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The Canadian Patent Office Record and Mechanics' Magazine

Vol. II.—No. 6. SEPTEMBER, 1874. Price in Canada $2.00 per An.
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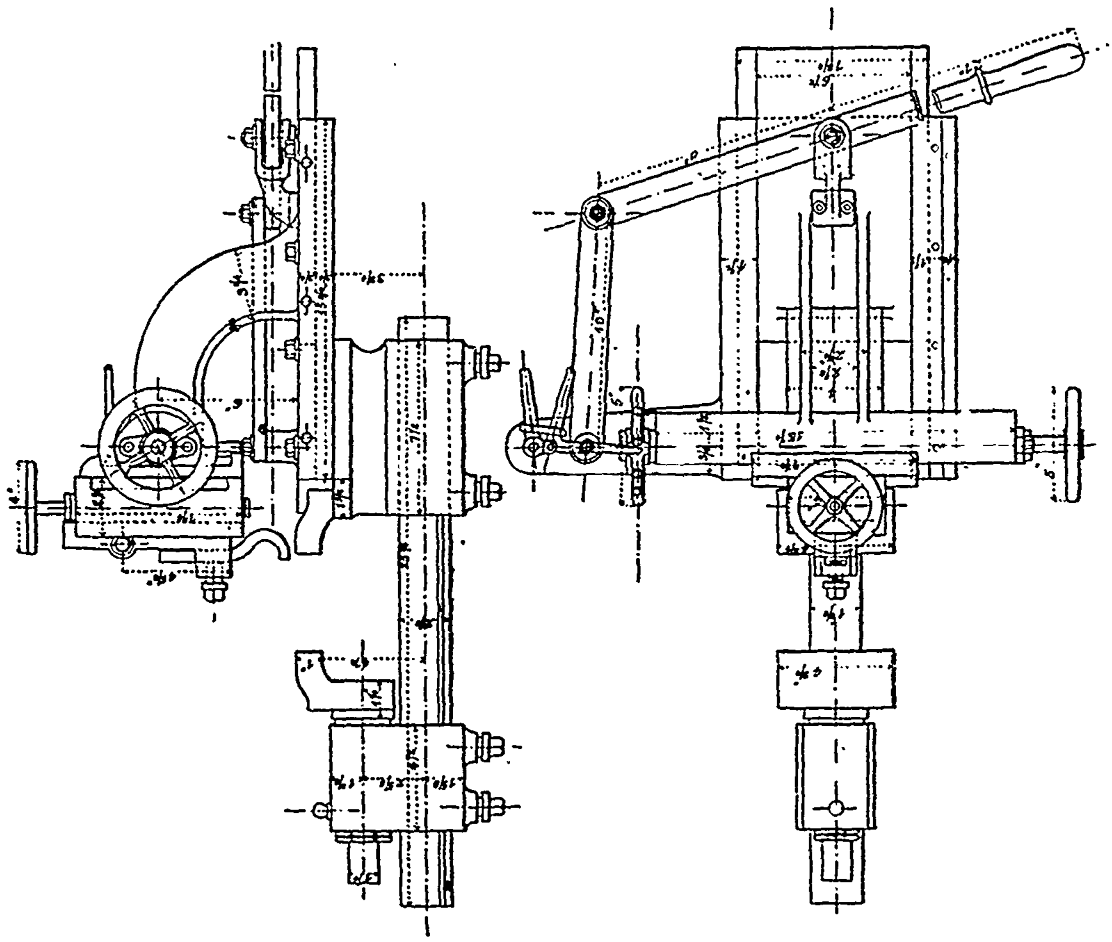


HAND-WORKED SLOTTING MACHINE.

HAND-WORKED SLOTTING MACHINE.

We illustrate on page 161 a handy form of hand-worked slotting machine, constructed by the students of the Alexandrowski Technical School, Moscow, the tool being intended for fixing to a bench. As will be seen, a vice is provided for holding the work to be operated upon, and the toolholder is worked to and fro by a hand lever, provision being made for giving a self-acting traverse. The details of the machine will be readily understood from the engraving without further description.

AMERICAN CENTENNIAL EXHIBITION.

The commissionners appointed for holding the above exhibition, in 1876, in Fairmount-park, Philadelphia, have issued their regulations, of which the following are the most important relating to foreign exhibitors:—

Products brought into the United States, at the ports of Boston, New Yorx, Philadelphia, Baltimore, Portland, Maine, Port Huron, New Orleans, or San Francisco, intended for display at the international exhibition, will be allowed to go forward to the exhibition buildings, under proper supervision of custom officers, without examination at such ports of original entry, and at the close of the exhibition will be allowed to go forward to the port from which they are to be exported. No duties will be levied upon such goods, unless entered for consumption in the United States. The general reception of articles at the exhibition buildings will commence on January 1st, 1876, and no articles will be received after March 31st, 1876. Space assigned to foreign commissions and not occupied on the 1st April, 1876, will revert to the director-general.

