apparatus to remove knots, and a judicious admixture of particular colouring minerals, so introduced that the paper shall be uniformly tinted, straw paper with a very small admixture of rags could be, and shortly will be, made suitable for books and paper of every description in common use.

BARBER & BROTHERS' WOOLLEN MILLS AT STREETSVILLE.

The manufacture of woollen fabrics of all descriptions is a branch of home industry which deserves all the encouragement the country can afford. Not only is it of special importance to the farmer, but in this climate it becomes a home question to people of all classes and conditions of life. Woollen clothing is absolutely necessary in Canada, if we wish to preserve health, during the extremes of summer heat and winter cold. We venture to say that not only would the average duration of human life in Canada and the United States be lengthened by the universal use of woollen wearing apparel, but there would also be a vast diminution in the suffering entailed on a large part of the population by rheumatism, neuralgia, and a host of kindred ailments, which can frequently be directly traced to unsuitable clothing, manufactured from cotton, and the neglect of woollen wearing apparel.

Messrs. Barber & Brothers, of Georgetown and Streetsville, have long been known in the Province as most enterprising woollen manufacturers and paper makers, and more recently as having so successfully introduced the manufacture of wall papers, specimens of which attracted well deserved attention at the recent Exhibition at Kingston.

It will be in the recollection of our readers that the Messrs. Barber's mill was burned down in June, 1862; but it is not generally known that on the morning after the fire, gangs of men might be seen wending their way to the pine forests on the Credit, to cut timber for the reconstruction of the mill; and two days after the destruction of their property, involving a loss of $90,000, one member of the firm was on his way to the New England States to purchase machinery for the new mill about to rise from the ashes of the old one. So energetic and untiring in their labour were these enterprising men, that the present establishment, commenced in June 1862, was completed in October of the same year.

It is divided into four stories, in each of which the different operations of picking, carding, spinning, weaving and finishing are carried on, by machinery of the best description. The dyeing operations are effected in a building adjoining the mill. We purpose to accompany our readers through the different departments of this establishment, and endeavour to give a general outline of the operations and processes (omitting details) which the wool of Canadian sheep undergoes, until it appears in the form of Canadian cloths, tweeds, flannels and blankets.

The first operation, after washing, is to dye the wool of the required colour. All the dye stuffs are imported, and a field is open for practical men in the preparation of certain dyeing materials which are much used in woollen manufactures; such as prussiate of potash, for the manufacture of Prussian blue, &c., of which abundance of materials suitable for its preparation are allowed to go to waste in many different manufacturing establishments. We hope, too, that the day may yet arrive when the chromic iron ores, noticed in page 232 of this journal, may be used for the manufacture of bichromate of potash, for home use, notwithstanding the announcement recently made in an English journal, that the manufacture of this valuable substance is diminishing, on account of the discovery and general adoption of the new aniline colours, which have yet to prove their worth as stable and persistent rivals of the well-known and beautiful chrome dyes.

The dyed wool is first picked, and then oiled, before it is subjected to further manipulation. This is an important process; olive oil is used, and in a large manufactory it forms an expensive item. Harsh wools require one-seventeenth of their weight of oil, others no more than one-fortieth. Until very recently, in Europe as well as in America, the oil has been scattered in drops over the wool by hand. The result has been that the oil was unevenly distributed, in some places the wool being clotted, in others escaping the oil altogether. As inequality in oiling produces inequality in the yarn, the defects of the present process are discernable in many parts of the manufacture. It is now proposed, by the invention of a simple and very appropriate instrument, to oil the wool with the aid of machinery, in a perfectly uniform manner. The invention of the apparatus is due to Mr. Leach, of the Britannia Mills, Leeds, and is noticed on page 285 of this journal. As the wool passes along the feed-sheet of the preparing machine, the oil is scattered over it in the form of a spray or mist. The quantity of oil can be varied at pleasure; and not only is there a great saving of labour, but also of oil—an important item in Canada.

The oiled wool is now submitted to the carding process, on the third story, by which the filaments are laid parallel to one another, the short wool and accidental impurities combed out, and the wool prepared for spinning. Messrs. Barber & Brothers keep 2,000 spindles in operation, one workman attending to 250 spindles. These occupy the second story. The first story is devoted to weaving, and here the manufacture of cloths, tweeds, shirtings, &c., is carried on. In August of this present year, 18,954 yards of cloth were manufactured at this establishment, employing on the whole ninety hands, whose wages amount to $1,600 a month. After the cloth is wove, it passes through the fulling mill, on the ground floor, and is thence carried to the drying room. This operation is technically called tentering, and the cloth suffers during its passage through the fulling mill a shrinkage of nearly one quarter. When sufficiently dried, it is brought back to the main building, carefully examined in every part, and freed from knots or uneven threads. It is then drawn through the teasling machine, the object of which operation is to raise up the loose filaments of the yarn into a nap. The teasles used for this purpose are imported, but it is Messrs. Barber's intention to grow them near the mill; and as this plant succeeds well in Canada, it is to be expected that the home-raised article will soon expel the imported one. Although many attempts have been made to supersede the delicate little hooks of the teasle by appropriate machinery, yet all efforts have hitherto failed. The operation of teasling necessarily draws out the filaments of the wool unequally, and it becomes essential to cut them off with different degrees of closeness, according to the appearance the cloth is desired to possess. Hence the cloth is passed through the shearing machine. The last finish given to cloth is by pressing, which is effected by powerful hydraulic machines; after which the pieces are formed into rolls, weighed, ticketed, and despatched to the store room.

It is impossible to pass through such an establishment as we have endeavored briefly to describe, without being struck with the mutual dependence of the manufacturer and the farmer. Ordinary Canadian wool is too coarse for the finer varieties of cloth, and consequently it is necessary to import a certain quantity of the finer sorts, which, by the way, could be produced in Canada just as well as in the States or in England, if farmers would give due attention to the subject. If wool be examined under the microscope, the sides of each filament will be seen to be serrated, and wool with the finest serrations is used for making superfine cloth. The finest Saxony wool contains generally about 2,700 serratures to a single inch, Merino wool 2,400, Southdown 2,080, and Leicester wool not more than 1,850 serratures to an inch. The process of felting depends upon these little serrations becoming entangled one in another. If the wool is coarse it does not felt easily and thoroughly, consequently very fine and compact cloth cannot be made from wool containing a small number of serrations. It is generally understood that the longer the wool, the less the number of serratures to the inch; hence short wools are preferred for the cloth manufacture, and long wools for the worsted manufacture. It should be the object of the farmer to endeavour to obtain short-wooled sheep, and by proper breeding and care make them preserve that characteristic. The splendid wools which now come from Australia originated from a few Merino sheep which were sent there. The climate, being dry, suits the breed admirably, yet the real Merino sheep cannot succeed in England, where the climate is damp, but it does well in Canada.

We have not thought it advisable to describe the different stages of the manufacture of different kinds of wool, such as long and short wool. Although it may not be out of place here, to mention briefly, that short wool is used for the manufacture of cloth, long wool for worsted goods. Short wool is best adapted for carding, and long wool for combing. Combing destroys to a certain extent, the felting properties of long wool, carding has no effect on short wool. Hence the great distinction between woollen cloth and worsted goods is, that the wool in the former retains the property of felting, but in the other it has been in part deprived of it. In the samples of cloth and flannel shirtings, which are to be seen in abundance at Messrs. Barber & Brothers, no one will fail to be struck with the excellent adaptation of these fabrics, to both the winter and summer climate of this country. The close compact texture of some of the winter goods, would enable the traveller to bid defiance to the most cutting wind, and on the other hand the light texture of the summer cloths and shirtings, are admirably suited to the climate of Canada. It is almost needless to say, that due encouragement given to Canadian woollen manufactures, such as those we have been describing, will rapidly render us independent of the foreign manufacturer, who buys our wool at 25 cents a pound, and returns it to us in the form of cloth, at $1 25, thus appropriating four-fifths of the value of the manufactured article; not a cent's worth of which should have been earned out of the country.

THE PROVINCIAL EXHIBITION.

Good fortune has not favoured the Kingston Exhibition this year. The weather was unpropitious at its commencement, and unfavourable at its close.

In a financial point of view, it has not been successful, and as a representation of the manufacturing industry of the country, it must be considered to have fallen below the mark. The representative short-comings are to be attributed in a great measure, to the geographical situation of Kingston, which places it so far from the manufacturers at Toronto and west of that city, that the great draw back of cost and loss of time, and risk of danger in bad weather in sending articles to the Exhibition, was largely instrumental in inducing many manufacturers to refrain from forwarding their contributions.

Among the growing manufactures of the Province, which a few years since were unknown as articles of domestic production, we may mention among many others without any invidious selection, that of tobacco, which being new to western Canada, giving employment to many operatives, and involving the circulation of a large amount of capital, promises to become of considerable importance to the country. The manufacture of wall-paper was also effectively represented, and the articles shown were equal to, if not in some respects superior to those of foreign production.

In carriages great improvement has taken place, but still it was evident that vehicles of superior construction and finish to those on exhibition, might have made their appearance at Kingston under more favourable circumstances.

Although woollen manufactures are fast becoming one of the staple industries of the province, yet some well known names were missing among the contributors. We have elsewhere in this number of the journal, alluded to the woollen manufactures of one enterprising firm near Toronto, from which some idea of the importance of encouraging this branch of industry may be gathered. The absence of steam-engines at Kingston, was generally recognized as a falling off in one department, in which an increase might reasonably have been expected.

The exhibition of specimens of flax was promising. Flax might become the ground work of the most important industrial interest in Canada. Efforts have been made by the Government, and by private individuals, to extend the culture of flax, and to introduce machines for its preparation. And although the progress is slow, yet it may be now asserted with confidence that it is sure; yet it has to be recorded that there were no flax dressing machines exhibited at Kingston. The total number of entries in the Arts and Manufactures department, did not exceed 1,200. We shall be able to give the exact number, with the corrected prize list, in the next number of the journal.

BRITISH ASSOCIATION, 1863.

The President's Address.

Gentlemen of the British Association,—I esteem it the greatest honour of my life that I am called upon to assume the office of your President. In that capacity, and as representing your body, I may be allowed to advert to the gratifying reception which the British Association met with on their former visit to this region of mining and manufacturing industry, and, as a member of the community which you have again honored with a visit, I undertake to convey to you the assurance of a renewed and hearty welcome. A quarter of a century has elapsed since the Association assembled in this town, and in no former period of equal duration has so great a progress been made in physical knowledge. In mechanical science, and especially in those branches of it which are concerned in the application of steam power to effect interchange between distant communities, the progress made since 1838 has no parallel in history. The railway system was then in its infancy and the great problem of trans-Atlantic steam navigation had only received its complete solution in the preceding year. Since that time railways have extended to every continent and steamships have covered the ocean. These reflections claim our attention on this occasion, because the locality in which we hold our present meeting is the birth place of railways, and because the coal mines of this district have contributed more largely than any others to supply the motive power by which steam communication by land and water has been established on so gigantic a scale.

The history of railways shows what grand results may have their origin in small beginnings. When coal was first conveyed in this neighbourhood from the pit to the shipping place on the Tyne, the pack-horse, carrying a burden of 3 cwt. was the only mode of transport employed. As soon as roads suitable for wheeled carriages were formed, carts were introduced, and this first step in mechanical appliance to facilitate transport had the effect of increasing the load which the horse was enabled to convey from 3 cwt. to 17 cwt. The next improvement consisted in laying wooden bars or rails for the wheels of the carts to run upon, and this was followed by the substitution of the four-wheeled waggon, for the two-wheeled cart. By this further application of mechanical principles the original horse load of 3 cwt. was augmented to 42 cwt. These were important results, and they were not obtained without the shipwreck of the fortunes of at least one adventurous man whose ideas were in advance of the times in which he lived. We read, in a record published in the year 1649, that "one Master Beaumont, a gentleman of great ingenuity and rare parts, adventured into the mines of Northumberland, with his £30,000, and brought with him many rare engines not then known in that shire, and waggons with one horse to carry down coal from the pits to the river, but within a few years he consumed all his money and rode home upon his light horse." The next step in the progress of railways was the attachment of slips of iron to the wooden rails. Then came the iron tramway, consisting of cast iron bars of an angular section: in this arrangement the upright flange of the bar acted as a guide to keep the wheel on the track. The next advance was an important one, and consisted in transferring the guiding flange from the rail to the wheel; this improvement enabled cast iron edge rails to be used. Finally, in 1820, after the lapse of about 200 years from the first employment of wooden bars, wrought-iron rails, rolled in long lengths, and of suitable section, were made in this neighbourhood, and eventually superseded all other forms of railway. Thus, the railway system, like all large inventions, has risen to its present importance by a series of steps; and so gradual has been its progress that Europe finds itself committed to a guage fortuitously determined by the distance between the wheels of the carts for which wooden rails were originally laid down.

Last of all came the locomotive engine, that crowning achievement of mechanical science,—

which enables us to convey a load of 200 tons at a cost of fuel scarcely exceeding that of the corn and hay which the original pack-horse consumed in conveying its load of 3 cwt. an equal distance.

It was chiefly in this locality that the railway system was thus reared from earliest infancy to full maturity, and amongst the many names associated with its growth, that of George Stephenson stands pre-eminent.

In thus glancing at the history of railways we may observe how promptly the inventive faculty of man supplies the device which the circumstances of the moment require. No sooner is a road formed fit for wheeled carriages to pass along, than the cart takes the place of the pack saddle: no sooner is the wooden railway provided than the waggon is substituted for the cart, and no sooner is an iron railway formed, capable of carrying heavy loads, than the locomotive engine is found ready to commence its career. As in the vegetable kingdom fit conditions of soil and climate quickly cause the appearance of suitable plants, so in the intellectual world fitness of time and circumstance promptly calls forth appropriate devices. The seeds of invention exist, as it were, in the air, ready to germinate whenever suitable conditions arise, and no legislative interference is needed to ensure their growth in proper season.

The coal-fields of this district, so intimately connected with the railway system, both in its origin and maintenance, will doubtless receive much attention from the Association at their present meeting.

To persons who contend that all geological phenomenon may be attributed to causes identical in nature and degree with those now in operation, the formation of coal must present peculiar difficulty. The rankness of vegetation which must have existed in the carboniferous era, and the uniformity of climate which appears to have prevailed almost from the Poles to the Equator, would seem to imply a higher temperature of the earth's crust, and an atmosphere more laden with humidity and carbonic acid than exist in our day. But whatever may have been the geological conditions affecting the origin of coal, we may regard the deposits of that mineral as vast magazines of power stored up at periods immeasurably distant for our use.

The principle of conservation of force, and the relationship now established between heat and motion, enable us to trace back the effects we now derive from coal to equivalent agencies exercised at the periods of its formation. The philosophical mind of George Stephenson, unaided by theoretical knowledge, saw that coal was the embodiment of power originally derived from the sun. That small pencil of solar radiation which is arrested by our planet, and which constitutes less than the 2,000-millionth part of the total energy sent forth from the sun, must be regarded as the power which enabled the plants of the carboniferous period to wrest the carbon they required from the oxygen with which it was combined, and eventually to deposit it as the solid material of coal. In our day, the reunion of that carbon with oxygen restores the energy expended in the former process, and thus we are enabled to utilize the power originally derived from the luminous centre of our planetary system.

But the agency of the sun in originating coal does not stop at this point. In every period of geological history the waters of the ocean have been lifted by the action of the sun and precipitated in rain upon the earth. This has given rise to all those sedimentary actions by which mineral substances have been collected at particular localities, and there deposited in a stratified form with a protecting cover to preserve them for future use. The phase of the earth's existence suitable for the extensive formation of coal appears to have passed away for ever; but the quantity of that invaluable mineral which has been stored up throughout the globe for our benefit is sufficient (if used discreetly) to serve the purposes of the human race for many thousands of years. In fact, the entire quantity of coal may be considered as practically inexhaustible. Turning, however, to our own particular country, and contemplating the rate at which we are expending those seams of coal which yield the best quality of fuel, and can be worked at the least expense, we shall find much cause for anxiety. The greatness of England much depends upon the superiority of her coal in cheapness and quality over that of other nations; but we have already drawn from our choicest mines a far larger quantity of coal than has been raised in all other parts of the world put together, and the time is not remote when we shall have to encounter the disadvantages of increased cost of working and diminished value of produce.

Estimates have been made at various periods of the time which would be required to produce complete exhaustion of all the accessible coal in the British Islands. These estimates are extremely discordant; but the discrepancies arise, not from any important disagreement as to the available quantity of coal, but from the enormous difference in the rate of consumption at the various dates when the estimates were made, and also from the different views which have been entertained as to the probable increase of consumption in future years. The quantity of coal yearly worked from British mines has been almost trebled during the last twenty years, and has probably increased tenfold since the commencement of the present century; but as this increase has taken place pending the introduction of steam navigation and railway transit, and under exceptional conditions of manufacturing development, it would be too much to assume that it will continue to advance with equal rapidity. The statistics collected by Mr. Hunt, of the Mining Records Office, show that at the end of 1861 the quantity of coal raised in the United Kingdom had reached the enormous total of 86 millions of tons, and that the average annual increase of the eight preceding years amounted to 2¾ millions of tons. Let us enquire, then, what will be the duration of our coal-fields if this more moderate rate of increase be maintained.

By combining the known thickness of the various workable seams of coal, and computing the area of the surface under which they lie, it is easy to arrive at an estimate of the total quantity comprised in our coal-bearing strata. Assuming 4,000 feet as the greatest depth at which it will ever be possible to carry on mining operations, and rejecting all seams of less than two feet in thickness, the entire quantity of available coal existing in these islands has been calculated to amount to about 80,000 millions of tons, which, at the present rate of consumption, would be exhausted in 930 years, but, with a continued yearly increase of 2¾ millions of tons, would only last 212 years. It is clear that long before complete exhaustion takes place, England will have ceased to be a coal-producing country on an extensive scale. Other nations, and especially the United States of America, which possess coal-fields thirty-seven times more extensive than ours, will then be working more accessible beds at a smaller cost, and will be able to displace the English coal from every market. The question is, not how long our coal will endure before absolute exhaustion is effected, but how long will those particular coal-seams last which yield coal of a quality and at a price to enable this country to maintain her present supremacy in manufacturing industry. So far as this particular district is concerned, it is generally admitted that 200 years will be sufficient to exhaust the principal seams even at the present rate of working. If the production should continue to increase, as it is now doing, the duration of those seams will not reach half that period. How the case may stand in other coal-mining districts I have not the means of ascertaining; but as the best and most accessible coal will always be worked in preference to any other, I fear the same rapid exhaustion of our most valuable seams is everywhere taking place. Were we reaping the full advantage of all the coal we burnt, no objection could be made to the largeness of the quantity, but we are using it wastefully and extravagantly in all its applications. It is probable that fully one-fourth of the entire quantity of coal raised from our mines is used in the production of heat for motive power; but, much as we are in the habit of admiring the powers of the steam-engine, our present knowledge of the mechanical energy of heat shows that we realize in that engine only a small part of the thermic effect of the fuel. That a pound of coal should, in our best engines, produce an effect equal to raising a weight of a million pounds a foot high, is a result which bears the character of the marvellous, and seems to defy all further improvement. Yet the investigations of recent years have demonstrated the fact that the mechanical energy resident in a pound of coal, and liberated by its combustion, is capable of raising to the same height 10 times that weight. But although the power of our most economical steam-engines has reached, or perhaps somewhat exceeded, the limit of a million pounds raised a foot high per lb. of coal, yet, if we take the average effect obtained from steam-engines of the various constructions now in use, we shall not be justified in assuming it at more than one-third of that amount. It follows, therefore, that the average quantity of coal which we expend on realizing a given effect by means of the steam-engine is about 30 times greater than would be requisite with an absolutely perfect heat-engine.