The ten departments of the classification which will determine the relative location of articles in the exhibition are as follows:—1. Raw materials—mineral, vegetable, and animal. 2. Materials and manufactures used for food, or in the arts, the result of extractive or combining process. 3. Textile and felted fabrics; apparel, costumes, and ornaments for the person. 4. Furniture and manufactures of general use in construction ahd in dwellings. 5. Tools, implements, machines, and processes. 6. Motors and transportation. 7. Apparatus and methonds for the increase and diffusion of knowledge. 8. Engineering, public works, architecture, &c. 9. Plastic and graphic arts. 10. Objects illustrating efforts for the improvement of the physical, intellectual, and moral condition of man.

Exhibitors will not be charged for space. A limited quantity of steam and water-power will be supplied gratuitously. The quantity of each will be definitely settled at the time of allotment of space. Any power required by the exhibitor in excess of that allowed will be furnished by the Centennial Commission at a fixed price. Exhibitors must provide, at their own cost, all show-cases, shelving, counters, fittings, &c., which they may require; and all counter-shafts, with their pulleys, belting, &c., for the transmission of power from the main shafts in the machinery hall. The Centennial Commission will take precautions for the safe preservation of all objects in the exhibition, but it will in no way be responsible for loss or damage of any kind, or for accidents by fire or otherwise, however originating. Foreign commissions may employ watchmen of their own choice to guard their goods during the hours the exhibition is open to the public.

Each package must be addressed "To the Commission for [*Name of country*] at the International Exhibition of 1876, Philadelphia, United States of America," and should have at least two labels affixed to different, but not opposite sides of each case, and giving the following information:—(1) The country from which it comes; (2) name or firm of the exhibitor; (3) residence of the exhibitor; (4) department to which objects belong; (5) total number of packages sent by that exhibitor; (6) serial number of that particular package. Within each package should be a list of all objects it contains.

If no authorised person is at hand to receive goods on their arrival at the exhibition buildings, they will be removed without delay, and stored at the cost and risk of whomsoever it may concern.

Communications concerning the exhibition should be addressed to "The Director-General, International Exhibition, 1876, Philadelphia, Pennsylvania, U.S.A."

It is hinted that another woollen manufacturing Company is to be started in St. Johns, Quebec.

LIFE IN THE BEEHIVE.

The following is a report of a lecture by Professor Agassiz, from the columns of the *English Mechanic*.

At the close of my last lecture I made some general statements with regard to parthenogenesis, a peculiar mode of reproduction by virgin females first investigated in some families of insects, among which the progeny thus brought forth consists of males and of males only. In the family of Phyllopods, among crustacea, the process obtains also; but the progeny in this case consists on the contrary, of females only. The deportment of these animals at the time of reproduction is so singular, they exhibit faculties so peculiar that they have been the objects of careful observation. Their seemingly intelligent action, known as instinct has been compared with the intellectual powers of the higher animals and even with the mental faculties of man himself.

A knowledge of the facts is, therefore, necessary to a first descrimination between these two faculties, which are considered by some as entirely distinct, while others consider them as modifications of one and the same power. It is often said that the possession of reason places man above the brute creation, to which instinct peculiarly belongs; and yet the facts do not justify such a distinction, as we shall find if we study carefully the lives of some of these creatures. The beehive consists, when in full activity, of one queen, several hundred drones, and many thousand working bees. These constitute a community by which a combined system of labour is carried on, transcending, in many respects, the most complicated actions of man himself. Their structure shows no organ similar to those by which the mental functions are manifested in the higher animals and in man. They have no brain proper, nor does their nervous system correspond in any way to that of the vertebrates. In all vertebrates the solid front mass of the nervous system which we call the brain is prolonged backward into a long cord, known as the spinal marrow, from which many nervous threads arise and branch, spreading through the whole organization. The brain and the spinal cord, in fact the whole central nervous system, are enclosed in a cavity, the skull and rachitic canal, separate from those in which the organs of digestion, respiration, circulation and reproduction are contained —the chest and abdominal cavity. For the articulates, on the contrary, to which all insects, crustacea and worms belong the nervous system is scattered along the length of the body in a succession of swellings connected together by threads. The first of the swellings is situated in the head, above the alimentary canal; the rest are at regular distances along the lower side of the body. Thus it appears that the battery from which all volition starts, by which all the acts of life are performed or regulated, through which all external impressions are communicated and acted upon, are very different in these two types of the animal kingdom. It is, therefore, hardly probable that the life work done by these organs should be the same.

Let us look at some of the acts by which the quality we call instinct is manifested in a community of bees. When such a community becomes too populous for a given hive, the bees "swarm," as it is called; that is, a part of the overcrowded population separates from the rest and goes off to establish a new colony. In such case the emigrants are chosen or form their own band with direct reference, seemingly to the future welfare of the new colony, preserving the numerical proportions characteristic of all prosperous hives. The swarm consists of one queen, some thousands of working bees or undeveloped females, some hundreds of males or drones. This is the normal combination in the bee community, and hives so organised may survive and keep together for many years.

There are reports of beehives a century old. It is, however, probably an exaggeration; for beehives 20 years old are rare, and they do not often survive more than seven, eight, or ten years. When I speak of the life of a beehive, I do not mean to say that the individuals composing it live together for that length of time; indeed, a queen rarely lives beyond three or four years; one of seven years is seldom seen, while the males never survive the summer in which they are born, and the working bees die gradually and are replaced by new ones. But the hive as a community holds together for a much longer period, being constantly renewed by the process of reproduction, and comes at last, like a human settlement, to consist of a variety of individuals born at different times. When a swarm breaks off from an old community to form a new colony, the division is generally due to the appearance of a new queen.

The queen bee, usually quite contented with her lot, watching over her progeny, active and patient in the care of her eggs, becomes furious if a rival arises in the hive. She pounces upon her, and they sometimes fight to the death. So well is this understood in the hive that the workers take care to prevent such conflicts by holding back the new queen, just ready to be hatched from her royal cell, till the bees have swarmed. At such a time the workers will stand by the cell, out of which a queen is to be born, ascertain how far her transformation is completed, and, should there be a disposition of the young queen shortly to creep out, they increase the deposit of wax upon the lid which shuts the cell, thus preventing the egress of the royal prisoner. If she tries to break through or attempts to gnaw her way out, the workers crowd around the opening or accumulate such an amount of wax upon it as to frustrate all her efforts. When the old queen has peacefully departed, the new one is set free. What makes this fact more extraordinary is, that usually the workers have never seen the birth of a queen or perfect female before; their hive has known but one queen, and yet they anticipate and guard against all the dangers likely to arise from a second. Can it be that these creatures do the right thing at the right time consciously, by means of any faculty similar to our reason?

The warm, having escaped, chooses a place for the new colony—a cavity in the rocks, perhaps, or a sheltered notch among branches of trees. The swarm having alighted near a favourable spot, a single working bee—one out of twenty thousand, perhaps—starts from the crowd and lays, not the first stone, but the first piece of wax which is to be the foundation of a new comb. Before swarming, they have provided themselves with an ample supply of wax and food, and are prepared to build their new home.

The construction of a honeycomb, with a double row of cells on opposite sides, dovetailed into each other, and with larger cells for the drones and the special cells for queens, is so well known that I need not dwell upon what every encyclopædia will give. The first cells, being raised upon an uneven surface, are often irregular and may be uninhabitable on that account, but they then make the foundation for perfect cells, whose regularity and precision of form and relation have been the wonder of all ages. The irregularity of the first cells, adapted to the unevenness of the surface, seems only another evidence that these animals work deliberately, not like machines. Dr. Wyman has published a most interesting paper upon the irregularities of the cells in a honeycomb; I dwell upon the fact that the first cells present every possible variety of shape modified to suit the situation, because it is not generally understood.

The first bee having made the first cell, a second bee comes and stands opposite her, head to head, then another at her side, so that the two stand side by side, and the rest follow in definite position, each building a cell around itself until gradually a good sized comb is built, it may be a foot in length and six or seven inches in depth, the width being uniformly that of a double row of cells. All this work is done by the imperfect females or so-called workers. Neither drones nor queen take any part in it. The working bees, on the contrary, are ever active, bringing in supplies for the community, swarming out daily to collect honey, filling the cells as fast as they are completed with food, and then closing them to prevent escape, thus securing a large store of honey. The drones meanwhile look lazily on. Sluggish and inactive, they seem to have different temperaments from the working bees.

The Distinctive Character of the Cells.

The honeycomb being sufficiently advanced, the queen now begins to lay her eggs in the cells. Here comes in another marvellous evidence of that power we call instinct. We have seen that a certain numerical proportion is essential to the well-being of a hive. There must be but one queen and at the most two or three queens' eggs, and even then trouble is sure to arise when these are hatched; there must be several hundred drones, and there must be many thousand workers. In preparation for this, the workers have laid out the cells as systematically as if they had been guided by a superior intelligence; special cells adapted for the eggs out of which thousand of imperfect females or workers are to be produced; others somewhat larger, intended for the development of the less numerous drones, and a very few so-called royal cells, still larger than those of the drones, many times larger than those of the workers, and of a very peculiar form, out of which perfect females or queens are to grow (Fig 5).