The causes which render the application of heat so uneconomic in the steam-engine have been brought to light by the discovery of the dynamical theory of heat; and it now remains for mechanicians, guided by the light they have thus received, to devise improved practical methods of converting the heat of combustion into available power.

Engines in which the motive power is excited by the communication of heat to fluids already existing in the aëriform condition, as in those of Stirling, Ericsson and Siemens, promise to afford results greatly superior to those obtained from the steam-engine. They are all based upon the principle of employing fuel to generate sensible heat, to the exclusion of latent heat, which is only another name for heat which has taken the form of unprofitable motion amongst the particles of the fluid to which it is applied. They also embrace what is called the regenerative principle—a term which has, with reason, been objected to, as implying a restoration of expended heat. The so-called "regenerator" is a contrivance for arresting unutilized heat rejected by the engine, and causing it to operate in aid and consequent reduction of fuel.

It is a common observation that before coal is exhausted some other motive agent will be discovered to take its place, and electricity is generally cited as the coming power. Electricity, like heat, may be converted into motion, and both theory and practice have demonstrated that its mechanical application does not involve so much waste of power as takes place in a steam-engine; but whether we use heat or electricity as a motive power, we must equally depend upon chemical affinity as the source of supply. The act of uniting to form a chemical product liberates an energy which assumes the form of heat or electricity, from either of which states it is convertible into mechanical effect. In contemplating, therefore, the application of electricity as a motive power, we must bear in mind that we shall still require to effect chemical combinations, and in so doing to consume materials. But where are we to find materials so economical for this purpose as the coal we derive from the earth and the oxygen we obtain from the air? The latter costs absolutely nothing; and every pound of coal, which in the act of combustion enters into chemical combination, renders more than two-and a-half pounds of oxygen available for power. We cannot look to water as a practical source of oxygen, for there it exists in the combined state, requiring expenditure of chemical energy for its separation from hydrogen. It is in the atmosphere alone that it can be found in that free state in which we require it, and there does not appear to me to be the remotest chance, in an economic point of view, of being able to dispense with the oxygen of the air as a source either of thermo-dynamic or electro-dynamic effect. But to use this oxygen we must consume some oxidizable substance, and coal is the cheapest we can procure.

There is another source of motive power to which I am induced to refer, as exhibiting a further instance in which solar influence affords the means of obtaining mechanical effects from inanimate agents. I allude to the power of water descending from heights to which it has been lifted by the evaporative action of the sun. To illustrate the great advantage of collecting water for power in elevated situations, I may refer to the waterworks of Greenock, where the collecting-reservoirs are situated at an elevation of 512 feet above the river Clyde. The daily yield of these reservoirs is said to be nearly 100,000 tons of water, which is derived from the rainfall on an area of 5,000 acres. The power obtainable from this quantity and head of water is equal to that of a steam-engine of about 2,000 horse-power, and the whole effect might be realized on the margin of the river by bringing down the water in a pipe of sufficient capacity, and causing it to act as a column on suitable machinery at the foot of the descent. But the hydraulic capabilities of the Greenock reservoirs sink into insignificance when compared with those of other localities where the naturally collected waters of large areas of surface descend from great elevations in rapid rivers or vertical falls. Alpine regions abound in falls which, with the aid of artificial works to impound the surplus water and equalize the supply, would yield thousands of horse-power; and there is at least one great river in the world which in a single plunge developes sufficient power to carry on all the manufacturing operations of mankind if concentrated in its neighborhood. Industrial populations have scarcely yet extended to those regions which afford this profusion of motive power, but we may anticipate the time when these natural falls will be brought into useful operation. In that day the heat of the sun, by raising the water to heights from which to flow in these great rapids and cascades, will become the means of economizing the precious stores of motive power, which the solar energy differently directed has accumulated at a remote period of geological history, and which when once expended may probably never be replaced.

I have hitherto spoken of coal only as a source of mechanical power, but it is also extensively used for the kindred purpose of relaxing those cohesive forces which resist our efforts to give new forms and conditions to solid substances. In these applications, which are generally of a metallurgical nature, the same wasteful expenditure of fuel is everywhere observable. In an ordinary furnace employed to fuse or soften any solid substance, it is the excess of the heat of combustion over that of the body heated which alone is rendered available for the purpose intended. The rest of the heat, which in many instances constitutes by far the greater proportion of the whole, is allowed to escape uselessly into the chimney. The combustion also in common furnaces is so imperfect, that clouds of powdered carbon, in the form of smoke, envelope our manufacturing towns, and gases, which ought to be completely oxygenized in the fire, pass into the air with two-thirds of their heating power undeveloped.

Some remedy for this state of things, we may hope, is at hand, in the gas regenerative furnaces recently introduced by Mr. Siemens. In these furnaces the rejected heat is arrested by a so-called "regenerator," as in Stirling's air-engine, and is communicated to the new fuel before it enters the furnace. The fuel, however, is not solid coal, but gas previously evolved from coal. A stream of this gas raised to a high temperature by the rejected heat of combustion is admitted into the furnace, and there meets a stream of atmospheric air also raised to a high temperature by the same agency. In the combination which then ensues, the heat evolved by the combustion is superadded to the heat previously acquired by the gases. Thus, in addition to the advantage of economy, a greater intensity of heat is attained than by the combustion of unheated fuel. In fact, as the heat evolved in the furnace, or so much of it as is not communicated to the bodies exposed to its action, continually returns to augment the effect of the new fuel, there appears to be no limit to the temperature attainable, except the powers of resistance in the materials of which the furnace is composed.

With regard to smoke, which is at once a waste and a nuisance, having myself taken part with Dr. Richardson and Mr. Longridge in a series of experiments made in this neighbourhood in the years 1857-58 for the purpose of testing the practicability of preventing smoke in the combustion of bituminous coal in steam-engine boilers, I can state with perfect confidence that, so far as the raising of steam is concerned, the production of smoke is unnecessary and inexcusable. The experiments to which I refer proved beyond a doubt, that by an easy method of firing, combined with due admission of air and a proper arrangement of fire-grate, not involving any complexity, the emission of smoke might be perfectly avoided, and that the prevention of the smoke increased the economic value of the fuel and the evaporative power of the boiler. As a rule, there is more smoke evolved from the fires of steam-engines than from any others, and it is in these fires that it may be most easily prevented. But in the furnaces used for most manufacturing operations the prevention of smoke is much more difficult, and will probably not be effected until a radical change is made in the system of applying fuel for such operations.

Not less wasteful and extravagant is our mode of employing coal for domestic purposes. It is computed that the consumption of coal in dwelling houses amounts in this country to a ton per head per annum of the entire population; so that upwards of twenty-nine millions of tons are annually expended in Great Britain alone for domestic use. If any one will consider that one pound of coal applied to a well-constructed steam-engine boiler evaporates 10 lb., or one gallon of water, and if he will compare this effect with the insignificant quantity of water which can be boiled off in steam by a pound of coal consumed in an ordinary kitchen fire, he will be able to appreciate the enormous waste which takes place by the common method of burning coal for culinary purposes. The simplest arrangements to confine the heat and concentrate it upon the operation to be performed would suffice to obviate this reprehensible waste. So also in warming houses we consume in our open fires about five times as much coal as will produce the same heating effect when burnt in a close and properly constructed stove. Without sacrificing the luxury of a visible fire, it would be easy, by attending to the principles of radiation and convection, to render available the greater part of the heat which is now so improvidently discharged into the chimney. These are homely considerations—too much so, perhaps, for an assembly like this; but I trust that an abuse involving a useless expenditure exceeding in amount our income-tax, and capable of being rectified by attention to scientific principles, may not be deemed unworthy of the notice of some of those whom I have the honour of addressing.

The introduction of the Davy lamp was a great event in the history of coal-mining, not as effecting any great diminution of those disastrous accidents which still devastate every colliery district, but as a means of enabling mines to be worked, which from their greater explosive tendencies, would otherwise have been deemed inaccessible. Thus while the Davy lamp has been of great benefit both to the public and the proprietors of coal, it has been the means of leading the miners into more perilous workings, and the frequency of accident by explosion has in consequence not been diminished to the extent which was originally expected. The Davy lamp is a beautiful application of a scientific principle to effect a practical purpose, and with fair treatment its efficiency is indisputable; but where Davy lamps are entrusted to hundreds of men, and amongst them too many careless and reckless persons, it is impossible to guard entirely against gross negligence and its disastrous consequences. In coal mines where the most perfect system of ventilation prevails, and where proper regulations are, as far as practicable, enforced in regard to the use of Davy lamps, deplorable accidents do occasionally occur, and it is impossible at present to point out what additional precautions would secure immunity from such calamities. The only gleam of amelioration is in the fact that the loss of life in relation to the quantity of coal worked is on the decrease, from which we may infer that it is also on the decrease taken as a percentage on the number of miners employed.

The increase of the earth's temperature as we descend below the surface is a subject which has been discussed at previous meetings of the British Association. It possesses great scientific interest as affecting the computed thickness of the crust which covers the molten mass assumed to constitute the interior portions of the earth, and it is also of great practical importance as determining the depth at which it would be possible to pursue the working of coal and other minerals. The deepest coal-mine in this district is the Monkwearmouth Colliery, which reaches a depth of 1,800 feet below the surface of the ground, and nearly as much below the level of the sea. The observed temperature of the strata at this depth agrees pretty closely with what has been ascertained in other localities, and shows that the increase takes place at the rate of 1° Fahr. to about 60 feet of depth. Assuming the temperature of subterranean fusion to be 3,000°, and that the increase of heat at greater depths continues uniform (which, however, is by no means certain), the thickness of the film which separates us from the fiery ocean beneath will be about 34 miles—a thickness which may be fairly represented by the skin of a peach taken in relation to the body of the fruit which it covers. The depth of 4,000 feet, which has been assumed as the limit at which coal could be worked, would probably be attended by an increase of heat exceeding the powers of human endurance. In the Monkwearmouth Colliery, which is less than half that depth, the temperature of the air in the workings is about 84° Fahr., which is considered to be nearly as high as is consistent with the great bodily exertion necessary in the operation of mining. The computations, therefore, of the duration of coal would probably require a considerable reduction in consequence of too great a depth being assumed as practicable.

At the last meeting of the British Association in this town, the importance of establishing an office for mining records was brought under the notice of the Council by Mr. Sopwith, and measures were taken which resulted in the formation of the present Mining Records Office. The British Association may congratulate itself upon having thus been instrumental in establishing an office in which plans of abandoned mines are preserved for the information of those who, at a future period, may be disposed to incur the expense of bringing those mines again into operation. But more than this is required. Many of the inferior seams of coal can be profitably worked only in conjunction with those of superior quality, and they will be entirely lost if neglected until the choicer beds be exhausted. Although coal is private property, its duration is a national question, and Government interference would be justified to enforce such modes of working as the national interests demand. But to enable Government to exercise any supervision and control, a complete mining survey of all our coal-fields should be made, and full plans, sections, and reports lodged at the Mining Records Office, for the information of the legislature and of the public in general.

Before dismissing the subject of coal, it may be proper to notice the recent discovery by Berthelot of a new form of carburetted hydrogen possessing twice the illuminating power of ordinary coal-gas. Berthelot succeeded in procuring this gas by passing hydrogen between the carbon electrodes of a powerful battery. Dr. Odling has since shown that the same gas may be produced by mixing carbonic oxide with an equal volume of light carburetted hydrogen, and exposing the mixture in a porcelain tube to an intense heat. Still more recently, Mr. Siemens has detected the same gas in the highly-heated regenerators of his furnaces, and there is now every reason to believe that the new gas will become practically available for illuminating purposes. Thus it is that discoveries which in the first instance interest the philosopher only, almost invariably initiate a rapid series of steps leading to results of great practical importance to mankind.

In the course of the preceding observations I have had occasion to speak of the sun as the great source of motive power on our earth, and I must not omit to refer to recent discoveries connected with that most glorious body. Of all the results which science has produced within the last few years, none has been more unexpected than that by which we are enabled to test the materials of which the sun is made, and prove their identity, in part at least, with those of our planet. The spectrum experiments of Bunsen and Kirchhoff have not only shown all this, but they have also corroborated previous conjectures as to the luminous envelope of the sun. I have still to advert to Mr. Nasmyth's remarkable discovery, that the bright surface of the sun is composed of an aggregation of apparently solid forms, shaped like willow-leaves or some well-known forms of diatomaceæ, and interlacing one another in every direction. The forms are so regular in size and shape, as to have led to a suggestion from one of our profoundest philosophers of their being organisms, possibly even partaking of the nature of life, but at all events closely connected with the heating and vivifying influences of the sun. These mysterious objects, which, since Mr. Nasmyth discovered them, have been seen by other observers as well, are computed to be each not less than 1,000 miles in length and about 100 miles in breadth. The enormous chasms in the sun's photosphere, to which we apply the diminutive term "spots," exhibit the extremities of these leaf-like bodies pointing inwards, and fringing the sides of the cavern far down into the abyss. Sometimes they form a sort of rope or bridge across the chasm, and appear to adhere to one another by literal attraction. I can imagine nothing more deserving of the scrutiny of observers than these extraordinary forms. The sympathy, also, which appears to exist between forces operating in the sun, and magnetic forces belonging to the earth merits a continuance of that close attention which it has already received from the British Association, and of labours such as General Sabine has with so much ability and effect devoted to the elucidation of the subject. I may here notice that most remarkable phenomenon which was seen by independent observers at two different places on the 1st of September, 1859. A sudden outburst of light, far exceeding the brightness of the sun's surface, was seen to take place, and sweep like a drifting cloud over a portion of the solar face This was attended with magnetic disturbances of unusual intensity and with exhibitions of aurora of extraordinary brilliancy. The identical instant at which the effusion of light was observed was recorded by an abrupt and strongly marked deflection in the self-registering instruments at Kew. The phenomenon as seen was probably only part of what actually took place, for the magnetic storm in the midst of which it occurred commenced before and continued after the event. If conjecture be allowable in such a case, we may suppose that this remarkable event had some connexion with the means by which the sun's heat is renovated. It is a reasonable supposition that the sun was at that time in the act of receiving a more than usual accession of new energy; and the theory which assigns the maintenance of its power to cosmical matter plunging into it with that prodigious velocity which gravitation would impress upon it as it approached to actual contact with the solar orb, would afford an explanation of this sudden exhibition of intensified light in harmony with the knowledge we have now attained that arrested motion is represented by equivalent heat. Telescopic observations will probably add new facts to guide our judgment on this subject, and, taken in connexion with observations on terrestrial magnetism, may enlarge and correct our views respecting the nature of heat, light and electricity. Much as we have yet to learn respecting these agencies, we know sufficient to infer that they cannot be transmitted from the sun to the earth except by communication from particle to particle of intervening matter. Not that I speak of particles in the sense of the atomist. Whatever our views may be of the nature of particles, we must conceive them as centres invested with surrounding forces. We have no evidence, either from our senses or otherwise, of these centres being occupied by solid cores of indivisible incompressible matter essentially distinct from force. Dr. Young has shown that even in so dense a body as water, these nuclei, if they exist at all, must be so small in relation to the intervening spaces, that a hundred men distributed at equal distances over the whole surface of England would represent their relative magnitude and distance. What then must be these relative dimensions in highly rarefied matter? But why encumber our conceptions of material forces by this unnecessary imagining of a central molecule? If we retain the forces and reject the molecule, we shall still have every property we can recognize in matter by the use of our senses or by the aid of our reason. Viewed in this light, matter is not merely a thing subject to force, but is itself composed and constituted of force.

The dynamical theory of heat is probably the most important discovery of the present century. We now know that each Fahrenheit degree of temperature in 1 lb. of water is equivalent to a weight of 772 lb. lifted 1 foot high, and that these amounts of heat and power are reciprocally convertible into one another. This theory of heat, with its numerical computation, is chiefly due to the labours of Mayer and Joule, though many other names, including those of Thompson and Rankine, are deservedly associated with its development. I speak of this discovery as one of the present age because it has been established in our time; but if we search back for earlier conceptions of the identity of heat and motion, we shall find (as we always do in such cases) that similar ideas have been held before, though in a clouded and undemonstrated form. In the writings of Lord Bacon we find it stated that heat is to be regarded as motion and nothing else. In dilating upon this subject, that extraordinary man shows that he had grasped the true theory of heat to the utmost extent that was compatible with the state of knowledge existing in his time. Even Aristotle seems to have entertained the idea that motion was to be considered as the foundation not only of heat, but of all manifestations of matter; and, for aught we know, still earlier thinkers may have held similar views.

The science of gunnery, to which I shall make but slight allusion on this occasion, is intimately connected with the dynamical theory of heat. When gunpowder is exploded in a cannon, the immediate effect of the affinities by which the materials of the powder are caused to enter into new combinations, is to liberate a force which first appears as heat, and then takes the form of mechanical power communicated in part to the shot and in part to the products of explosion which are also propelled from the gun. The mechanical force of the shot is reconverted into heat when the motion is arrested by striking an object, and this heat is divided between the shot and the object struck, in the proportion of the work done or damage inflicted upon each. These considerations recently led me, in conjunction with my friend Capt. Noble, to determine experimentally, by the heat elicited in the shot, the loss of effect due to its crushing when fired against iron plates. Joule's law, and the known velocity of the shot, enabled us to compute the number of dynamical units of heat representing the whole mechanical power in the projectile, and by ascertaining the number of units developed in it by impact, we arrived at the power which took effect upon the shot instead of the plate. These experiments showed an enormous absorption of power to be caused by the yielding nature of the materials of which projectiles are usually formed; but further experiments are required to complete the inquiry.