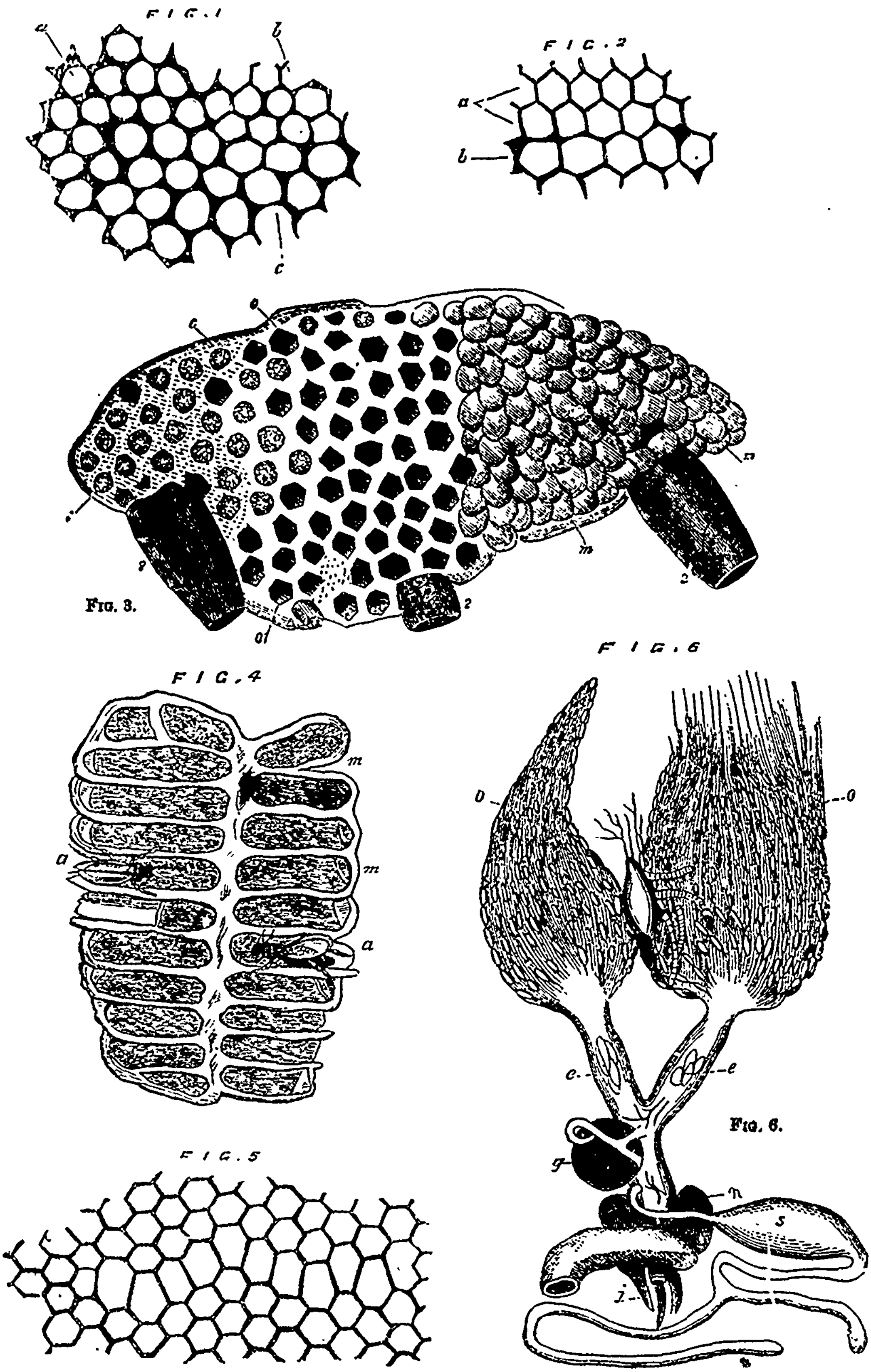
The queen cells stand out from the rest of the comb, and have a large opening. Two or three such cells, will usually be formed in one comb. In old colonies, it often happens that no provision is made for the advent of a new queen, and in that case no royal cells are built; but in a new community several such cells may often be seen upon one comb. Still more perplexing than the impulse, or instinct, or unconscious perception, by which the workers are guided in the preparation of these cells, is the intelligent selection shown by the queen in distributing her eggs among the various kinds of cells. She finds thousands and thousands of small cells, and in these she deposits fecundated eggs out of which nothing but workers grow. In the royal cells, or, as is the case in many hives, in one royal cell, she lays an egg, also fecundated, out of which is sure to grow a perfect female, or, in other words, a queen. The eggs of the perfect and imperfect females do not differ originally; the ultimate difference is brought about by a special mode of nursing and feeding the royal egg, the workers supplying the royal cells, in advance with pollen from the stamens of flowers and honey; so that when the little grub comes out of the egg, it finds itself in the midst of the nourishment necessary for its development into a queen bee. How do these careful nurses know the amount and quality of food needed by the eggs they have in charge? To this question there is no answer. But there is no doubt of the fact, and they perform their work with surprising economy and accuracy. In the drone cells the queen lays only unfecundated eggs, and these always produce males and males alone. The faculty by which all these acts are performed without teaching, without preceding experience, without any antecedent knowledge of the conditions necessary to the life and growth of the eggs, that faculty we call instinct, in contradistinction to those mental processes involving argument, rational consideration, combination and adaptation, by which acts are performed under full consciousness of all contingent conditions.