Whilst speaking of the subject of gunnery, I must pay a passing tribute of praise to that beautiful instrument invented and perfected by Major Navez of the Belgian Artillery, for determining, by means of electro-magnetism, the velocity of projectiles. This instrument has been of great value in recent investigations, and there are questions affecting projectiles which we can only hope to solve by its assistance. Experiments are still required to clear up several apparently anomalous effects in gunnery, and to determine the conditions most conducive to efficience both as regards attack and defence. It is gratifying to see our Government acting in accordance with the enlightened principles of the age by carrying on scientific experiments to arrive at knowledge, which, in the arts of war as well as in those of peace, is proverbially recognized as the true source of human power.

Prof. Tyndall's recent discoveries respecting the absorption and radiation of heat by vapours and permanent gases constitute important additions to our knowledge. The extreme delicacy of his experiments and the remarkable distinctness of their results render them beautiful examples of physical research. They are of great value as affording further illustrations of the vibratory actions in matter which constitute heat; but it is in connexion with the science of meteorology that they chiefly command our attention. From these experiments we learn that the minute quantity of water suspended as invisible vapour in the atmosphere acts as a warm clothing to the earth. The efficacy of this vapour in arresting heat is, in comparison with that of air, perfectly astounding. Although the atmosphere contains on an average but one particle of aqueous vapour to 200 of air, yet that single particle absorbs 80 times as much heat as the collective 200 particles of air. Remove, says Prof. Tyndall, for a single summer night, the aqueous vapour from the air which overspreads this country, and you would assuredly destroy every plant incapable of bearing extreme cold. The warmth of our fields and gardens would pour itself unrequited into space, and the sun would rise upon an island held fast in the grip of frost. Many meterological phenomena receive a feasible explanation from these investigations, which are probably destined to throw further light upon the functions of our atmosphere.

Few sciences have more practical value than meteorology, and there are few of which we as yet know so little. Nothing would contribute more to the saving of life and property, and to augmenting the general wealth of the world, than the ability to foresee with certainty impending changes of the weather. At present our means of doing so are exceedingly imperfect, but, such as they are, they have been employed with considerable effect by Admiral Fitz-Roy in warning mariners of the probable approach of storms. We may hope that so good an object will be effected with more unvarying success when we attain a better knowledge of the causes by which wind and rain, heat and cold are determined. The balloon explorations conducted with so much intrepidity by Mr. Glaisher, under the auspices of the British Association, may perhaps in some degree assist in enlightening us upon these important subjects. We have learnt from Mr. Glaisher's observations that the decrease of temperature with elevation does not follow the law previously assumed of 1° in 300 feet, and that in fact it follows no definite law at all. Mr. Glaisher appears also to have ascertained the interesting fact that rain is only precipitated when cloud exists in a double layer. Rain-drops, he has found, diminish in size with elevation, merging into wet mist, and ultimately into dry fog. Mr. Glaisher met with snow for a mile in thickness below rain, which is at variance with our preconceived ideas. He has also rendered good service by testing the efficiency of various instruments at heights which cannot be visited without personal danger.

The facility now given to the transmission of intelligence and the interchange of thought, is one of the most remarkable features of the present age. Cheap and rapid postage to all parts of the world—paper and printing reduced to the lowest possible cost—electric telegraphs between nation and nation, town and town, and now even (thanks to the beautiful invention of Prof. Wheatstone) between house and house—all contribute to aid that commerce of ideas by which wealth and knowledge are augmented. But while so much facility is given to mental communication by new measures and new inventions, the fundamental art of expressing thought by written symbols remains as imperfect now as it has been for centuries past. It seems strange that while we actually possess a system of short-hand by which words can be recorded as rapidly as they can be spoken, we should persist in writing a slow and laborious long-hand. It is intelligible that grown-up persons who have acquired the present conventional art of writing, should be reluctant to incur the labour of mastering a better system; but there can be no reason why the rising generation should not be instructed in a method of writing more in accordance with the activity of mind which now prevails. Even without going so far as to adopt for ordinary use a complete system of stenography, which it is not easy to acquire, we might greatly abridge the time and labour of writing by the recognition of a few simple signs to express the syllables which are of most frequent occurrence in our language. Our words are in a great measure made up of such syllables as *com, con, tion, ing, able, ain, ent, est, ance,* &c. These we are now obliged to write out over and over again, as if time and labour expended in what may be termed visual speech were of no importance. Neither has our written character the advantage of distinctness to recommend it: it is only necessary to write such a word as "minimum" or "ammunition," to become aware of the want of sufficient difference between the letters we employ. I refrain from enlarging on this subject, because I conceive that it belongs to social more than to physical science, although the boundary which separates the two is sufficiently indistinct to permit of my alluding to it in the hope of procuring for it the attention which its importance deserves.

Another subject of a social character which demands our consideration is the much-debated question of weights and measures. Whatever difference of opinion there may be as to the comparative merits of descimal and duodecimal division, there can at all events be none as to the importance of assimilating the systems of measurement in different countries. Science suffers by the want of uniformity, because valuable observations made in one country are in a great measure lost to another, from the labour required to convert a series of quantities into new denominations. International commerce is also impeded by the same cause, which is productive of constant inconvenience and frequent mistake. It is much to be regretted that two standards of measure so nearly alike as the English yard and the French mètre should not be made absolutely identical. The metric system has already been adopted by other nations besides France, and is the only one which has any chance of becoming universal. We in England, therefore, have no alternative but to conform with France, if we desire general uniformity. The change might easily be introduced in scientific literature, and in that case it would probably extend itself by degrees amongst the commercial classes without much legislative pressure. Besides the advantage which would thus be gained in regard to uniformity, I am convinced that the adoption of the decimal division of the French scale would be attended with great convenience both in science and commerce. I can speak from personal experience of the superiority of decimal measurement in all cases where accuracy is required in mechanical construction. In the Elswick Works, as well as in some other large establishments of the same description, the inch is adopted as the unit, and all fractional parts are expressed in decimals. No difficulty has been experienced in habituating the workmen to the use of this method, and it has greatly contributed to precision of workmanship. The inch, however, is too small a unit, and it would be advantageous to substitute the mètre if general concurrence could be obtained. As to our thermometric scale, it was originally founded in error; it is also most inconvenient in division, and ought at once to be abandoned in favour of the Centigrade scale. The recognition of the metric system and of the Centigrade scale by the numerous men of science composing the British Association would be a most important step towards effecting that universal adoption of the French standards in this country which, sooner or later, will inevitably take place; and the association in its collective capacity might take the lead in this good work, by excluding in future all other standards from their published proceedings.

The recent discovery of the source of the Nile by Captains Speke and Grant has solved a problem in geography which has been a subject of speculation from the earliest ages. It is an honour to England that this interesting discovery has been made by two of her sons; and the British Association, which is accustomed to value every addition to knowledge for its own sake, whether or not it be attended with any immediate utility, will at once appreciate the importance of the discovery, and the courage and devotion by which it has been accomplished. The Royal Geographical Society, under the able presidency of Sir Roderick Murchison, was chiefly instrumental in procuring the organization of the expedition which has resulted in this great achievement, and the success of the Society's labours in connexion with this and other cases of African exploration shows how much good may be effected by associations for the promotion of scientific objects.

The science of organic life has of late years been making great and rapid strides, and it is gratifying to observe that researches both in zoology and botany are characterized in the present day by great accuracy and elaboration. Investigations patiently conducted upon true inductive principles cannot fail eventually to elicit the hidden laws which govern the animated world. Neither is there any lack of bold speculation contemporaneously with this painstaking spirit of enquiry. The remarkable work of Mr. Darwin promulgating the doctrine of natural selection has produced a profound sensation. The novelty of this ingenious theory, the eminence of its author, and his masterly treatment of the subject have, perhaps, combined to excite more enthusiasm in its favor than is consistent with that dispassionate spirit which it is so necessary to preserve in the pursuit of truth. Mr. Darwin's views have not passed unchallenged, and the arguments both for and against have been urged with great vigor by the supporters and opponents of the theory. Where good reasons can be shown on both sides of a question, the truth is generally to be found between the two extremes. In the present instance we may without difficulty suppose it to have been part of the great scheme of creation that natural selection should be permitted to determine variations, amounting even to specific differences, where those differences were matters of degree; but when natural selection is adduced as a cause adequate to explain the production of a new organ not provided for in original creation, the hypothesis must appear, to common apprehensions, to be pushed beyond the limits of reasonable conjecture. The Darwinian theory, when fully enunciated, founds the pedigree of living nature upon the most elementary form of vitalized matter. One step further would carry us back, without greater violence to probability, to inorganic rudiments, and then we should be called upon to recognise in ourselves, and in the exquisite elaborations of the animal and vegetable kingdoms, the ultimate results of mere material forces left free to follow their own unguided tendencies. Surely our minds would in that case be more oppressed with a sense of the miraculous than they now are in attributing the wondrous things around us to the creative hand of a Great Presiding Intelligence.

The evidences bearing upon the antiquity of man have been recently produced in a collected and most logically-treated form, by Sir Charles Lyell. It seems no longer possible to doubt that the human race has existed on the earth in a barbarian state for a period far exceeding the limit of historical record; but notwithstanding this great antiquity, the proofs still remain unaltered that man is the latest as well as the noblest work of God.

I will not run the risk of wearying this assembly by extending my remarks to other branches of science. In conclusion, I will express a hope that when the time again comes round to receive the British Association in this town, its members will find the interval to have been as fruitful as the corresponding period on which we now look back. The tendency of progress is to quicken progress, because every acquisition in science is so much vantage ground for fresh attainment. We may expect, therefore, to increase our speed as we struggle forward; but however high we climb in the pursuit of knowledge we shall still see heights above us, and the more we extend our view, the more conscious we shall be of the immensity which lies beyond.

Proceedings of Societies.

THE TORONTO MECHANICS' INSTITUTE.

Evening Classes.

The following classes are about to be formed in this institution, and will commence on Monday, the 2nd November, viz.:

1. An English Grammar and Composition Class.
2. A French Class.
3. A Drawing Class.
4. A Mathematical Class.
5. A Book-keeping and Penmanship Class.
6. An Architectural and Mechanical Drawing Class.

Each class will meet two evenings per week, from 8 to 10 o'clock, and will continue twenty weeks.

Fees—Members of the Institute, $2; non-members, $3—to Nos. 1, 4, 5 and 6. The French Class—Members, $3; non-members, $5. The Drawing Class, No. 3—Members, $3; non-members, $4.

A lecture introductory to these classes will be delivered in the institution by Mr. Richard Lewis, on Friday, October 23rd, when names will be enrolled and the classes commenced. We will be glad to record the proceedings of any other institutions in the matter of classes, or means of improvement for the working classes.

ALPHABETICAL LIST OF THE PRINCIPAL ENGLISH PUBLICATIONS FOR THE MONTH ENDING AUGUST 31, 1863.

Ainsworth (W. F.) Illustrated Universal Gazetteer, sup.-roy. 8vo	£1	1	0	*Houlston.*
Badham (Chas. D.) Esculent Funguses of England, edited by F. Currey, 8vo	0	12	0	*L. Reeve.*
Boutell (Rev. Charles) Heraldry, Historical and Popular, 2nd edit. revised, 8vo	0	10	6	*Winsor & N.*
Chamber's Encyclopædia: a Dictionary of Universal Knowledge, vol. 5, sup.-roy.	0	9	0	*Chambers.*
Cooper (T. S.) Drawing Book of Animals and Rustic Groups, complete, obg. red. to	0	5	0	*Ward & Lock.*
Cox (Edward W.) Arts of Writing, Reading and Speaking, 12mo	0	10	6	*Crockford.*
Ede (George) Management of Steel, Forging, Hardening, &c., 2nd ed. fcap. 8vo	0	1	0	*Tweedie.*
Edwards (Milne) Manual of Zoology, 2nd ed., edited by C. C. Blake, fcap. 8vo	0	8	6	*Renshaw.*
Harbord (Rev. J. B.) Glossary of Navigation, cr. 8vo	0	6	0	*Blackwoods.*
Harker (W.) English Standards of Weight, Capacity and Coin, fcap. 8vo	0	0	6	*Simpkin.*
Hiley (Richard) Progressive English Composition, part 3, 12mo.	0	4	6	*Longman.*
Hill (Caroline S.) Wild Flowers and their Uses, 18mo	0	1	0	*Chambers.*
Hoskold (H. D.) On Mining, Land and Railway Surveying, Engineering, &c., r. 8vo	1	10	0	*Atchley.*
Hind (J. R.) Introduction to Astronomy, with Astron. Vocab, 3rd ed. enl., p. 8vo.	0	3	6	*Bohn.*
Lennie's Principles of English Grammar, by P. A. Nuthall, 18mo	0	0	9	*Routledge.*
Manual of British Rural Sports, by Stonehenge, 6th edit. revised, fcap. 8vo	0	10	6	*Routledge.*
Mining and Smelting Magazine, vol. 3, 8vo	0	7	6	*Office.*
Rivers (Thomas) Rose-Amateur's Guide, 8th edit., enlarged, fcap. 8vo	0	4	0	*Longman.*
Robinson (R.) Manual of Method and Organization, 12mo	0	6	6	*Longman.*
Stationers' Handbook (The) and Guide to the Paper Trade, 3rd ed. rev., fcap. 8vo.	0	8	6	*Groombridge.*
Stevens (Robert W.) On the Stowage of Ships and their Cargoes, 3rd ed. 8vo	0	8	0	*Longman.*
Thompson (B.) Healthy Moral Homes for Agricultural Laborers, 8vo	0	5	0	*Longman.*
Thoughts on Population and Food. By Agestris. Cr. 8vo	0	4	6	*Longman.*
Watts (Henry) Dictionary of Chemistry and the allied branches, vol. 1, 8vo	1	11	6	*Longman.*

Selected Articles.

THE CORK STEAM BISCUIT FACTORY OF BAKER, SIMPSON & CO.

The stranger viewing this establishment from Patrick-street, will observe the lofty stores on both sides, with their projecting cranes and windlasses, numerous carts and floats clustered beneath, each waiting its turn for the box to be delivered in the city, or hurrying off to some terminus for transmission by train, or it may be to the quay for shipment to foreign countries, while here and there gliding through the different offices and lofts overhead, or rapidly moving to and fro across the street from one store to the other, pen in hand, may be seen the active clerk or man of business, giving directions to porters and carters, who are as busy as nailers, and, while roaring and shouting, transferring from the cranes to their carts immense packages of biscuit, the manufacture of which is rapidly going on. The atmosphere of the whole place seems to breathe of invoices, bills of lading, and so forth, reminding us of our Thames-street warehouses, with the same energy, activity and business-like appearance. In this little street we may learn a chapter on Irish manufacture, and what Irish interprise and intelligence can effect when combined with integrity and despatch, and a spirit of fair dealing. Here we see what can be done to foster and create a spirit of industry, which while it affords remunerative employment to a vast number of our population, increases individual wealth, and adds to the resources of the country; the philanthropist and patriot may also witness the partial fulfillment of what to him may sometimes seem but the ideal dream of the establishment of Irish manufacture and staple branches of Irish trade, and witness here in the factories a practical illustration of how much may be done by private enterprise in creating and promoting the trade and manufacture of Ireland. If Ireland is ever to assume her proper commercial position, it is only by such men and such means it can be affected, while to the political economist it must be an equally interesting study.

We shall now proceed to conduct our readers to the biscuit factory, making our way through the floats, carts, and vans, round the other stores of the firm, while along the sideway are ranged high boxes and flour barrels, and immense hampers; we leave the retail store and confectionary factory on the right hand, and come to a large concern on the left, which extends to Paul-street. The store itself or main part of the building, is a massive structure of four stories in height, from the highest of which projects a powerful crane, capable of raising enormous weights. Connected with the store, and extending to Paul-street, is an extensive handsome erection, its front ornamented with stucco, with handsome pillars, supporting ten arches. On entering the basement story, we find ourselves surrounded by the boiler, furnace, and reservoir, which supplies the steam that propels the machinery throughout the entire building. Here in fact, is the main-spring of the works in operation. From this dark, cavern like place proceeds the silent moving power, which here as elsewhere throughout the world, sets the mightiest and sometimes the most minute machinery in motion, and which has effected a revolution in the affairs of men, banishing distance, economising time, and appears destined to go on "conquering and to conquer" till its wonder working agency will produce effects which the present generation can but dimly foresee. Here, on the left, stands the huge unwieldy boiler, creating the power that propels the machinery and the busy wheels whirring throughout the factory. At the end of the basement-story is an immense reservoir for supplying the engine and other parts of the factory with water. This runs nearly across the store, and is capable of containing 200,000 gallons of water.

At the corner of this store is placed the steam hoist, made by Vickers, of Liverpool, certainly a wonderful improvement on the old slow method of raising by the windlass, which formerly and still is in use in many of our stores and factories. By means of this invention a weight of from two to five tons can be raised with extraordinary swiftness to any loft. This is a great advantage, as it effects an immense saving of time, which in Ireland unfortunately, in too many instances, is not sufficiently appreciated. But this establishment forms an exception. Every improvement in biscuit baking that ingenuity can devise, or money obtain is here brought to bear, and its fruits are apparent in the manufacture of an article that has obtained a world wide reputation, and at the late International Exhibition was chosen to supply a portion of the contract for the French and English refreshment-rooms—a circumstance which ought to afford gratification to Irishmen, while "Honourable Mention" was awarded to the manufacturers, "for the goodness quality of their biscuits," by the Council and Jurors of Class III.