The Eggs: What they Bring Forth, and How they are Fecundated.

It may be asked how it has been known that certain eggs were fertilised while other remained unfecundated. The facts have been gradually made out by very careful and connected observations. It is known that with bees, as with most birds, the act of copulation takes place outside of the hive—i.e. the air during flight. It happens sometimes that a queen bee, from injury or from malformation, defective wings, for instance, is unable to fly and cannot leave the hive. Under these circumstances she is incapable of fecundation and yet has been seen to lay eggs, and those eggs invariably produced males or drones. This fact gave the clew, and successive observations proved beyond a doubt that the workers were always born from fecundated eggs. It remained a mystery how, in the same ovary, a certain number of eggs could come under the fertilising influence while the rest remained untouched.

Siebold ascertained by a skillful anatomical investigation, that the special organ of the queen bee, in which spermatic particles are received, has a muscular apparatus which enables her to close or open it at will. This organ, known as *receptaculum seminis*, is placed just at a point of the oviduct or canal through which the eggs are passed when they are dropped from the ovary, half way between the ovary and the outlet of the oviduct. The queen stands on the edge of the cell in which either fecundated or unfecundated eggs are to be deposited. If the former, she has the power to open this receptacle, the organ in which the spermatic particles have already been received, and to allow one or two such particles to come into contact with the egg; if not, she can close the organ and allow the egg to pass out unfecundated Siebold has shown that eggs cut out above the opening of the *receptaculum seminis* into the oviduct, at which these organs connect, are always unfecundated.

Siebold has investigated a similar set of facts in the history of another species of Hymenoptera, a kind of wasp of the genus *Tolistes*. In this case, the queens, which are fecundated in the autumn, begin to lay their eggs early in the spring; out of these eggs are born a variety of individuals, workers and males, as in the bee community. By a careful destruction of all the males, which was accomplished without injury to the comb,



LIFE IN THE BEEHIVE.—(See page 162.)

CARNIVOROUS PLANTS IN THE ROYAL BOTANIC GARDENS, KEW.—(See page 174).

Siebold ascertained that parthenogenesis obtains in this family also. Plenty of eggs were laid after the males were destroyed, but the perfect insects they produced were always males and never a single female. It is now clearly proved, not only for wasps and bees, but also for a number of other insects belonging to the Hymenoptera, that virgin females may produce male offsprings without any participation of males

Description of Figures.—1. Transition cells of bee: *a*, *b*, rows of intercalated cells: *c*, drone cells 2. Transition cells: *a*, working bees, *b*, drones. 3. Worker cells: showing variations in the form and size of the mouth, copied from Professor Wyman's paper. 4. Cells in a beehive: *a*, *a*, bees bringing honey in; *m*, *m*, honey cells with lid. The whole is seen against a pane of glass. 5. The three kinds of cells: *m*, *m*, honey cells, closed; *c*, *c*, cells with young bees, closed; *o*, open cells; 2 2 2, royal cells, open. 6. Ovaries, etc, of bee: *q*, *o*, ovaries; *c*, *e*, eggs in oviducts; *g*. *Receptaculum seminis*. *n*, *j*, sting, *s*, Poison bag.

THE REAL REASONS WHY CASTINGS IN IRON ARE ACCURATE COPIES OF THE MOULD.

By Robert Mallet, C E., F.R.S., &c.