On the left hand of the basement story, near the check-taker's little desk, we enter by folding-doors the bakehouse, a large spacious room (to which we shall afterwards refer); passing through this and the fancy bakery on the left, we ascend to the third story, or, as it is termed, the Flour Loft. In this department commences the first process in machine biscuit making. The flour being raised from the street by the patent hoister, here passes through a number of sifters of the finest texture, and every particle of coarse grain or dust with which it may have come in contract during its passage through the mill is thoroughly extracted. And we may add that this firm manufacture a large quantity of their own wheat into flour, as the market affords opportunity. In addition, there is also a large sifting machine, capable of sifting a ton of sugar per day, and reducing it to a powder as fine as the finest flour. From these sifters the pulverised material is passed by means of a shoot or tube passing through the floor into the mixers in the loft beneath, termed the "The Preparatory Mixing Loft." This department, which occupies the second story, is large and well ventilated. Around the room are a number of patent mixers of cylindrical shape, standing on iron supporters. At the side of these machines are wheels propelled by line-shafts connected with the powerful engine. From these wheels a spindle passes through the centre of the cylinder, to which are attached, at intervening distances, what are termed "arms,"—a name derived from the circumstance that they perform the work hitherto done by the arms of men in mixing dough—and which is a much cleaner process, and consequently a great improvement on the old system. These "arms" or mixing-knives, are constantly revolving, mixing and blending the flour and other ingredients. In the centre of the cylinder or mixer is a large upright tube or shoot that runs through the ceiling to the loft overhead, where the sieving process already described is going on, and from the sieve descends through this tube into the mixer. Alongside the tube is a water pipe, which also runs through the ceiling, and is connected with the cistern on the roof, by means of which sufficient moisture is conveyed into the mixer during the preparatory compounding process. This cistern can be made to answer a double purpose; for besides supplying water to the mixer, it can, in case of fire, be brought to bear, by inundating the place and thus extinguishing it in a moment. From the mixers the dough is transmitted, by an immense tube, to the bake-house on the basement story.

On this loft is also the sugar and almond mill and mixing pan,—a large, circular, flat-bottomed metal vessel shaped somewhat like a basin, that turns on a pivot, fastened to the floor round a roller attached to an iron bar placed across the pan. By means of a screw the roller can be raised or depressed, so that the ingredients can be ground, as with a pestle and morter, to the requisite degree of fineness required for the making of pastry. The roller which is an immense mass of metal with a grooved surface, crushes and grinds the sugar, almonds, and other ingredients in the pan into the finest powder,—so fine that it appears to the uninitiated like flour.

In another part of the loft are barrels and hogsheads of sugar, treacle, and other depositories containing the ingredients used in the making of the biscuits and cakes. In addition to which, thousands of gallons of milk are made use of, while the quantity of eggs and butter mixed up and blended with the dough and paste is truely astonishing, all to be blended with the pastry in course of preparation. The whole place is so perfectly clean, and the tables and floors so free from flour or refuse of any kind, that a stranger would scarcely imagine that here the mixing of immense quantities of dough and paste is constantly going on for the supply of the patent mixers (where the kneeding is finally completed), while the air is quite free from those dusty particles with which we generally find the atmosphere impregnated in similar establishments where baking by the ordinary process is carried on, and which acts so injuriously on the lungs, producing disease, and consequent premature old age among the *employes*.

Descending from the preparatory mixing-loft, we enter the Fancy Biscuit Bakery, and passing through it, enter the bake-house, a spacious lofty building. On one side of the entrance stands a high pressure steam engine, of twenty horse power, worked by the boiler in its adjoining outside store. Some idea may be formed of the amount of capital involved in this undertaking, when it is stated that this engine with the boiler alone cost the firm several hundred pounds, though they form but a very small portion of the vast machinery in operation throughout the concern. By this engine a large wheel, about twelve feet in diameter, is set in motion, and from it proceed many hundred feet of line shafts worked by six sets of connections, by which the whole machinery throughout the factory is propelled.

On the left hand side as you enter is the railway oven (an invention of one of the firm), and which is so termed from the pans gliding in and out on rails. This curiously constructed oven, is heated at top and bottom, also by a new process, and has three mouths, through which the pans are constantly entering and returning, being laid on rails; each batch of cakes takes ten or twelve minutes in baking. On the right hand side of the room, and near the railway oven, are tables at which men are busily employed cutting and stamping into every variety of shape sheets of dough, from which are produced those beautiful cakes coloured by the rich ingredients of which they are composed, rendering them as pleasing to the palate as they are deservedly popular. From these tables they are transferred to the pans of the railway oven.

In the other parts of the bakehouse are many large patent double power reversing break rollers, cutting machines, and other large ovens, driven by cranks and rods, and heated by furnaces underneath, while the flues, like those of the other furnaces, are all underground, so that a stranger can scarcely conjecture how the smoke is got rid of; for though the ovens and furnaces are in full operation, no smoke is seen to issue. This is a great improvement, and a capital preservative against fire or other accident, while, in case of the least appearance of ignition, of which there is little danger, the water cistern on the roof is always in readiness. In fact from the present construction of the building, ovens, and flues, as well as from the precautions taken it would appear that the circumstances of such an establishment being injured by fire is almost an impossibility. The consumption of fuel in such a factory, with furnaces in full blast, must as a matter of course, be very great, the firm have therefore taken the adjoining premises for the manufacture of the coke which is used in their concern.

Through other parts of the bakehouse are stands on which are piled in heaps what appear to the stranger at first view to be sheets of thick pasteboard, but which, on examination turn out to be tough sheets of dough in course of preparation for the oven, while the cutting machines resemble so many printing presses, and the whole process is so different from the old system, that a person, unacquainted with machine baking would scarcely imagine that he was standing in the middle of a bakehouse where immense biscuit baking operations are carried on.

On the left hand side of the room commences the first part of the process in this department. Protruding through the wall a couple of feet from the floor, is the mouth of a large tube, communicating with the second loft, or preparatory mixing department already referred to, and through which the dough is sent down from the mixers, and is here received in lumps into a large square box, moving on castors, to the break rollers or cutting machines which these traveling boxes are constantly supplying, transferring to the iron plane of the press, and then by a curious process passing through different revolving rollers until it is kneaded into a proper consistency.

At one side of the room, and connected with the oven which it feeds, is one of those curious compound cutting machines where the dough is received on a metal plane which glides beneath a a roller that reduces it to the proper thinness, and then passes over a large cylinder, which lifts the "scraps," that appear like a piece of perforated cloth; these, passing over the cylinder, drop into a receiver, while the cakes remain on the gliding plane, which takes them into the oven, and through which they slowly move and in about twenty minutes drop out of the aperture at the other end into a box or shallow drawers with grated bottoms in order to cool the cakes coming hot out of the oven. From this they are raised by a patent hoister to the packing room. Taking the ovens and cutting machines altogether they are a singular invention. Here the dough that you see at one end is kneaded, stamped, glides into the oven, and in a short time comes out in showers of cakes and biscuits at the other end, and all this without a hand being put to it.

Opposite to this, and at the other side of the room, is the large biscuit oven, also connected with a cutting machine, and worked in much the same manner as the one we have described, and which is capable of turning out an almost endless supply of biscuits.

At the same side of the room we observed a round boiler, into which a man was throwing a number of dough cakes just brought from the stamper, and after floating in the hot water awhile are removed to the baking pans, thence to the ovens, and come out in that hollow rounded shape peculiar to the "cracknell."

In another part of the room a man was pouring out with a ladle what appeared to be a liquid paste made of the richest ingredients—sugar, milk, eggs and so forth,—to be formed into pastry cakes; while around and through the room at the different tables and machines a number of men and boys were busily engaged at different occupations, for the supply and feeding, with an endless variety of cakes of every shape and form that fancy can devise, the large ovens that here are constantly in operation during the entire day.

Passing out of this large room or bakehouse, we enter the Fancy Biscuit Bakery. The plan of operation and mode of manufacture is somewhat similar to those of the bakehouse. Here the arrowroot and fancy biscuits are produced. The oven is what is termed a "chain oven," and worked by a pressure regulator. It is also fed by one of the compound cutting machines already described, at one end of which was passing the dough-like sheets of pasteboard, not more than the thickness of half-a-crown, and passing beneath the stamper or cutter is moulded into the required fancy form, and has printed on it in raised letters those familiar names of "William," "Mary" &c., which render it such a favourite, particularly among the juvenile portion of the public. From this they are removed to pans with cross-bar bottoms, on which they are laid, then passed into the oven, and in a few minutes come out at the other end in actual showers transferred to boxes, and then taken to the Packing Loft.

Ascending by flights of steps from the basement story to the fourth or top loft we enter the packing department, which bears a strong resemblance to an arcade, being lit by a glass roof, shaded by a long linen blind, which while it shields off the rays of the sun, imparts a softened and cheerful light to the apartment. This extends the entire length and breadth of the building; and through the room are long tables, at which a number of men and boys are busily engaged packing an endless variety of cakes and biscuits in tin cases, canisters &c., of every size and description. These packages are then lowered to the street by the hoister into the carts and vans waiting in regular order to receive them for transit to every part of the world—some for different European countries, others for the East and West Indies, America, China, Canada, and the Colonies. We saw a number of boxes passing down the hoister, the first stage in their transit to Ceylon and Vancouver's Island; and all this, independent of a vast home consumption, may serve to give some idea of the quantity manufactured, and the extent of the business and correspondence of this enterprising firm.

This factory may, in fact be considered as a step in the right direction towards the introduction of manufactures into Ireland, and thus giving employment to the population,—an object so much needed and so much desired by every well wisher of his country; and to the citizens of Cork it must afford gratification to think that in the midst of their city one of the largest biscuit factories in the empire is in full and active operation, where a large number of persons obtain work, wages, and a livelihood; for all the barrels, canisters, &c., required are manufactured under the firm's own immediate inspection, so that hundreds obtain employment in the various departments.—*The Grocer.*

PETROLEUM WELLS OF PENNSYLVANIA.

In 1853 there was upon the premises of Brewer, Watson & Co., extensive lumber dealers, in Titusville, Pa., a well which from time immemorial, had been remarkable for producing oil, that floated in limited quantities upon the surface. This oil had been occasionally gathered for medicinal purposes, by absorbing it with blankets. Dr. Brewer, (who, by the way, is of New England birth, and received a medical education at Dartmouth,) conceived the idea of collecting this oil and using it in the saw mills of the firm for illuminating and lubricating purposes. The experiment was so successful that the foreman of the mill proposed to increase the production by pumping water from the well into tanks and collecting the oil from the surface. Considerable quantities were thus gathered "at the halves" by arrangement between Brewer, Watson & Co., and their foreman. This was the beginning of a business which now amounts in value to millions of dollars per annum.

Dr. Brewer subsequently interested Dr. Albert Crosby, (now of Wells River, Vt.,) in this discovery through whose efforts, and the active exertions of Eveloth & Bissell, of New York, the Pennsylvania Rock Oil Company was formed, in the fall of 1854, with a nominal capital stock of $300,000. The company purchased a hundred acres of land in the vicinity of the original oil well. But although some efforts were made to develop the property thus acquired, and to gather the surface oil, yet the corporation was regarded as a "fancy stock" concern, and the shares soon declined to a merely nominal price.

In the winter of 1854, Professor Silliman analyzed specimens of the oil, and his report upon its economic value was so favourable, that parties in Connecticut invested largely in the stock of the Pennsylvania Company, and sent out Mr. E. L. Drake to develop the property. But the enterprise languished for several years, until in 1856, Mr. Drake having heard that oil had been obtained in boring for salt in the Alleghany valley, conceived the idea of sinking a well on the lands which had yielded so promising a surface show of oil. He persevered in spite of pecuniary embarrassments, drilling through solid rock to the depth of seventy-eight feet, when he was rewarded by striking oil, his well pumping from sixty to seventy barrels per day.

This discovery created great excitement, and speculators were not slow to appreciate its importance. All the farms in the valley of Oil Creek which could be purchased or leased were secured, and numerous adventurers flocked to that promising locality to bore for oil. Some were successful, while others after expending all their funds were compelled to relinquish their hopes. One well was struck in 1860, which flowed, without pumping about fifty or sixty barrels per day. This was considered marvellous.

In 1861, the first large flowing well was struck. This well run, as was estimated, about one thousand barrels per day. But before arrangements could be made to take care of this astonishing product, the well caught fire, as was supposed from a lighted cigar, and twenty-two persons were burned to death. Shortly after, a well was struck on land of Brewer, Watson & Co., which yielded the enormous amount of 2,500 barrels a day. Another and another flowing well was struck, until the production became so large that the market in the infancy of the trade became over-stocked. It was estimated that the production, in the winter of 1861–2, was 15,000 barrels per day, and oil declined to ten cents per barrel at the wells. The pumping wells could no longer be profitably worked and the flowing wells, whose product could not be regulated, kept the market glutted for many months. But this proved to be a fortunate circumstance in the end, for the low prices favoured the introduction of the oil into domestic use, and created an export demand, which has constantly increased, until there is now a steady market for the oil, which has again advanced in price to $5.00 per barrel at the wells.

A description of the process of boring for oil, and of the oil wells, from personal observation, will doubtless be interesting to our readers. We will premise that Oil Creek, where the discoveries of oil have been made, is an affluent of the Alleghany river, and rises in Northern Pennsylvania, It is a mountain stream about thirty miles long. and was rightly named from the oily appearance of its surface, where the current was sluggish—a phenomenon which was noticed at the early settlement of the region. There are traces of excavations in the flats about Titusville, evidently for the purpose of obtaining oil, but whether by the Indians who inhabited this region when America was discovered, or by the French who at one time occupied the valley, or by the mysterious race of whom we have traces in the remarkable mounds of the West and in the iron tools found in the copper mines of Lake Superior, is not satisfactorily determined. Certain it is that trees which must be at least two hundred years old have grown over these excavations. The valley of Oil Creek is narrow, and is bordered by woody mountains. It is only in the flats or meadows that oil has been discovered, wells sunk even on the lowest ridges being failures.

In boring for oil, heavy iron tubing, about six inches in diameter, is first sunk through the surface soil by means of a pile driver, until it reaches the solid rock. A derrick is then erected and the rock is drilled with a centre bit of two and a half inches in circumference. As the work progresses, a rimmer is put in which enlarges the orifice to four inches. The stone which is bored is mainly shale, slate and sandstones of different varieties. Oil is sometimes found at the depth of one hundred to one hundred and fifty feet. But in these wells it must be pumped up. The flowing wells are sunk from four hundred to 500 feet, and oil is found at what is called the third sand rock. The greatest depth which has been bored is one thousand and six feet, but the operators in this case did not obtain oil. The enterprise is now considered unsuccessful, and the well is abandoned unless oil is reached at the depth of five hundred feet. Thousands of wells have been bored in the Oil Creek Valley, but it is estimated not more than fifteen per cent. have been productive. Boring for oil is in fact a lottery. Some obtain rich prizes, but more are ruined, and the valley is dotted with dilapidated derricks, the malancholy monuments of departed hopes and ruined fortunes.

The most productive wells are now from five to ten miles down the Creek from Titusville. The flowing wells gradually decrease in productiveness. One of the original large flowing wells run from 2,500 to 3,000 barrels for several months, when it went down to 400 barrels, and then suddenly ceased to flow. With the aid of a pump, however this well now yields about 100 barrels per day. The Sherman well, which was sunk about a year ago flowed 1,500 barrels and now yields about 500. A new well was struck in February, opposite the Sherman well, which yielded 2000 barrels. Other parties boring in the neighborhood, struck the same vein about a month ago and got a well of the same capacity. But the production of the first well suddenly fell off to 100 barrels, and the parties who owned it proposed to sink another well between the two hoping to recover their lost property. To avert this the owners of the new well bought them out, paying $145,000 for all their right, title and interest to the well, machinery, fixtures and land, and the bargain was considered a good one.

As an illustration of the uncertainties of the search for oil, the following incidents are related: one well was bored with the usual centre bit to a considerable depth. Upon withdrawing the bit and putting in the rimmer, a vein was struck at the side. The drill had just missed the vein, and the well would have been a failure had not the orifice been enlarged. A well was at one time bored which promised to be very productive, flowing a large amount. The proprietors not being ready to take care of the oil, a plug was driven into the iron tubing, upon removing which, when the tanks had been built, the oil had disappeared. The hopes of the proprietors faded away like the "baseless fabric of a vision."

Although fortunes are often realized from an oil well, yet it may be doubted whether speculations in land have not been equally productive. All the lands on Oil Creek valley have been inhanced to almost fabulous prices. One farm was recently sold for $10,000 in specie, equal to $15,000, cash. It was bought by a minister from Cincinnati. Brewer, Watson & Co. immediately took one-half of it off his hands, paying the whole amount of the purchase money, and he has since been offered $20,000 for one-half of the balance There are now three flowing wells on this farm. Many farms which were originally worth not more than $2000 to $3,000 have been sold for $20,000 and $30,000. The lands are generally leased to the parties who sink the wells for one-quarter of the net yield of oil.

The aggregate production of petroleum in the in the Oil Creek valley, is now about 7000 barrels per day, worth $3.00 per barrel at the wells. The product has been as high as 15,000 barrels per day in the winter of 1861–62, when the oil market was glutted and oil was sold for ten cents per barrel at the wells. The net value of the product is now $21,000 per day, or $7,000,000 per year. The oil must be refined before it can be used for illuminating purposes. This is done by distillation, the lighter and more volatile portions passing off, first in the shape of naptha, which is largely used in the arts instead of spirits of turpentine. The second run is illuminating oil, and lastly a heavier oil flows from the still, which is used for lubricating purposes. There is a residum like coal tar, which is sometimes burned under the still. There are not far from eighty refineries in the Oil Creek valley, and the enterprising Samuel Downer of this city has a large refinery, built of brick, at Corry, about twenty-seven miles from Titusville.

The oil business has already built a branch railroad from Corry (at the junction of the Atlantic and Great Western Railroad) to Titusville, which is to be extended down the creek. Another branch of the Atlantic and Great Western Railroad runs to Franklin at the mouth of French Creek, and a road is projected from the Philadelphia and Erie Railroad to tap the Oil Creek valley. At present between three and four thousand two horse teams are employed in transporting the oil from the wells to Titusville, where it is loaded upon the cars. Each team carries seven barrels, for which the teamsters get a dollar a barrel. The roads are in a horrible condition, and the teaming is very difficult, especially in muddy weather, when horses sometime become inextricably fixed and perish in the slough holes. Much of the oil is run to Pittsburg in boats constructed expressly for the purpose, the oil generally being loaded in bulk, and the boats being floated down the Creek to its junction with the Alleghany by artificial freshets produced by letting water out of the dams on the head waters. The scenes at these freshets are very exciting. There is great risk of the boats being snagged or swamped and sometimes the boats are piled one upon another and thousands of barrels of oil are lost in the current. Some months ago a fire broke out among a lot of boats loaded at Oil City, and caused an immense destruction of oil, besides burning a bridge.

The Oil Region presents many of the peculiar characteristics of a productive gold locality. New houses spring up in a day. The population increases rapidly. Villages have grown into towns. Money is abundant, and is lavishly spent. Titusville, the principal town in the valley, has increased its population from 400 to 2,500. It has its newspaper, numerous stores and workshops, a bank, with a capital of $500,000, and all the other adjuncts of a thriving business. Corry is quite a village at the junction of the Oil Creek and Great Western Railroad, the site of which last year was a wilderness. Oil City has also been built up to the proportions of a town by the oil business, and Franklin has largely increased in population.

The trade in oil is destined to increase steadily. Already Petroleum is largely exported, 14,597,440 gallons having been shiped from the United States during the first four months of this year, against 3,861,912 gallons last year. It is estimated that the value of the exports from the United States this year will be $10,000,000—an item of no inconsiderable importance in our commerce. We see no reason why the demand for the oil should not increase even faster than the supply, when its excellence as an illuminator becomes generally known. Already kerosene (under which name this oil is sold by the retailers) is found to be the best material for burning in the cottages of the poor, and the naphtha, which is the first product of distillation, is rich in gas, which is beginning to be used in the mansions of the rich. Petroleum is the cheapest illuminating agent now employed, and comes into use at a time when whale oil has become scarce and high, and when burning fluids are costly from the scarcity of turpentine. New oil fields will doubtless be discovered, new wells sunk, and the production may be increased by again operating the pumping wells, but there is no danger that the market will again be glutted or that prices will decline to the point of unprofitableness to the operators.

There are various opinions as to the source of this remarkable product of oil, which is found in the depths of the earth not only in Pennsylvania, but in Ohio, Virginia and Canada, as well as in other parts of the world. Professor Rogers attributes Petroleum to the distillation of the bituminous coal. His theory is that "the subterranean heat which converted the bituminous into anthracite coal had the effect of distilling from that coal the rock oil or Petroleum of commerce, which creeping into the fissures of the strata, and impregnating the porous sandstones, remained collected as it were in vast underground tanks, for the use of the present generation." But this theory of Professor Rogers is different from that of most geologists. Professor Ridgway, who made a geological survey of the Oil Region of Pennsylvania, considers that the oil is the result of the fermentation of vegetable matter of long standing, deep beneath the surface of the earth. The carburetted hydrogen gas evolved and which is plentifully mixed with the oil as it flows from the wells, was "cabined, cribbed, confined" for a long period of time, until the boring tubes probed it to the great pools below. Then this gas became the chief agent in bringing the oil to the surface, producing the spouting wells whose yield has been from 100 to 2,500 barrels of Petroleum each per day.

GUN-COTTON.

Dr. Gladstone read the chemical portion of the report of the Committee on Gun-Cotton before the British Association. The report stated that during the year the committee had been put in possession of the fullest information on the subject, by Baron William Von Lenk, Major General of the Austrian Artillery, who was the inventor of the system by which gun-cotton was made available for warlike purposes; and Professor Abel, chemist of the War Department, by permission of the Secretary of State for War, had communicated to them the information given by the Austrian Government to the Government of this country. The committee had made no experiments themselves. The subject might naturally be divided into two conditions—the chemical and mechanical. Taking the chemical first, that department included the manufacture of gun cotton itself, its liability or non-liability to spontaneous combustion, and the nature and effects of the products into which it was resolved on explosion. As to the chemical nature of the material itself the gun-cotton differed from the gun-cotton generally made, in its complete conversion into a uniform chemical compact. General Lenk secured the production of his gun-cotton by several precautions. Of these the most important were, the cleansing and perfect dessication of the cotton as a preliminary to its immersion in the acid; the employment of the strongest acids obtainable in commerce the steeping of the cotton in a fresh strong mixture of acids, after its first immersion and consequent imperfect conversion into gun-cotton; the continuance of this steeping for 48 hours. Equally necessary is the thorough purification of the gun-cotton so produced from every trace of free acid. There is one part of the process of the manufacture, the value of which is not open to doubt—viz., the treatment of the gun-cotton with a solution of silicate of potash, commonly called water-glass. The chief advantages of the material were set forth in the mechanical report; but it was here stated that the fact that gun-cottom is not injured by damp like gunpowder, is one of its recommendations; while a still greater chemical advantage which it possesses arises from its being perfectly resolved into gases on explosion, so that there is no smoke to obscure the sight of the soldier who is firing, or to point out his position to the enemy, and no residue left in the gun to be got rid of before another charge can be introduced.

Mr. Scott Russell, F.R.S., submitted the mechanical report. After a long and careful examination, the committee were able to understand and reconcile themselves to the fact that greater mechanical effects are produced from gases generated by gun-cotton than by those generated by gunpowder. The same quantity of gases and the same number of atmospheres seemed to be produced from both materials, and it did not appear to mechanical men that there was a greater advantage in gun-cotton in that respect. The next inquiry was into the distinctive nature between the action of these gases in gunpowder and the action of those gases in gun-cotton. The great waste of force in gunpowder constituted an important difference between it and the gun-cotton, in which there was no waste. Gunpowder consisted of about 68 per cent. of solid matter, only 32 per cent. of which was useful gases. It might be seen, therefore, that one-third of gunpowder is not directly useful in producing gases. There was another peculiar feature of gun-cotton, it could be exploded in any quantity instantaneously. Gen. Lenk had discovered the means of giving gun-cotton any velocity of explosion that is required by merely the mechanical arrangement under which it is used. Gun-cotton in his hands had any speed of explosion, from one foot per second, to one in 1000th of a second, or to instantaneity. The spontaneous explosion of a large quantity of gun-cotton is made use of when it is required to produce destructive effect, and it is found that the condition necessary to produce instantaneous combustion is the absolute perfection of the closeness of the chamber containing the gun-cotton. On the other hand, if they desired gun-cotton to produce a different effect, they must provide for its slower combustion. It must be abstracted and opened out mechanically, so as to occupy a large space, and in this state it can be made to act even more slowly than gunpowder, and come within the limits which render it fit for the purposes of artillery. In general it is found that the proportion of 11lb. of gun-cotton occupying one cubic foot of space, produces a greater force than gun-powder, and a force of the nature required for ordinary artillery. But each gun and each kind of projectile requires a certain density of cartridge. Practically, gun-cotton is most effective in guns, when used at a quarter to one-third weight of powder, and occupying a space of one and one-tenth of the length of the powder cartridge. In regard to safety, it was a fact that during the ten years of the manufacture of General Lenk's gun-cotton at the imperial factory at Kirtenberg, and during ten years storage of that material in the imperial magazines at Steinfeldt, in which thousands of cwts. were deposited, not one single accident occurred. The best temperature for gun-cotton was 136 degrees centigrade, or between 277 degrees and 338 degrees Fahrenheit—a temperature sufficiently high to ensure safety for all practical purposes. The cost of production was considerably less than that of gun-powder, the price and quantities being compared, which will produce equal effects. As to the mechanical purposes of the cotton, it is used for artillery in the form of gun-cotton thread or spun yarn. In this simple form, it would conduct combustion slowly in the open air at the rate of not more than one second. This thread was woven into a texture or circular web. These webs were made of various diameters, and out of them cotton rifle cartridges were made by cutting them into the proper length. The cotton web was generally inclosed in india-rubber tubes, in which form it is most convenient. For the explosion of mines it is used in the form of ropes. Conveyance and storage of gun-cotton:—One pound of gun-cotton produces effects somewhat exceeding 3 lb. of gunpowder in artillery. This is a material advantage, whether it be carried by men, by horses, or in waggons. It may be placed in a store and preserved with great safety. The danger from explosion does not arise until it is confined. It may become damp and even perfectly wet; and, without injury, may be dried by mere exposure to the air. Practical use in artillery:—The gun keeps clean, and requires less windage, and therefore performs much better in continuous firing. In gunpowder there is 68 per cent, of refuse, or the matter of fouling. In gun-cotton there is no residum, and therefore no fouling. Experiments made by the Austrian Committee proved that 100 lb. could be fired with gun-cotton against 30 lb. lb of gunpowder. From the low temperature produced by gun-cotton, the gun does not heat. Experiments showed that 100 lb. were fired with a 6 pounder in 34 minutes, and the heat was raised by gun-cotton to only 122 deg. Fahr.; whilst 100 lb. lb. of gunpowder took 100 minutes, and raised the temperature to such a degree that water was instantly evaporated. The firing with the gunpowder was therefore discontinued, but the rapid firing with the gun-cotton was continued up to 180 lb. without any inconvenience. The absence of fouling allows the mechanism of a gun to have more exactness than where allowance is made for fouling. The absence of smoke permits rapid firing and exact time. The fact of a smaller recoil from a gun charged with gun-cotton is established by direct experiments. Its value is two thirds of the recoil from gunpowder the projectile being equal. Practical application to destructive explosion:—It is ascertained that the same shell is exploded by the same volume of gas generated from gun-cotton and gunpowder into more than double the number of pieces; and it is a startling fact that the stronger and thicker the shell the smaller and more numerous are the fragments. Mining uses:—The fact that the action of the gun-cotton is violent and rapid in exact proportion to the resistance which it encounters, tells us the secret of the far higher efficacy of gun-cotton in mining than gunpowder. The stronger the rock, the less gun-cotton comparatively with gunpowder is found necessary for the effect—so much so that while gun-cotton is stronger than gunpowder, weight for weight, as 3 to 1 in artillery, it is stronger in the proportion of 6·27 to that of strong solid rock, weight for weight. It is the hollow rope form which is used for blasting. Its power in splitting up material is executed exactly as you wish. With regard to the military and submarine explosion, it is a well-known fact that a bag of gunpowder nailed on the gates of a city will blow them open. A bag of cotton exploded in the same way produces no effect. To blow up the gate of a city with gun-cotton, it must be confined before explosion. Twenty pounds of gun cotton carried in the hands of a single man would be sufficient, only he must know its value.—Other effects of the Austrian invention were enumerated, and the paper throughout was of a most interesting character. The experiments the results of which were detailed, had been conducted on a gigantic scale.

LEATHER CLOTH.

On the subject of leather cloth the London *Times* has the following:—

"The recent continuous increase in the price of leather has naturally directed the attention of practical chemists to the best methods of perfecting the imitations which, under the name of leather cloth, are now so largely used as substitutes for leather itself. The improvements in this branch of manufacture has been so steadily progressive that the original standard taken for imitation—the American leather cloth—has been long since surpassed, and it is, perhaps, not too much to say that the art of making artificial leather has now attained a perfection which promises to make the imitation a better, and, though cheaper a more valuable article than that which it imitates. Among the many new processes and inventions shown in the late Exhibition, there was no lack of English representative of this rising branch of manufacture, striving to displace the American fabric. Nearly all these however, were too much like the Transatlantic article to be successful. With its merits they reproduced its grave defects—the liability of the varnish to crack, the colours to fade, and the material itself to wear out fast as compared with real leather. One series of specimens, however, in this class attracted a good deal of attention, though they failed to attract a medal. These specimens were shown by Mr. Szerelmy, a gentleman well known for his most curious chemical discoveries in hardening wood, stone and paper; and to the present time, the most successful of all the many competitors for preserving the House of Parliament from further decay by indurating the surface of the stone with a fluid silica, which, it is asserted, renders the stone beneath perfectly indestructible. The leather cloth of Mr. Szerelmy has grown in reputation, till it now promises to become a most important manufacturing discovery, since while the cloth thus prepared possesses all the best attributes of leather in great strength and durability, it has other and special advantages of its own, which even the advocates of the famous virtues of leather have never claimed for it—namely complete impermeability to water, a flexibility and softness equal to a woollen fabric, and a cheapness which makes its cost one-third that of real leather. Thus a good calf-skin costs from 10s. to 14s., and yields leather for three or three and a half pairs of boots; whereas six square feet of the calf-skin leather cloth yields materials for five or six pairs of boots, and costs only about 4s. 6d. Such an important difference and saving as this ought to satisfy any inventor; but even more than this is claimed for the 'panonia,' in its capability of being produced in any quantity at a few days' notice, and in sizes only limited to the size to which the fabrics can be woven, on which the composition is laid. The nucleus of a factory has been established at Clapham, where the leather is now made, and where a company is about to construct large works, and carry on the manufacture on the most extensive scale. The fabric used in the manufacture is entirely according to the kind of imitation leather wished to be turned out. Thus 'moll'—a very thick, soft kind of cotton fabric, made at Manchester—is preferred for calf-skin; fine calico or linen for water proof material for macintoshes, siphonias, etc., as perfectly waterproof as india rubber itself; and alpaca, silk, cloth or common cotton for boots and shoes, bookbindings, harness, carriage furniture, and all the thousand purposes to which real leather is applied. What the composition of the pigment is which in a few hours changes common cotton into a substance like enamelled leather, and only to be distinguished from the real article by its non-liability to crack, and its greatly additional strength is of course a strict trade secret. The mode of manufacture however is simple. The fabric to be converted into leather, silk, alpaca, or whatever it may be, of any length or width, is merely wound on rollers beneath a broad knife-blade, which by its weight presses in and equally distributes the pigment previously placed upon it. A hundred yards may thus be done in a single minute, and in this most simple application the whole manufacture begins and ends except that three coats of the pigment are necessary to perfect the leather, and an interval of twenty-four hours must elapse between the application of each. During this period the sheets are carried to a drying house heated to a temperature of 94°, and where they are hung like oil-cloth, according to the order in which they arrive, the last comers displacing those which have completed their time, and are ready for their second coat. Thus the manufacturer never stops, and three days suffice to complete 'hides' of any length or breadth to which fabrics can be woven. For imitations of morocco or other marked leathers the long sheets are simply passed, when finished, through iron rollers, which indent them in any pattern required. For enamelled leather the enamel is applied after the third coat by hand-labour, which, though slower, of course than that of machinery, is nevertheless rapid enough to cover the sheet in a very short time. The enamel, when dry is infinitely superior to any description of patent leather. It is perhaps scarcely necessary to state that the pigment which transforms the cotton into leather is capable of being tinted to any shade that may be wanted of red, green, brown, black, blue, yellow, etc., and that whatever are the ingredients of the composition no admixture of india-rubber or gutta percha forms part of it, inasmuch as the leather cloth, when complete, even when folded and exposed to considerable heat, is entirely free from the tendency to stickiness, which has been the great objection to all waterproof material."

REGENERATIVE GAS FURNACES.

Mr. C. W. Siemens read the following paper on these ingenious pieces of machinery, before the British Association:

The principle of the regenerative gas furnaces has already been explained to the scientific public, by Professor Faraday, in a lecture delivered by him at the Royal Institution in June, 1862. Its general construction and the history of its invention and gradual development form, moreover, the subject of a paper which was read by me in January, 1862, before the Institution of Mechanical Engineers. Since that period this principle of heating has been extensively applied in England, France, Germany, and other countries to glass-houses, for heating gas retorts and muffles for metallurgical purposes, for melting steel, and for puddling and welding iron. The ostensible object of this invention being to save fuel, it could hardly be expected that it would be favourably looked upon in this, the greatest coal-producing district of the whole world; but experience has proved that there are other advantages resulting from its application which, in the case of puddling and working iron, are even superior in value to mere saving of fuel in a money point of view. A diagram was exhibited representing a furnace for welding and working iron, and the gas-generator connected with it. The heated chamber is of the usual form, but instead of a fireplace there are four passages (two at each end of the chamber) leading downwards into four regenerators or chambers filled with loosely piled fire-bricks. The lower extremities of these four regenerator chambers communicate with two cast-iron reversing valves. The gas arriving from the producer through a pipe is directed by the valve into one regenerator or other according to the position of the valve. The gas then ascends through the one regenerator, where it takes up the heat previously deposited in the brickwork, and issues into the furnace at a point where it meets with a current of heated air arising from the second regenerator to effect its combustion. The products of combustion pass away through the opposite regenerator and the reversing valves into the chimney flue. The last named regenerators receive at this time the waste heat of the furnace, heated at their upper extremity to the temperature nearly of the furnace itself, but remaining comparatively cool towards the bottom. Every hour or half-hour the direction of the currents is reversed by a change of the valve lever, the heat before deposited in the one pair of regenerators is now communicated to the air and gas coming in, while the waste heat replenishes the second pair of regenerators. The gas producer consists of two inclined planes upon which the fuel descends, being gradually deprived in heating of its gaseous constituents, and finally burnt to carbonic oxide by the air entering through the grate at the bottom of the inclines. Water admitted at the bottom also assists in the decomposition of the ignited coke at the bottom, converting the same into carbonic oxide and hydrogen gas. The saving of fuel which has been effected by this arrangement amounts to from 40 to 50 per cent. In the application to reheating and puddling furnaces a saving of iron has been effected, owing to the mildness of the gas flame, of from 3 to 4 per cent. of the entire put in; the iron also welds more perfectly than it does in the ordinary furnaces. Smoke is entirely obviated. By another arrangement the regenerative principle has been applied also to coke ovens, the result being that the separation of the coke from its gaseous constituents is effected without losing the latter. In placing the coke ovens, constructed on this plan, near the works where the iron is puddled and reheated, the latter operation may be entirely effected by the gas generated in producing the coke necessary for the blast furnace in producing the pig iron. The gas resulting from the regenerative coke oven may be used to heat the blast, and boilers connected with the blast furnace. These latter improvements are now in course of being carried into effect on a large scale. The gas produced is of a very illuminating character, and may, it is repeated, be used for that purpose in preference to the hydrocarbon now manufactured for that purpose by a much more expensive process.

BOILER EXPLOSIONS.

The following communication on "Boiler Explosions," from the Astronomer Royal, was read at the meeting of the British Association:

In considering the cause of the extensive mischief done by the bursting of a high-pressure steam boiler, it is evident that the small quantity of steam contained in the steam-chamber has very little to do with it. That steam may immediately produce the rupture, but as soon as the rupture is made and some steam escapes, and the pressure on the water is diminished, a portion of the water is immediately converted into steam at a slightly lower temperature and lower pressure, and this in the same way is followed by other steam at still lower temperature and pressure, and so on until the temperature is reduced to 212 deg. Fahr. and the pressure to 0. Then there remains in the boiler a portion of water at the boiling point, the other portion having gone off in the shape of steam, of continually diminishing pressure. From this it is evident that the destructive energy of the steam, when a certain pressure is shown by the steam-guage, is proportional to the quantity of water in the boiler. By the assistance of Professor Miller, of Cambridge, Messrs. Ransome, of Ipswich, and Mr. George Biddell, I have been able to obtain a result which I believe to be worthy of every confidence. I will first state as the immediate result of Mr. Biddle's experiments, that when there were in the boiler of a small locomotive 22 cubic feet of water, at the pressure of 60lb. to the square inch, and the fire was raked out and the steam was allowed gently to escape with perfect security against priming, the quantity of water which passed off before the pressure was reduced to 0 was 2¾ cubic feet, or one-eighth of the whole. In regard to the use made of Professor

Miller's theory, Professor Miller had succeeded in obtaining a numerical expression for the pressure of the steam at 12 different measures of the volumes occupied by water and steam, which expression I have succeeded in integrating accurately, and I have thus obtained an accurate numerical expression for the destructive energy of the steam. In regard to the use of General Didion's experiments, giving the velocity of the ball in cannon of different sizes produced by different charges of powder, I have found which of these experiments exhibits the greatest energy per kilogramme of powder, and have adopted it in the comparison. The result is as follows:—The destructive energy of one cubic foot of water, at 60 lb. pressure per square inch, is equal to the destructive energy of two English pounds of gunpowder in General Didion's common experiments, which were made, as I understand, with smooth-bored cannon. It cannot be doubted that much energy is lost in the windage, some also from the circumstance that the propelling power ceases at the muzzle of the gun, before all the energy is expended, and some from the coolness of the metal. If we suppose that from all causes one-half of the energy was lost, then we have this simple result:—The guage pressure being 60 lb. per square inch, one cubic foot of water is as destructive as one pound of gunpowder. In one of Mr. Biddle's experiments the steam valve was opened rather suddenly, and the steam escaped instantly with a report like that of a heavy piece of ordnance. This is not to be wondered at, for it appears from the comparison that the effect was the same as that of firing a cannon with a charge of 44 lbs. of gunpowder.