The fact that cast iron does take very accurately the form of the mould in which it is cast has been for a length of time attributed to the supposed fact that the metal expands in volume while passing from the liquid to the solid state—a supposition which for more than a century has passed current, though without any sufficient proof. In a paper read before the Royal Society on the 14th June last, an abstract of which, taken from the "Proceedings' of that society, has appeared in The Engineer for the 3rd July last, I have disproved by two independent experimental methods the supposed fact that cast iron does expand in consolidation from fusion. The paper itself will probably be published in full by the Royal Society in the latter part of this year. Meanwhile it may be stated that the methods pursued consisted in, first, the determination of the specific gravity of liquid cast iron, by weighing equal volumes of the liquid metal and of distilled water, the specific gravity of the same cast iron at 60 deg. Fah. being also determined; secondly, by determining the dimensions of a spherical shell of cast iron heated to bright redness, and then filled with liquid cast iron before being heated, when filled, and during the cooling back to the temperature of the atmosphere, when its dimensions were found the same as at the beginning; also by determining the specific gravities of the circumferential and central portions of the ball of cast iron when cold which had filled the shell. The central portions were found much less dense than the circumferential parts, as is well known to be the case in all castings in iron, of whatever size and form, but if the expansion in volume had taken place in the ball cooling by radiation, the central portions must have been found much more dense than the circumferential parts. The agreement of these two independent trains of experiment removes all doubt as to the completeness of the proof that cast iron does *not* expand in volume in passing from the state of liquid fusion to that of solidity by cooling; and it is therefore certain that the degree of exactness with which cast iron takes the form of the mould into which it is cast is to be otherwise accounted for. It is not necessary I should here advert to the objects in relation to certain lunar volcanic theories with which the above experiments were undertaken, nor to the conditions under which cast iron in the solid state may or may not float on cast iron in fusion; the latter facts, erroneously interpreted, having been, in fact, the foundation upon which the supposed notion of the expansion of cast iron during consolidation has been based. For these and the details of the experiments I must refer to the paper itself. In the mean time some useful deductions of a practical character may be drawn from the facts ascertained. Were it the fact that cast iron in solidifying *did* expand in volume, a little consideration will show that such expansion would result, not in the casting being an accurate copy of the mould—whether of green or dry sand, or loam—but must be a distorted copy, the expansion in volume of the metal filling the mould being, in effect, the same as if it were exposed to the hydrostatic pressure of a liquid pumped into it, the yielding to which would be greatest where the walls were least resistant, or where the force to which they are exposed is greatest—namely, where the surfaces exposed to pressure were the largest. Thus, for example, a flat plate moulded from a pattern of equal thickness throughout would when cast be no longer of equal thickness throughout, but have one or both of its broad surfaces forced outwards so as to make the plate thickest towards the central parts, whilst the edges and corners of the plate which consolidate first would remain nearly unaltered, and the metal be found not even completely forced into contact with those parts of the mould; in fact, no form of casting except that of a sphere could under the supposed conditions of expansion in volume remain an undistorted ectype of the pattern, nor could any rigidity in the mould prevent this, the expansive force being by hypothesis irresistible, like that of water freezing into ice.

Cast iron does, however, as it well known, take the form of the mould, as formed of sand or loam by the usual methods of the founders, with great fidelity. We must except, however, the case of chills or massive moulds of cast iron, the liquid metal cast into which is so instantly chilled by contact as not to form a very accurate transcript of the mould. But though cast iron does take a very sharp and accurate transcript of the mould when cast, it does not do so to a greater extent than do several metals to which the supposed property of expanding or consolidation has never been attributed. Thus zinc affords castings of exquisite sharpness from sand moulds, as all those must have remarked who have seen the superb ornamental castings in that metal for architectural and other purposes which form the staple trade of the great German and Belgian zinc foundries. Lead also, when carefully preserved while in fusion free from oxidation and cast in slightly greased moulds so as to reduce any oxide formed therein, affords castings of exquisite sharpness, as may be observed in those of the ancient lead work of the roofs of churches and other buildings of from 200 to 300 years ago in France and Belgium. Gold, silver, copper, and most of their alloys, on the contrary, afford generally more defective castings and wanting in sharpness. The circumstances upon which these opposite results arise are extremely complicated, and to fully elucidate them would require more space than can be here afforded; they involve conditions mechanical, chemical, and molecular, affecting both the metal cast and the nature of the mould in which it is cast, as well as the relations of these to each other. Amongst these the following are, perhaps, the most important:—First, the density of the metal itself. Whatever be the nature of the metal, it fills the mould when full under a certain hydrostatic pressure due to the height of the liquid column and to the density of the metal, and whatever the metal may be, this is the mechanical force by which it is compelled to follow and fill while liquid the sinuosities of the mould. Let us suppose the liquid head constant, say 2½ft. or 30in., we readily see how enormous a difference there yet is in the mould filling force due to density alone in the five metals, aluminium (which gives extremely defective castings), zinc, cast iron, lead and gold, their densities being—

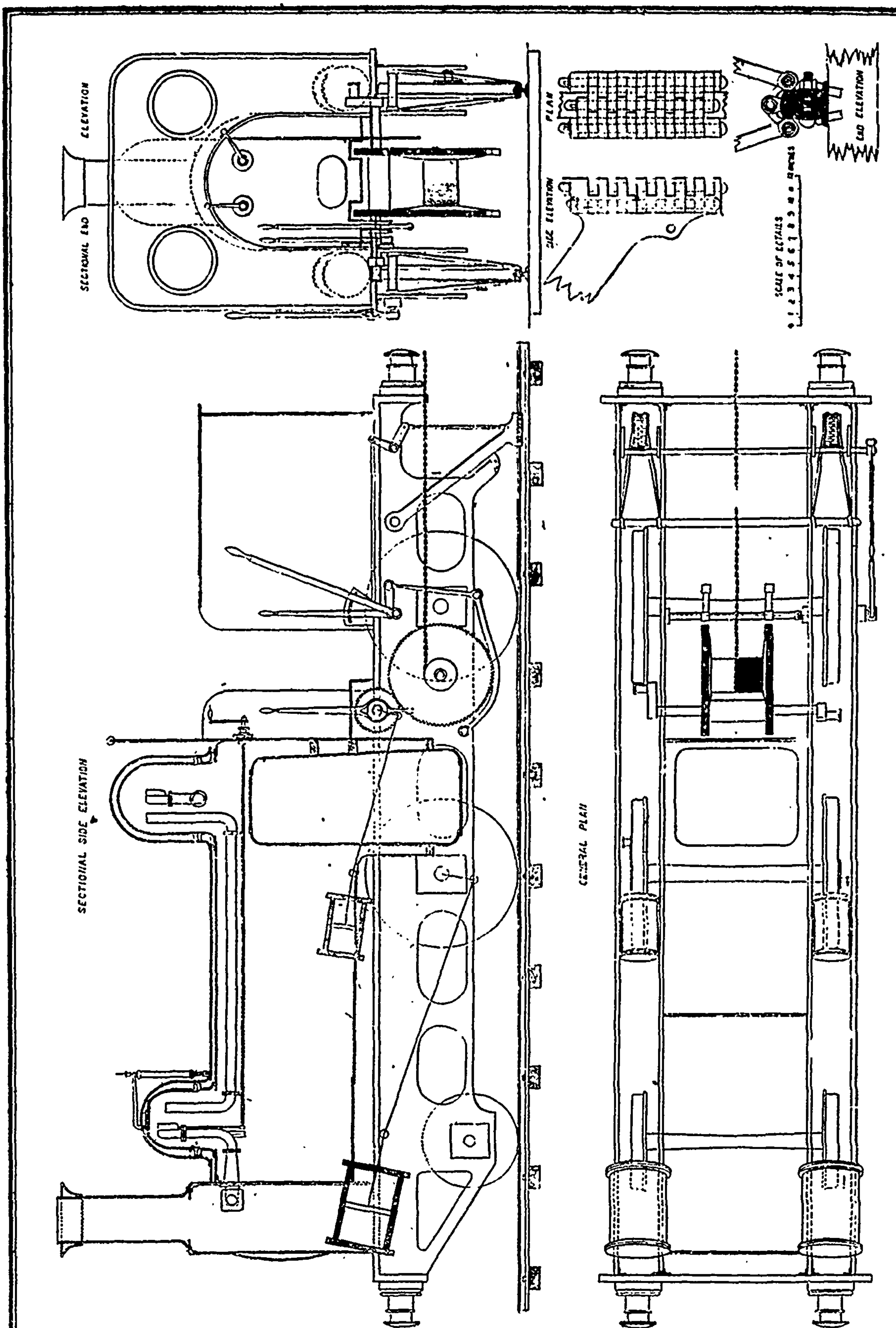
	Specific gravity.	lbs. per sq. inch. under 30in. head.
Aluminium	2.560	2 82
Cast iron	7.110	7 856
Zinc	7.146	7.896
Lead	11 360	12 552
Gold	19.340	21.371