ON PHENIC ACID.

Its Action on Vegetables, Animals, Ferments, Poisons, Virus, Miasmas, and its Applications to Hygiene, to Therapeutics, and to the Anatomical and Industrial Sciences.

BY M. LE DOCTEUR JULES LEMAIRE.*

As the subject treated of in these papers is of considerable practical importance, we shall present our readers with a short abstract of them.

Phenic acid ($C_{12}H_6O,HO$) was discovered in 1834, by Runge, who has given it the name of carbolic acid. Laurent, who studied this body, and described many of its combinations, designates it under the name of phenic and hydrate of phenyle, because he objects to place it among the acids. Gerhardt gave it the name of phenol. It has also received the names of phenic alcohol, of spyrol, and of salicone. [In this country the acid is best known in trade as carbolic acid.]

It has been formed synthetically by M. Berthelot by passing alcoholic or acetic acid vapours through a porcelain tube heated to redness. The acid is also obtained in the dry distillation of benzoin, quinic acid, &c. Gerhardt has obtained it from salicylic acid by the action of lime or baryta. Stædeler has found that the urine of man, the horse, and the cow, contain it in quantities easily perceivable. It exists also in commercial creosote;† but it is from the oil from gas tar, which contains it in considerable quantity, that it is obtained.

Preparation.—The oil from coal tar is submitted to fractional distillation. The part which passes over between 160° and 190° is treated with a solution of hot saturated caustic potash and some powdered potash. A mass of crystals is thus obtained, which may be separated by decantation of the fluid.

When this mass is dissolved in water the solution separates into two layers, one light and oily, the other heavy and watery. The latter is separated and treated with hydrochloric acid, which sets free the carbolic acid. To obtain it pure, it must be digested with fused chloride of calcium and re-distilled once or twice. After several rectifications, and by cooling slowly, it can be obtained in a solid colourless crystalline mass.

The pure acid has an odour resembling creosote; the specific gravity = 1·065. It burns with a reddish flame; boils between 187° and 188°. It does not redden litmus, only making an oily stain on the paper. It is soluble to some extent in water, but is very soluble in alcohol, ether, and acetic acid, as well as in glycerine and the fixed and volatile oils.

The pure acid acts energetically on the skin. A weak aqueous solution coagulates albumen and the blood, and acts as a strong antiseptic. Putrid meat and fish, fæcal matters, and fermented urine instantly lose their disgusting odour when immersed in or treated with the solution.

Chemically, phenic acid is a weak acid. It combines with metallic oxides, but the salts have little stability; carbonic acid decomposes them. Those with an alkaline base have always an alkaline reaction.

In consequence of the supposed little insolubility of carbolic acid in water, it has hitherto been chiefly employed mixed with powders, as in the case of Smith & McDougall's disinfecting powder; but the author of these papers has by careful experiments determined that the pure acid is sufficiently soluble in water for the solution to possess the power of coagulating albumen, of arresting or preventing spontaneous fermentation, and consequently of destroying infection. The saturated solution acts also on plants and the lower animals as a violent poison, though containing but about five per cent. of the acid. The solubility of the acid may be considerably increased by the addition of from five to ten per cent. of alcohol or of acetic acid.

From the experiments which the author has made on the action of phenic acid on plants and animals, it appears that a very weak solution will instantly destroy the lowest forms of animal and vegetable life. The juices of vegetables are prevented from becoming mouldy by the addition of the smallest quantity of the acid. Herbs and shrubs watered with a stronger solution rapidly die.

The microscopic beings concerned in the production of putrefactive fermentation are as quickly destroyed by a weak solution, and the putrefaction

* *Le Moniteur Scientifique*, vol. iv. p. 649, and *passim*.

† The substance sold commercially under the name of creosote is often only phenic acid more or less pure; but the true creosote, extracted from wood tar by Reichenbach, is a perfectly distinct body. It is to this latter creosote that wood vinegar, tar water, the soot and the smoke of wood owe their antiseptic properties. (Gerhardt, t. iii. p. 18.) According to M. Fairlie and M. Scrugbain, this creosote would be a combination of phenic acid and hydrate of cresyle.

is completely arrested. Parisitic and earth worms also are easily killed by a solution containing one half per cent., or by exposure to air containing but a small proportion of the acid. An injection of water containing one half per cent. of the acid brought away from a child a large quantity of *ascarides lumbricoides*, all dead. A stronger solution kills the eggs of ants and earwigs, and larvæ of butterflies, caterpillars, &c.

The author has studied the action of the acid on the mammalia, and mice, guinea pigs, dogs and horses, as well as men.

Action on the Human Skin.—Immediately after the application of a thin coating of the pure acid, a sharp smarting is felt, which lasts about an hour. The epidermis becomes wrinkled, and in a short time the formation of a white body may be remarked wherever the acid has touched. This white colourization results from the action of the acid on albumen; it disappears by degrees, and is replaced by some congestion, which lasts about twenty days. This congestion presents all the characters of an intense inflammation, being attended with redness, heat and swelling. If a small piece of the epidermis (which appears raised as in a blister) be stripped off, no serum escapes. The epidermis becomes detached by degrees, and when the exfoliation is complete a brown spot remains, which testifies for a long time to the energetic action of the acid. After a number of experiments on his own arms, and the arms of his friends, M. Lemaire assures us that the smarting never lasts longer than an hour. The redness of the skin endures about twenty days, but the inflammation never extends beyond the part to which the acid has been applied.

Action on the Mucous Membrane.—The action of the pure acid on the mucous membrane is, of course, analogous to its action on the skin; acute smarting, shrivelling up of the epithelium, and a milky colouration being observed. The smarting does not last so long as on the skin, especially on such membranes as produce an abundant secretion; and the epithelium quickly return to its normal condition.

Action on the Respiratory Organs.—From experiments on mice and horses, the author concludes that the higher animals may breathe the diluted vapour of the acid for a long time without discomfort or danger.

Mode of Action.—The general fact resulting from the author's experiments is that phenic acid acts on plants and the lower animals as a violent poison.

When the action of the acid on a semi-transparent leaf is examined, it is easy to prove that it coagulates albumen, and that the parenchyma and epiderm are contracted. This explains how it is that microphytes and microzoons die so quickly in its presence. All animals with a naked skin, and those which live in the water, die sooner than those which live in the air and have a solid envelope. The difference appears to result from the power of absorption, which is much greater in the former than the latter.

When frogs are placed in a saturated solution (5 per cent.) of the acid the skin shrivels and becomes milky from the coagulation of the albumen. The branchiæ of fishes also become white. This coagulation of albumen led the author to suppose that the death of the animals resulted from the coagulation of their blood. To verify this supposition, he examined, under the microscope, the action of the acid on the branchiæ of the larvæ of the salamander, in which the circulation of the blood is easily seen. He then observed that although the solution arrested the circulation instantaneously, it altered neither the form nor appearance of the blood-globules. All the change consisted in their immobility. When the blood is coagulated by mineral acids the form of the globules is changed. With carbolic acid nothing of the kind takes place. Besides this, a post mortem examination of a dog and horse proved that the blood was not coagulated. Phenic acid, then, does not kill by producing coagulation of the blood! Its action on the blood globules, however, leads M. Lemaire to think that these globules are living beings.

Insects exposed to a weak dose of the acid become asphyxiated, but they soon recover in pure air.

When a gramme or two dissolved in water are administered to a dog, the animal falls as if struck with lightning, but soon recovers again. The sudden fall the author ascribes to violent pain, and the rapidity with which it is absorbed and carried to the nervous centres. It is on the nervous system, then, that phenic acid principally acts.

DISINFECTION OF VESSELS.

Heat is the most speedy, certain, powerful, and practicable disinfectant known to science. In Egypt the plague is destroyed by the heat of midsummer. Putrefaction is arrested; mummies are preserved in the burning sands for an indefinite period. And in climates where epidemic diseases are most likely to prevail, they rarely do so at an average temperature above 85° Fahrenheit. Dryness doubtless has something to do with this. In tropical marshes, "a fire in the camp" is proverbial for its disinfecting properties. Nevertheless, heat appears to be equally efficacious in the form of steam and hot water. The writer of this paper has a lively recollection of an intermittent fever which he shared with two of his messmates in the ward-room of a small naval steamer, more than a dozen years ago, while far out at sea and without having had any communication with the shore to account for it. On searching for the cause, putrefying vegetables were found in the mess-lockers under the bunks of the parties affected. The removal of these and a thorough cleansing with *hot salt-water* put an effectual stop to the disease. Sausage poison, which has killed many persons in Germany, is effectually destroyed by boiling water.

Impressed with facts similar to these, Dr. Wm. Henry, F. R. S., of Manchester, as long ago as the year 1824, instituted a series of experiments to test the effects of heat upon the "*contagious element*" of small pox. Contagion is sometimes used synonymously with infection. It has, however, a different signification. The meaning of contagion is the transmission of disease from one person to another by contact: direct, as by the touch of the diseased person, or indirect, by contact with things that have been used by such person, or by breathing the air in close proximity with him. Syphillis, small pox, and typhus are examples of contagious disease; and these diseases are, in a great measure, independent of some of the most important conditions of infection. They are more liable to prevail in a low than in a high temperature, and in their origin chiefly depend upon filth and bad food. Persons sick with contagious disease are liable to infect surrounding things, clothing, furniture, the air of the room, etc.; but as the character of the disease continues the same, it is still denominated contagious—*communicable by persons.* Infectious disease is *not* communicable by persons but by *things*, and a person sick with it, when divested of *fomites*, clothing, etc., can neither communicate his disease to other persons nor to other things. In this, however, they are fortunately alike: their *fomites* are equally capable of being destroyed by heat. Dr. Henry's first series of experiments satisfactorily established the fact "that the infectious matter of cow-pox is rendered inert by a temperature of 140° Fahrenheit," from whence he "inferred that more active contagions are probably destructible at temperatures not exceeding 212° Fahrenheit." His next series of experiments were upon the personal *fomites* of typhus and scarlet fever. Three flannel shirts, taken on three successive days from a strongly marked case of typhus fever, were subjected to 204° Fahrenheit for an hour and three-quarters. These personal *fomites* being, before the application of heat, as thoroughly charged with the contagious principle as any garment could be, were tested as follows: One was placed directly under and within twelve inches of the nostrils of a person engaged in writing, and who was excessively fatigued from previous exercise and had observed an unbroken fast for eight hours. This test of exposure was continued for two hours. The second shirt was put on and worn next to the body of a person for two hours. And the third, with the view of giving activity to any contagious matter "which might possibly have escaped decomposition," was put into an air-tight canister for twenty-six days. It was then taken out and placed within twelve inches of the face of a person for four hours, "a gentle current being contrived to blow upon him from the flannel during the whole time." *In none of these instances was the fever communicated, and no injurious effects were experienced.* Dr. Henry next performed a precisely similar series of experiments with the *fomites* of scarlet fever, which proved to his satisfaction "*that by exposure to a temperature not below* 200° *Fahrenheit, during, at least, one hour, the contagious matter of scarlatina is either dissipated or destroyed.*" And he remarks, "the circumstances under which the experiments were conducted render it, I think, demonstrable that the disinfecting agency belongs to heat alone; for the receptacle in which the infected waistcoats were placed having in every instance been closed, change of air could have had no share in the effect. The phenomena, then, are reduced to their simplest form, and the results put us in possesion of a disinfecting agent the most searching that nature affords—*one that penetrates into the inmost recesses of matter in all its various states.*" Having satisfied himself in this direction, Dr. Henry next undertook to ascertain what elevation of temperature "cotton and other substances likely to harbour contagion of the plague or typhus would sustain without injury, the heat being applied to both the raw staples and to their various fabrics. A quantity of raw cotton, subjected to a dry temperature of 190° Fahrenheit, which was steadily kept up in the inner compartment of a double vessel heated by steam during two hours, become 'fuzzy' on account of the loss of its natural moisture, and for the same cause the strength of the yarn was for the time impaired; but after being left for two or three days in a room without fire a great change had taken place in its appearance, and it was found on trial that the cotton was as capable of being spun into perfect yarn as that originally employed. On accurate trial of the twist which had been spun from it, a hank supported an equal weight with a hank of the same fineness that had been spun from cotton fresh from the bag. This fact, established by repeated experiments, proves that, with the recovery of its hygrometrical moisture, cotton which had been heated regains its tenacity and becomes as fit as ever for being applied to manufacturing purposes." A quantity of cotton yarn was tested in like manner with like result. "Articles of cotton, silk, and wool, after being manufactured, both separately and in a mixed state, into piece-goods for clothing, were submitted to the same treatment. And some of these were of the most fugitive colors and delicate textures, yet after being exposed three hours to a dry heat of 180° Fahrenheit, and then left a few hours in a cool room, they were pronounced perfectly uninjured in every respect. Furs and feathers, similarly heated, were also uninjured. In subsequent experiments the temperatures were raised forty or fifty degrees higher without injury to the fabrics."*

Dr. Von Busch, of Berlin, having the benefit of Dr. Henry's experiments, in February and March, 1851, after having ineffectually made all the usual appliances—thorough cleansing, aeration, fumigation, etc.—for the purpose of disinfecting the Berlin Lying-in Hospital of puerperal fever, determined to try the effect of dry heat. All the beds, wardrobes, and hospital utensils being retained in the wards, common wood stoves were introduced, and a steady temperature of about 150° Fahrenheit was kept up for two days. The wards were immediately reoccupied by the same class of patients, with the same individual liabilities as before, and the result was found to be triumphant! The infection was destroyed and the inmates were safe. A subsequent return of the disease on the following year was destroyed in the same manner.*

A striking instance of the disinfecting power of heat to a badly infected ship is referred to in Vol. VIII. of the Royal Medico-Chirurgical Transactions, as being contained in the official report of Dr. Wm. Ferguson, Inspector General and Chief Medical Director for many years in the Windward and Leeward Islands. The reference states that "the transport ship *Regalia*, being badly infected with yellow fever, while at English Harbor, underwent fumigations without the least effect in arresting future attacks or their fatality; and that it was not

*Philosophical Magazine, 1831-32.

*Neue Zeitschrift Fur Geburtskunde, 1852 Be Bullderlin, Therapeut. 1853.

until after her arrival in Carlisle Bay, where she was completely cleared, and with her hatches closed, and *her whole hold exposed to the concentrated heat of many stoves, that fever ceased.*"

ON A PACKING FOR PISTONS OF STEAM ENGINES AND PUMPS.*

By Mr. George M. Miller, of Dublin.

This packing consists of two rings, pressed outwards against the cylinder by the pressure of the steam as it acts on the alternate faces of the piston, without the use of any springs. This construction of piston is used by the writer in the locomotive engines on the Great Southern and Western Railway of Ireland. The piston is of cast iron, 2 inches in thickness and 15 inches diameter. Two square grooves are turned in the edge of the piston, ⅜ in. in width and ⅜ in. apart, and a corresponding steel ring is fitted into each groove, the rings being divided at one part with a plain butt joint, and sprung over the piston into their places. Two small holes, ⅛ in. diameter, open from each face of the piston to the bottom of the nearest groove, whereby the steam is admitted behind the packing ring and presses it out against the cylinder so long as the steam is acting upon that face of the piston. The alternate action of the two rings is continued as long as the steam is acting on the piston, one of them being always pressed steam-tight against the cylinder.

Another form of the piston has been used in cases where the piston is desired to be flush on both faces or to fit a cylinder with flat covers; in this a circular flat head forged upon the piston rod is fitted between the turned faces of the two halves of a cast-iron piston, which are held together by turned pins riveted over, forming a hollow piston flush on both faces, fast upon the piston rod, and without any loose part besides the two packing rings.

The ends of the rings, where divided, are made either with a butt joint or a lapped joint. The piston body is turned to pass through the cylinder easily; and the joints of the rings have been found to be practically steam-tight. In some cases the joints have been tongued, as shown, but in the writer's experience this has not been found requisite; the butt joint has invariably worked well, whilst it has the advantage of perfect simplicity of construction. In pistons where the packing ring travels over the opening of the cylinder port, a small stop is fixed in the bottom of the groove, entering a short slot in the packing ring, to prevent the ends of the ring coming opposite the cylinder port, but still leaving the ring free to travel round a little in the piston grooves; but it is preferred for the packing rings not to travel over the cylinder ports.

These steam-packed pistons have been used more than seven years in the locomotives of the Great Southern and Western Railway, and have proved so satisfactory and advantageous that their use has been extended to all the 94 locomotives working upon that line. The following are the results of the working in the engines running from Dublin, as regards the durability of one set of rings, the period of their wear, and the mileage of the engines whilst wearing them out. Nineteen engines working with one set of steel rings averaged 33,020 miles and 16½ months' running, one engine having worked for 3 years and run as much as 98,073 miles with one set of packing rings. Five engines working with one set of brass rings under the same circumstances averaged 30,986 miles and 19 months' running, the greatest work amongst them being 2¼ years and 43,197 miles. Twenty other engines with steel rings, which are still in use, have also averaged 40,444 miles and 21 months' work, one of these having worked for 3¼ years and run 94,399 miles with the original set of rings.

The general result of the above is that one set of steel packing rings have lasted 37,000 miles and 19 months' work, and one set of brass rings 31,000 miles and 19 months' work, the difference in durability being about 16 per cent. in favour of the steel rings. In some of the individual cases of the pistons with steel rings, a very considerable variation from the average result of 37,000 miles is found in the durability of the packing rings, some of them having lasted 2⅝ times the average, and some only as much below the average. In the cases of the brass rings the variation is not so great, amounting to 1⅜ times the average in the highest, and about as much below the average in the lowest. This variation in wear has not been fully accounted for; it may have occurred from a different character of metal in the cylinders, from priming of the boiler, and from the presence of grit in the water; but the writer has reason to believe that the rings have been frequently put in to work and set with a pressure upon the cylinder from their own elasticity, thus causing a source of wear. It is found the best plan to turn the rings to the exact diameter of the cylinder, and to put them in without any spring upon them, so that they are not subjected to any wear except when the steam is acting on them. The steel rings are now slightly tempered, to admit of their being sprung into the grooves without altering their form. In all these pistons the steel packing rings were ⅜ in. thick originally, and ⅜ in. wide, and they were worn down to about ⅛ in. thick in the thinnest part before being removed. The brass rings are worn down from 7-16ths in. until they are ⅛ in. thick. Specimens were exhibited of steel rings from four engines that have worked 38,000, 61,000, 84,000, and 96,000 miles respectively, since first put into the pistons. It must be remarked that, when opportunities occur, as when engines are under repair, the rings are taken out and reset to the size of the cylinder.

It is found in practice that two steam ports of ⅛ in. diameter are quite sufficient for each of the steel packing rings. The rings must be made to fit easily in their grooves, so as to move freely, with a clearance of 1-16ths in. at the bottom of the grooves for the steam to pass round behind the rings. No difficulty has been experienced from the steam passages becoming stopped up a moderate use of tallow in the cylinders.

The use of this piston-packing in locomotive engines has been productive of economy by reducing the friction, and by prolonging the wear of both pistons and cylinders. It will be observed that only one ring is in action at the same time, and

* Read before the Institution of Mechanical Engineers: Charles F. Beyer, Esq., in the chair.

that when the steam is shut off, as in descending inclines and approaching stations, the piston is free to move without any friction. The cylinders of the four engines from which the specimen rings exhibited have been taken, show a highly polished surface, are very little worn, and are nearly parallel throughout. The operation of putting in these rings so as simply to fit the cylinder is extremely easy, whilst great care and skill are required in giving springs the requisite degree of elasticity, and in making them to maintain it.

A set of brass packing rings was also exhibited, taken out of the pistons of a pair of vertical stationary engine cylinders at the Dublin Railway station, in which they have been in constant work for the last four years, with a pressure of 50 lb. steam. The diameter of the cylinders is 19½ in., and the rings were originally ⅜ in. thick and ¾ in. wide; they are now worn down to 5-16th in. thick.

A number of stationary engine pistons are working with these packing rings, and they have proved very durable and thoroughly satisfactory, giving an advantage in reduction of friction, and in preserving the cylinder face in perfect condition. In one case of the engine of the Oldbawn Paper Mill, near Dublin, with vertical cylinder 18 in. diameter and 2½ ft. stroke, working with 50 lb. steam, the cylinder had previously been worn considerably out of truth and much grooved, and one of these pistons was put in having two steel rings of ¾ in. width and ⅜ in. thickness, and was in constant work for four years without the packing rings requiring renewal. They have lately been taken out for examination, and were found to be still ¼ in. thick; and the cylinder from its previous defective condition, has been brought completely to truth throughout, with a highly polished surface.

These packing rings have also been used for four years for pump buckets, and have proved very satisfactory. In one case of a double acting pump 8 in. diameter, the two packing rings are of brass, ⅜ in. wide, and 5-16ths in. thick, and are pressed out by the pressure of the water acting at the alternate faces of the bucket through two ports, ⅛ inch diameter, similar to those in the steam pistons. This pump had two years' constant work at quarries and bridge foundations upon the Great Southern and Western Railway, before the packing rings required renewal.

In the case of single acting pumps the bucket has only a single packing ring with ports opening from the upper side. A pump bucket 5 in. diameter has been working constantly for 2½ years at a station on the railway near Dublin. This bucket was exhibited, having been taken out for the purpose; the packing ring was originally ½ in. wide and ¼ in. thick, and has worn less the 1-16th inch in the 2½ years that it has been working up to the present time. As the diameter in this case is too small to allow of the ring being sprung over the body of the bucket into its place, it is put in by means of a junk ring screwed on at the under side of the bucket.

An application of the same construction of packing that has also been made to the gland packing of a 9 in. pump plunger, in which two brass packing rings are used, ½ in. wide and ⅜ in. thick, just like the piston packing rings, except that they act in the opposite direction, being pressed inwards upon the plunger by the pressure of the water through the ports.

Mr. Miller exhibited specimens of the steel packing rings from the pistons of four locomotives which had run from 38,000 to 96,000 miles; and also the brass packing rings from the pistons of the stationary engine, together with the bucket of the 5 in. single-acting pump referred to in the paper.

MANGANESE.

This substance, although not used in the arts in a metallic condition, is in many respects valuable to all who are engaged in the pursuit of science, owing to the peculiar affinity it has for oxygen. The most common source of manganese is the black oxide, known also as the binoxide, or peroxide, MnO_2. In the form in which it is usually met in commerce, peroxide of manganese is an intensely black heavy powder, prepared by grinding up the native variety. The chief uses of peroxide of manganese are for the preparation of oxygen and chlorine. When it is heated to a dull redness, a portion of the contained oxygen is evolved, and sesquioxide of manganese is left behind. If the manganese has been free from chlorides, the oxygen will be pretty pure, but otherwise the first portions of gas which come over are liable to be contaminated with chlorine.

Binoxide of manganese is of constant use in the laboratory for the preparation of chlorine; for this purpose it is acted on by hydrochloric acid, either by the direct addition of this acid to it, or by making a mixture of common salt and binoxide of manganese, and then heating this with oil of vitriol. The chlorine is liable to be contaminated with free hydrochloric acid, and should, therefore, be washed in water which will hold back the free acid. If required dry, it should then be passed through oil of vitriol. When peroxide of manganese is ignited with caustic potash or soda, in contact with air, or when fused with an alkaline chlorate or nitrate, more oxygen is absorbed by the manganese forming manganic acid, MnO_3, which unites with the alkali present forming a manganate. Manganate of potash forms an intense bluish green solution, which is permanent when an excess of alkali is present. When an acid is added, or when the manganate of potash is allowed to remain in contact with the atmosphere containing carbonic acid the manganic acid set at liberty is split up into peroxide of manganese and into another acid, permanganic acid, $Mn\ O_3$, which instantly unites with some of the alkali, forming a permanganate of an intense purple-red color.

Permanic acid in aqueous solution, may be obtained by adding to permanganate of baryta the exact quantity of sulphuric acid necessary to precipitate all the baryta, and then filtering through asbestos or gun-cotton. Sulphate of baryta remains on the filter and the filtrate consists of permanganic in aqueous solution. It forms a beautifully-coloured liquid, which appears dark carmine red by reflected, and dark violet by transmitted, light. When somewhat diluted it is reddish blue, and a still larger addition of water gives it a carmine color. The acid imparts a distinct red color to very large quantities of water. It is inodorous, and has at first a sweet and afterwards a bitter, rough taste. It stains the skin, but does not redden litmus, as, owing to its powerful oxidizing properties, it destroys the colouring matter of the paper, at the same time turning it brown, from deposition of hydrated peroxide of manganese.

So far as we know, manganese is not used in the arts in a pure state, but as an oxide. Its value depends upon the oxygen which it contains, and the facility with which it parts with this useful gas. Vast beds of it have been opened up at Brandon, Chittenden and Irasburg, in Vt., and it is found in several other localities in the United States. In the manufacture of the chloride of lime which is used so extensively for bleaching linen and paper, 1 part of the binoxide of manganese, 1¼ parts of common salt, 2 parts of concentrated sulphuric acid, and two parts of water, are mixed together in a retort, to which heat is applied. By their action which takes place in the retort, the salt which is a chloride of sodium, gives off its chloride and the gas is conveyed into chambers containing hydrate of lime. The lime absorbs the gas, and in this condition it is as conveniently exported as the chloride of lime, so well known as a disinfectant, and so much used for bleaching purposes. The binoxide of manganese gives off its oxygen freely at a comparatively moderate heat; hence, its adaptibility for obtaining oxygen gas in large quantities and at a moderate cost. It is also employed in the manufacture of steel, by mixing a small quantity with ground charcoal, in the crucibles containing the iron to be smelted and converted into steel.—*Scien. Amer.*

THALLIUM AND ITS POISONING PROPERTIES.

The history of this new metal has been the subject of a dispute for priority between Mr. Crookes and M. Lamy. The latter gentleman, in a paper addressed to the Academy of Sciences, now announces a property of that metal, the discovery of which undoubtedly belongs to him, viz., its deleterious power. Having experienced certain pains, especially in his lower limbs, while pursuing his studies on thallium, he was induced to attribute them to a noxious influence of the metal; and in order to ascertain whether such was the fact, he dissolved five grammes of sulphate of thallium in milk, and offered it to two puppies, each about two months old. But after tasting the liquid they left it, and could not be induced to take any more. On the following day the milk, which had been left in the yard, had disappeared, and it soon turned out that it had been partaken of by a dog, two hens, and six ducks. For a few hours after ingestion the dog became sad, and refused to eat. During the night it was seized with violent gripes, which caused it to utter piercing cries. Its features had undergone a change; its back was bent up, through the effect of pain, the seat of which was evidently in the intestines. Its hind legs, after a continuance of convulsive motions, became paralysed, and it died sixty-four hours after taking the poison. On the day before its death a hen and six ducks died, and in those which were watched in time the paralysis of the legs was remarked. The two puppies, which had scarcely touched the milk, had meanwhile shown symptoms of fatigue; by degrees they were seized with convulsive trembling, and could hardly stand; then came the acute pains, which ended in death, although every precaution had been taken, apparently in good time, to save their lives. All these animals being subjected to dissection, there could not be found the slightest corrosion or even inflammation of any consequence; only the gall bladder of the dog was found considerably extended, and in some of the ducks various serous membranes; that of the liver especially had assumed a whitish and granulous appearance. As to the nature of the poison, if there could have been any doubt about it, it would have been at once dispelled by the characteristic green band peculiar to thallium in the spectrum analysis of the organs of the dead animals. Eight days later, another hen was taken ill. Its wings hung down, it could hardly walk, and when it wanted to peck its food, its neck seemed to have lost the power of bending down sufficiently, so that its beak did not reach the food. The hen was killed, and thallium found in the intestines, but in a very small dose indeed, and the other organs did not contain any. M. Lamy next administered a decigramme (a grain and a half) of the sulphate to a dog two months old, and it died forty hours after taking it. Hence M. Lamy justly infers that sulphate of thallium is a powerful poison, producing pain in the intestines and paralysis of the lower members. This poison and the nitrate have but little taste, and might therefore be used for criminal purposes; but fortunately there is not a poison that can be traced with more certainty through spectrum analysis than this. This new method of analysis bids fair to render excellent service in cases relating to forensic medicine.

ECONOMICAL ADVANTAGES OF SYSTEM.

Persons who have noticed how work is carried on in many of our large machine-shops, cannot but wonder why it is that no established system and routine is laid down to be observed by the workmen. The advantages of such a plan are too obvious to require any comment; and it is, as we have remarked, incredible how many things are left to take care of themselves, that should have been regularly classified, and arranged with reference to the demands of the work. Let us take, for instance, the item of mandrils, as they are called here; or arbors, as they are better known in some other parts. These valuable, and indeed indispensable aids to machine work in too many instances have no more care or attention bestowed upon them than if they were scrap-iron. They are often made of iron, instead of steel, and are cut, hacked, battered, and ground in the centres, by careless workmen, until they are utterly useless. A good mandril costs too much money to be subjected to such usage, and this is but a little part of the evil; for where such bad practices prevail there are not likely to be good workmen, and no shop can create or maintain a reputation where such carelessness is permitted.

Such folly and wastefulness as this must and should receive the severest condemnation of every right-thinking person. System as applied to the use of mandrils, is not the only place where it might be adopted with good results. Let us take the matter of measurement, for instance. In too many workshops the only reliance for proper fitting work is placed on an old, illegible, greasy, shaky-jointed, smooth-ended, wooden two-foot rule; which is about as useful for measuring purposes as so many inches of a broomstick. With this valuable aid the old-fogy workman gravely takes a pair of callipers, and turns up a shaft from it to the size of "four inches." Another individual bores out a wheel to "fit" it by *his* wooden rule; and the consequence is that, between them, about a sixteenth of an inch of daylight passes through the wheel when the shaft goes in, or else there is a similar quantity of iron to be forced through the bore of the wheel in excess of the proper measurement. These are not instances created for the sake of maintaining our assertion that some system is required, but are cases of too frequent occurrence, as every one familiar with the routine of a machine shop can testify. What is true in the case of lathe-work is also correct as regards every other transaction where fitting depends upon actual measurement. The steel scale is an excellent substitute for the boxwood rule, and should be more generally employed by workmen; but none of these can compare in value with a set of standard gauges such as are used in the Novelty Iron Works in this city, and other large and smaller machine works throughout the country. These guages, we believe, are made on the Whitworth standard, and for sizes of three inches are divided into sixteenths, while beyond that they are only graduated to eighths of an inch. These guages can be made so that one end can be used in turning a shaft, while the other end is flattened like a fish-tail, and reduced to exactly the dimensions of the calliper ends. Thus a shaft turned by one end, and a hole bored so as to fit the opposite part, will cause both wheel and shaft to fit each other beautifully without loss of time. This is so much better than the old fashioned way of using callipers for the purpose, that the two are not to be spoken of in the same breath.

Every part of the machine business can be made the subject of a general and thorough reform. There are numbers of establishments in which wooden chucks, mandrils, bolts, washers, old files, stray hammers, lathe-tools, and every conceivable thing are scattered under the benches, lying on window-sills, and trodden under foot generally. What a spectacle of slovenliness and disorder such a place presents; and what a commentary it is upon the character of those in charge! The pecuniary loss sustained by such a state of things is enormous, and might be dispensed with by having everything in its proper place, and a regular and recognized system of procedure for all, so that work would not be spoiled by carelessness. One of the many advantages would also be soon apparent in encouraging a better class of workmen, and result in good to the whole trade generally.—*Sci. American.*

NATURAL MAGNETS.

A discovery has recently been made in Swedish Lapland, of a seam of magnetic iron, which will probably produce the most perfect natural magnets hitherto known.

This seam is several feet thick, and crosses a mountain of minerals more or less magnetic. It is situated upon the left bank of the Rautusjocki, in 67½ degrees latitude and 39¾ longitude.

M. Berg, to whom this property belongs, is working an iron mine in that locality, and he hopes to obtain sufficient natural magnetic iron to supply the whole of the European collections.

Miscellaneous.

Cultivation of Fruit Trees.

We have already mentioned the Emperor's visit to M. Jacquesson's extensive grounds near Chalons, where a new system of arboriculture has been introduced, under the management of M. Daniel Hoolbrenck. The following description will give an idea of that horticulturist's method. In the case of vines, M. Hoolbrenck, at the end of winter, bends down one or two vine shoots of the preceding year upon each stock, so as to lie below the horizontal, at an angle of 112 deg. counted from the vertical. All the other shoots are pruned away. In consequence of this inclination, the sap lingers under the bark, and favours the development of a great number of buds, which in due time become branches laden with grapes. On the other hand the sap produces at the base of the inclined branch a vigorous shoot, which springs up vertically, and which, in the following year, will replace the fruit branch. When several buds appear on the stem which, in the preceding year, produced the shoot laden with grapes, the weaker ones are removed, and only that which appears most vigorous is preserved. By this means the exhaustion of the stock is prevented, and in the following autumn a long and vigorous shoot is obtained, which replaces the other. M. Hoolbrenck proposes to apply this method to all fruit trees. Nevertheless, as the pear, apple, and plum trees produce fruit on the old branches, those which bore fruit in the preceding year cannot be suppressed. The bending of fruit branches on the pear and apple tree have produced extraordinary results in M. Jacquesson's orchards. The Emperor examined some young pear trees in the nursery with great attention, and found their branches, two years old, laden with abundance of very fine fruit. The bending down of the fruit branches is peculiarly well adapted to trees that are slow in producing fruit. It gives the shoots which would only give wood time to be transformed into fruit branches in the course of a year, and it favours the production of fruitful shoots even on the old branches and bark. The Emperor's attention was especially attracted by certain old lemon trees, the branches of which were inclined at 112 deg., and which now display young lemons directly implanted on old branches deprived of twigs and leaves. Experience can show whether the trees subjected to M. Hoolbrenck's mode of treatment will live long, and continue to yield the abundant crops they have been producing for these last two years. Certain it is that his system is also applicable to herbaceous plants, such as asparagus, for instance, the stems of which, being bent down, produce new alimentary shoots from the middle of August to the middle of September. But M. Hoolbrenck does more; it is well known that the white part of asparagus is bitter and hard, and, therefore unfit to eat. M. Hoolbrenck takes a bottle with the bottom broken off, and gives it a strong coating of whiting. With this fragment of a bottle thus prepared he covers each shoot of asparagus as it makes its appearance, thus preventing the admission of air and light. By this means all that part of the asparagus so protected becomes as edible as the upper part. M. Hoolbrenck treats the alianthus, or Japan varnish tree in the same way, in order to provide a larger quantity of food for the new species of silkworm that feeds upon it, and as this insect thrives in the open air, he protects it from birds by means of nets.—*Galignani.*

[There is nothing new in the practice of bending the branches of fruit trees down to cause them to send out fruiting buds. We remember seeing in England the branches of a pear tree bent in the manner described nearly twenty years ago.—Ed.]

The Harvest.—Increased Fertility of Land.

The grain crops of the country are in all probability worth £20,000,000 to £30,000,000 more this year than they were last year. We shall certainly arrive at the knowledge of one great class of the causes of fertility if we inquire what has occasioned this great instance of its increase. Has it been owing to an extension of land drainage? That often repays its cost in a few years, although it is sometimes allowed ten or fifteen years for that purpose in agreements between landlord and tenant. But how many millions spent on land drainage would create an increased value of grain to the extent of £20,000,000 in a single season? Rapidly as land drainage is proceeding, so great an increase of fertility cannot be set down to this as its efficient cause. Can it then be attributed to improved tillage? Unfortunately for that idea the autumn which preceded the crop of 1862 was much better for tillage work than that which preceded 1863. There has rarely been a finer autumn than that of 1861 for tillage operations, but the crop of 1862 was generally inferior and below the average. Can it then be set to extra manuring? How many million pounds' worth of guano put on the land in spring will produce £20,000,000 of grain in autumn? It would need, we fear, almost all the contents of the guano islands spread upon the land at once to produce an effect so great. Notwithstanding all our boasted advances and improvements in all farm operations, this great increase in the year's fertility is not a work of art at all. It has arisen out of causes altogether independent and outside of human effort, will, or science. Here then we have pointed out to us one great class of facts affecting fertility which are altogether outside of agriculture—including the whole series embraced between climate on the one side and constitution of the plants we grow upon the other. The fitness of climate to the constitution of the plants we grow (both being entirely beyond human control, and to be simply accepted as absolute and inevitable facts) is one great cause of fertility. When the farmer has chosen the plants best adapted to the circumstances of his cultivation the outer and maximum limits of their productiveness are fixed for him—they are independent of any power he can exercise. Up to those limits he can force his will upon the crops he grows, but beyond those limits he cannot urge them. All the subsequent causes he can bring to bear are in the nature of opportunities given to the plant—its power to use those opportunities is limited by the climate of the year, and by its own essential character and constitution. Of course the wonderful produce this year is to some extent a work of art—if the difference upon the whole between the harvest of the present season and that of 1862 cannot be put down to deeper ploughing, more perfect drainage, more liberal manuring, or to any difference in the efforts of the farmer, there are plenty of differences between particular farms and fields either of this year or of last which can. The reports which we have received of the current crops speak of barley in particular as being extremely various; where early sown it has prospered, but in the hands of those whom the reporter calls "afternoon farmers," *i. e.*, where sowing has been delayed, it has failed. And in the previous year the wheat harvest was extremely various; on undrained clay lands it was a failure, while on well drained land and well put in it yielded well. If, therefore, one great class of circumstances affecting fertility, including all those particulars which make up the climate of the year, and the natural character of the plant—are beyond us, there are many others, including both the adaptation of the soil to the plant and the treatment of the plant itself, according to its natural character, by which we can make or mar a crop. In Mr. Caird's reports of farms, published several years ago in the columns of the *Times*, there is an instance given illustrative of the rise in the fertility of land during successive weeks of years during which the average climate must have been nearly constant. The wheat crop in the seven years preceding 1839 averaged twenty-five bushels per acre on the farm of Mr. Blyth, near Burnham, Norfolk. In the seven years ending 1846, it was twenty-nine bushels; in the next seven years it was thirty-six bushels per acre. In like manner, during the same period, oats had yielded thirty-four, fifty-seven, and sixty-eight bushels per acre, respectively, and barley had yielded thirty-one, thirty-three, and forty-five bushels per acre. Mr Caird's remark upon this history is that the great increase in the period since 1846 may be attributed to the use of artificial manures, as a direct application to every crop, which has since that time become a universal practice. Here then, is one great and obvious way in which fertility is in our hands; we can feed our plants up to the limit of their power to assimilate this food; and that this is not always nor generally done is plain from the fact that some increase in productiveness almost always follows the application of additional manuring. Up to the extent which the living powers of the plant permit, and they are determined by the climate of the season, we can urge its growth by the liberal supply of all its wants. Does fertility depend on the consistence of soil, we can marl light lands, we can burn clays, we can harden by the sheep fold and the roller, we can lighten by the scarifier and the plough. Does it depend on full opportunity being given to rain water to traverse soil and subsoil and feed the roots of plants, we can by underground channels which carry off the water as it sinks, preserve its continual circulation throughout both. Does it depend on the natural contents of the land being fitted for the food of plants, we can lime and burn and till, introduce the natural agency of air and rain and the artificial agency of lime and heat, and thus stimulate that chemical action within the soil on which the preparation of food for plants depends. Does it hinge on the supply of additional fertilising matter, we can add these matters directly from the dung heap, the manure manufactory, and the guano ship, or we can add them indirectly by feeding sheep and cattle on the land upon imported food. Unquestionably fertility is to a very great extent a work of art. This is not less true on natural and shallow soils, where no such extraordinary change has to be effected in the original character of the land before it will yield good crops, than it is in the fens of Lincolnshire and Cambridge, now laden with rich grain crops and herds and flocks of cattle and of sheep, where the natural fertility yielded formerly but sedge and rush and bog and sea-side plants, with only wild fowl for the live stock.—*Agricultural Gazette.*

Wilson, the Ornithologist.

Among the most recent English volumes is one, by Allan Park Paton, entitled: "Wilson the Ornithologist: a New Chapter in his Life—embodying many letters hitherto unpublished." Wilson, who died in 1813, aged forty-seven, was a weaver in Scotland, who came to America to improve his fortunes, after having failed at home in the unromantic occupation of a peddler. He arrived at the Capes of the Delaware on the 14th July, 1794, came to Philadelphia, where he worked a little at the loom, learned to draw, etch, and color, and also to write good prose (he had previously made indifferent rhymes), became a schoolmaster, visited Niagara at the age of thirty-eight, and from that time devoted himself to the completion of a work on American Ornithology which has made his name famous. To obtain materials, he travelled extensively over the North American Continent. The first volume of his work appeared in 1808, published by William Bradford, of Philadelphia, and ere his death every crowned head in Europe had subscribed for it. In Pennsylvania, soon after his arrival, he became acquainted with Charles Orr, a writing master, who was then a much better educated man than himself, and a correspondence took place between them, seven years of which have been recovered, and the letters are given by Mr. Paton, forming the "new chapter" in Wilson's life. The chief fact which they communicate is, that when Wilson taught school at Milestown (now within the chartered limits of Philadelphia), he formed an attachment to a young lady, which, or its consequences, caused him to change his residence to Bloomfield, New Jersey, where he again taught a school. It has hitherto been believed that Wilson had never exhibited the slightest susceptibility for the tender passion. His book has been edited by a prince of the Napoleon family, and now, half a century after his death, the citizens of Paisley, his native town, proud of his reputation, and not unwilling to share it, are about to erect a public monument in his honour. Mr. Mossman, a sculptor of Glasgow, is engaged on a design for this statue, which is to represent the naturalist dressed for his work; a dead bird, which he has just shot, in his hand, his gun slung round his shoulder, and a sketch book and parrot at his feet—a well-contrived and very proper model of the great man. The *London Athenæum*, noticing this "new chapter" in Wilson's life, thus eloquently and justly characterizes his favorite pursuit: "In the very name of an ornithologist there is a charm. He is a lonely man, who loves Nature and has an animal delight in air and color. With a gun slung on his back, with a wallet on his thigh, and an inkhorn in his belt, he sallies forth into the copse, he jumps into his boat, and for weeks and weeks he may be lost to the sight of man. When he comes back into the world, it is with rare spoil of knowledge won from Nature in her most secret haunts. No roof domes in his workroom, which is wide as the land and open as the sky. His feet are among the young ferns—his nostrils filled with the scent of trees and flowers—his eyes are soothed by the green earth and the blue vault—his ears lulled with the sighing of leaves or roused by the whirr of wings. Beauty lies about him at every step. In almost everything that man does there is some near limit of scenery. The judge is confined to his court. The secretary must attend to his office. The journalist is chained to his desk. The physician sees little beyond his patient and his brougham. The preacher has but his pulpit and his Sunday audience. Even in the more stirring occupations of war and trade, there is an order, a discipline, a sequence, which in the course of time palls upon the sense. A sailor tires of the sea. A soldier longs to lay down his sword. A merchant prays for the hour when his ships shall have come home and he may take his rest in peace. But we have heard it said, that a man who has once become a freeholder of the woods—like Macgillivray or Gould—who has watched all day for a grebe by the lonely English tarn, or bagged his bird of Paradise on the coast of New Guinea, will never tire of his sport so long as he can hold a gun. The canoe, the fowling-piece, the forest glade, the hill-top, are to such a man health and life. He pines in cities. In society he is dreaming of the loch and the heather; at his club-room he is musing of the log-hut in the backwoods or the camp-fire by the Yarra-Yarra. He is the lion who has lapped up blood, the Howadjee who has tasted of the Nile, the poet who has eaten of the insane root. His life is not as that of other men; he is set apart; his career is not a profession but an adventure."

Operations of English Shipbuilding Firms, by Mr. Palmer, Newcastle.

I may perhaps be allowed to describe very briefly, the operations of my own firm, which I trust, will prove of some interest, as showing the extent to which one establishment may be developed. In the first place, we obtain the greater portion of our ironstone from our own mines. At a point on the coast ten miles north of Whitby, the ironstone seams crop out in the sides of the cliffs, and here we have formed the small harbour of Port Mulgrave, where vessels can ride in safety, and ship their cargoes with ease and expedition. Between the Tyne and Port Mulgrave, some of our steamers run direct, making on the average four voyages per week, whilst others of a larger class call to load stone on their return voyage from London. At Jarrow the ore is delivered to the furnaces by means of the Armstrong hydraulic cranes, and mixed with ores from Cumberland, Devonshire, and Lincolnshire, thence it is passed to the mills, and from the mills to the ship-yards. The number of men employed in these operations is upwards of 3,500. The number of tons of iron consumed per annum in our yards and engine works is about 18,000. The amount of tonnage launched during the year ending the 1st August was 22,000 tons. We have 15,000 tons in course of construction, and orders spread over a period for 40,000 tons more. Amongst these latter are steamers of upwards of 3,400 tons burthen, pronounced by their owners to be "the finest and most complete merchant steamers ever built." They are intended to bring cotton from the Southern States of America, so soon as the unhappy war in that country shall cease, and they will no doubt be but the pioneers of others of a similar class. One of these steamers is of sufficient capacity to carry 6,000 bales of cotton, and it is estimated that, during one year, she will bring from New Orleans to Liverpool 38,000 bales. The crew of such a vessel consists of sixty hands, and it would require five sailing vessels of 1,200 tons each, employing 130 seamen, to do the same work. A consideration of the future of the iron shipbuilding trade opens out a vast field for speculation; but the ultimate result is not difficult to anticipate. We have seen with what success sailing vessels have been superseded by steamers in the coasting and coal trades, and we know that magnificent fleets of steamers, engaged in the postal and other services, are ploughing almost every known sea. As commerce increases, there will be few trades in which the employment of iron steamers will not be found of advantage. Most of the carrying trade to the Baltic and Mediterranean is already conducted in vessels of that class, and the sailing ships that cross the North Atlantic are being rapidly displaced by iron steamers. Their advantages in strength, speed, and capacity, are so marked, that sailing vessels of timber must give way before them. Even the Admiralty, cautious and unyielding though it be, will have to abandon its "wooden walls" in favour of the stronger and more useful material; a material, too, that lies in rich profusion beneath our feet, and has not, like timber, to be purchased of other nations. The commercial men of this country have set the Admiralty a single example of industry and enterprise. It is they who have made the experiments, and adopted the inventions, that have established the maritime supremacy of this country; and it is owing to their energy that we find on every sea, in the shallow rivers of the east, and the deep broad waters of the west, English built ships of commerce diffusing the benefits of free trade, and linking nations and tribes together in the bonds of amity and peace. The true source of our national greatness is to be sought in this wonderful development of our merchant navy. Other nations are entering into friendly rivalry with us, but the larger share of the carrying trade of the world will ever be secured to that country that can produce vessels combining the largest capacity with the utmost amount of economy and expedition in construction, and that can, at the same time, navigate those vessels with the greatest degree of skill and rapidity. In conclusion, permit me to express the proud conviction I entertain that the mineral wealth of this district, and the skill and endurance of its workmen, whether on land or sea, will enable the locality that gave birth to an Armstrong and a Stephenson to maintain its character for maritime industry and enterprise, and bear its full share in promoting the commercial greatness of the country.—*British Association.*

A Mode of Rendering Timber Built Ships Impregnable and Unsinkable, Under Moderate Screw Power, or in a Leaky Vessel.

Admiral E. Belcher recently read an interesting paper on rendering ships unsinkable, by closely sealing the holes under the planking of the hold beams, and saving those spaces between for the storage of light dry goods above the deck, (which were generally lost), and placing loose planks as a temporary deck. In the event of a dangerous leak, or even a large hole being stove in the bows or bottom of a vessel, he proposed securing the hatches from beneath and the hatches from above, screwed firmly in opposition to each other, and filled in by pitch from the upper or open hatch. It was apparent that if a ship was air-tight the water could only enter so long as the air was compressible; and by inverting the pump boxes, and rendering them air pumps, the leak would not only be stopped, but by the continual action of the air it would be expelled by the very orifice by which it entered; therefore the customary and continued labour and power of the crew would not be required to such an extent, if at all, when once the necessary quantity of air had been forced in. So far back as 1823-4, he had introduced this principle at Bermuda; and, on a late occasion, when he was consulted by Mr. Marryatt, chairman of the London Dock Company, as to the value of one of those lifting caissons, he proved to the parties that, by aid of a a glass tube, about three feet long and half an inch bore, he could by his lungs, even at his age, effect the very same displacement which they had obtained by machinery. He then proceeded to explain, in detail, how, by pursuing his mode of construction, the vessel would not only become very much less liable to injury by the ram advocates, but, if carefully and scientifically fitted, she might be over-run by an adversary, come up on the other side, and perhaps return the compliment. The gallant admiral concluded by making a few observations on moveable armour, which might be adapted as a further protection to those vessels, which might be carried to a foreign station or long voyage in the hold, and, when war was declared, might be put on as occasion might demand.

An Immense Iron Deposit.

The Lake Superior *Journal* says that recent explorations show the deposit of iron ore, embracing what is known as the St. Clair Mountain, on the Esconawba River, to be very much more extensive than was supposed. West of the river it not only skirts along the south side of Sections 1 and 2, but covers the entire north half of Sec. 11, and also that of Sec. 12, being nearly two miles in length and about three quarters wide, and rising from fifty to three hundred feet above the level of the surrounding country. On the east side of the river it has been found to extend over large portions of Sections 5 and 6, comprising a length of about one and-a-half miles, with an average width of over one-half mile, and rising from fifty to one hundred and fifty feet. What the ultimate value of these huge deposits may prove to be, can only be fully established by more minute examination and practical tests; but from the specimens we have seen, there is hardly a question but that they will prove of the highest value, in location, they being only 30 miles from the lake, and in the quality of ore they contain; while they will be easily opened and cheaply mined, as the railroad within one year will pass up the valley of the Esconawba, directly between them. But while iron is thus being found, and roads constructed to bring it to the lake—many more vessels must also be built, or it will be wholly out of the question to place it in the lower lake markets. Let there be a corresponding amount of work done in this direction.

Extensive Copper Mines.

One of the proprietors, Mr. Dean, has lately returned from a visit to the Lake Copper Mines, and brings a report up to Saturday afternoon last. From him we learn that the veins which we spoke of a fortnight ago, have quite equalled the expectations which were then entertained; they have gone down fourteen feet, on what was then the eastern vein, and the miner in charge estimates that in the last fathom he has taken out of the vein a ton of ore,—about nineteen-twentieths being purple,—sixty per cent,—and one-twentieth yellow, or thirty-three per cent ore.

He has also opened another vein, on the eastern slope of the ridge, of the same kind of ore, four feet and a half wide, and clearly traced two other veins below this last, on the same ridge, so that the matter stands thus,—a little below the top of the ridge on the west side they have a vein four feet and a half wide; twelve feet east of this, a vein three feet and a half wide, and two feet east of the second a vein five feet wide. This brings them to the eastern slope, and down this thirty feet is the one lately opened four feet and a half wide, while between this last and the bottom of the ridge are two veins more, not yet explored.

Even to a person not versed in mining, the advantage of parallel veins close together, and likely to come into one, in depth, will at once be apparent, and we fancy that this one ridge gives no slight indication of the existence of copper in the neighbourhood.

But by far the greatest development was made on Friday and Saturday last; we give it in the words of the superintendent miner. We quote from his report made on Saturday afternoon:—

"I commenced yesterday morning to strip and open a vein on the same lot as above, but on the east side of the river, about a quarter of a mile nearly due east from the other.

"The vein comes to the top of the ridge, and we have stripped and blasted about fourteen feet from North to South, (the direction of the vein,) and find it extends from East to West across the ridge *twenty-seven feet* from wall to wall; the walls are slate, and the veinstone a very soft sand stone with occasionally quartz; *the whole rock is full of yellow copper ore* in small veins and finely disseminated, with occasionally lodes of two or three inches, we have saved all the rock, as we have taken out nothing here unfit for working; we find it gets richer as we go down; it drills very easily, so much so that we are using drills we began with yesterday without sharpening.

"I estimate that there is thirty pounds of ore in every hundred pounds of rock in this vein, the ore is all yellow."

This settles the question as to the ore existing in concentrated quantities, and the fact that it appears at innumerable places over a large extent of land leaves no doubt that a mineral region of boundless and inexhaustible wealth exists just behind us, which can no longer remain unworked.

From Tudor we learn that Mr. Chard has "brought to grass" some eight or ten tons of lead by the labor of two or three men, and that his vein is constantly increasing, and a vein equally good has been stumbled upon near Mumby's Mill, just in the rear of Madoc.—*Hastings Chronicle.*

Photography on Stone.

A curious communication was recently sent in to the Academy of Sciences by M. Morvan, in which he describes a method of his for obtaining direct photographic impressions upon stone, and which he can afterwards print off. He first gives the stone a coating, which he applies in the dark, of a varnish composed of albumen and bi-chromate of ammonia. Upon this he lays the right side of the image to be reproduced, whether it be on glass, canvas, or paper, provided it be somewhat transparent. This done, he exposes the whole to the action of light, for a space of time varying between thirty seconds and three minutes if in the sun, and between ten and twenty-five minutes if in the shade. He then takes off the original image, and washes his stone, first with soap and water, and then with pure water only, and immediately after inks it with the usual inking roller. The image is already fixed, for it begins to show itself in black on a white ground. He now applies gum water, lets the stone dry, which is done in a few minutes, and the operation is complete. Copies may at once be struck off by the common lithographic process.

A Tremendous Shock.

Dr. Jerome Kidder, of New York, has lately enjoyed the happiness of receiving, with perfect safety, a shock of electricity sufficient, according to the previous ideas of scientific people, to kill fifty men. The experiment took place at the Cooper Institute, under the direction of the eminent Professor Vander Wede, of that institution. The battery consisted of six of the large Bunsen cups and a Ruhmkorff coil, of sixteen miles of wire, made by E. S. Ritchie, of Boston—one of the best makers in the country. A most formidable battery truly! The New York *Tribune* states that Dr. Kidder had observed that the longer the wire was used the greater the tension, and consequently the greater the ease with which the current is conducted through the body. Hence he argued that the enormous length of the wire in the Ruhmkorff coil must render the current so highly conductible that, in spite of its great power, it would not lacerate the tissues of the body. He staked his life on his opinion and won it.