Thus, in the last of these metals the hydrostatic pressure tending to fill the mould completely is about seven and a-half times greater than in the case of aluminium, and yet both these metals produce inferior castings, while the three intermediate metals afford sharp and good ones. Secondly, the specific capillarity when in fusion and viscosity while passing from the liquid to the solid state. Different metals are liquid in very different degrees while in perfect fusion, and therefore require very different degrees of pressure to force them into angular cavities. Upon this point physicists have as yet given us but little exact information. The greatest diameter of spherical drops capable of being assumed by any metal when taken in connection with it density is, however, a rough measure of the resistance which its presents to being forced into angular cavities of a mould of such material that it is not wetted by the liquid metal; thus fluid solder will readily penetrate between the edges of two clean tin plates, but will not enter at all if the plates be tarnished or blackened by a candle flame. Drops of mercury cohere at larger diameters than those of liquid lead. So also different metals differ in the range of viscosity through which they pass between their state of most perfect liquidity and that of solidity. Lead and some of its alloys, such as plumbers' solder, pass through a very long range of viscosity; brass and copper do so likewise though in less degree; cast iron, and in general all the metals that crystallise most readily and best, pass through a very brief stage of viscosity. Where the melting point of the metal is a low one, one of the effects of this prolonged viscous stage, during which the metal contracts by loss of heat, is that its withdrawal from the sides of the mould is not compensated by a sufficient continuance of hydrostatic pressure, owing to imperfect liquidity. Cast iron is remarkably free from this objection; its melting point being very high and its range of viscosity small and confined to a small range of temperature, the metal is maintained, though constantly contracting by loss of temperature, in close contact with the mould by hydrostatic pressure up to within a brief period of its setting. Thirdly, upon the tendency of the metal to oxidate or combine with other elements presented to it in casting, and producing compounds less fusible than the metal itself, greatly depends the perfection or imperfection of the castings produced from it. Fluid zinc oxidates but very slowly up to a temperature somewhat above its melting point, but it oxidates rapidly at and above a bright red heat; hence zinc gives perfect castings; but when it is alloyed with copper the melting point of the brass is raised to such a point that the zinc oxidates very rapidly, and produces that "tailing" and general scurfiness of surface which is the plague of the brass founder, and the oxide of zinc is not reducible back to metal at the temperature at which brass is cast by any chemical agent capable of being introduced into the substance of the mould. In cast iron, on the other hand, its tendency to oxidate by contact with the atmosphere when in fusion is opposed by the presence of silicon and carbon in the metal itself, and any oxide superficially formed is reduced back to metal with great facility by the hydrogen and carbonic oxide evolved from the moisture and charcoal, or coaldust, or other carbonaceous matter entering into the constituents of the mould. Gold is inoxidisable, but possesses a vigorous affinity for sulphur, and it is probable that the film which may be observed upon the surface of molten gold in casting, and which produces "tailiness" in the ingot or bar, consists of some sulphur compound taken up from the gases from the fuel employed for fusing it. Copper also casts badly, as when in fusion it is constantly either taking up carbon or oxygen as the heat of the furnace is either a reducing or an oxidating one, and the great cleanness of castings produced from phosphorised copper arises from the presence of the small amount of that element precluding it from taking up carbon, on the one hand, and shielding it from oxidation on the other. Fourthly, a high melting point and a high specific heat are favourable to the production of perfect castings, as prolonging the time during which *cæteris paribus* the metal filling the mould is subjected to its own hydrostatic pressure, thus more completely forcing it into sinuosities and expelling air bubbles or other gaseous matters. If the fusing point be very low, as in the case of lead or tin, the viscous point is so rapidly reached by the loss to the mould of the small amount of heat present in the metal that there is but little chance of air bubbles or particles of unreduced oxide being previously forced out. Fifth, the absolute amount of contraction of any metal between the temperature at which it is poured and th of the atmosphere, forms also an element in the perfect correspondence of the casting to the form of the mould in which it was cast. On comparing this rough sketch of some of the principal conditions upon which the degree of perfection of castings in various metals depends, it will be obvious that amongst all the metals commonly used for castings in the arts, cast iron occupies an extremely favourable position; its density is sufficient to press it when liquid effectively into the mould, its capillarity is not very great, its range of viscosity is small, and it possesses the paramount advantage that whatever oxide may be formed in the casting processes is precluded from becoming diffused throughout the masses by the silicon and carbon present, and that any oxide formed on the surfaces in contact with the mould is instantly again reduced by the hydrogen and carbonic oxide evolved from the mould itself. In these conditions, indeed, cast iron may be said to stand unrivalled amongst metals in the perfection of the castings made from it, and they are quite sufficient to account for that perfection without calling in the now disproved supposition that it expands like ice at the moment of consolidation. The experimental determination of the specific gravity of liquid cast iron adverted to at the beginning of this paper affords us the means—and for the first time—of determining the total dilatation in volume as well as the linear dilatation of cast iron of the quality experimented upon, viz., the fine-grained, bright grey tough cast iron employed by mechanical engineers. As the specific gravities of this iron when cold and when melted were 7·170 and 6·650, so that the unit in volume when cold being taken as 1000, was increased to 1078·2 at the temperature somewhat above the melting point at which the iron was poured; the total dilatation in volume being thus 0·0782, and this divided by three—*i.e.*, neglecting all but the first term of the series—gives for the total linear dilatation 0·02606, which, taking the whole range of temperature between 60 deg and 2400 deg., and if we assume the dilatation uniform throughout the range, gives a coefficient of dilatation of 0·00001086 for 1 deg. Fah. This, however, is not quite correct, as the rate of dilatation increases rapidly within a few degrees of the melting point. The dilation found as above is also in excess of that due to the precise range between 60 deg. an the melting point of cast iron, the higher temperature in my experiment being somewhat above the melting point, exceeding it by probably about 200 deg. Fah. My direct object being simply to prove that melted can iron is not denser—as has been stated—than the same cast iron in the solid state, and not that of ascertaining the exact dilatation due to the precise range between 60 deg. Fah. and the melting point; we are enabled, however, incidentally to deduce the latter with approximate accuracy. I must reserve, however, for a future communication some further remarks upon this part of the subject, as also upon the interesting phenomena of the movements observable in large masses of liquid iron, as in the largest crane ladies, which have been erroneously appealed to as affording proof that liquid cast iron is denser as its temperature is higher.

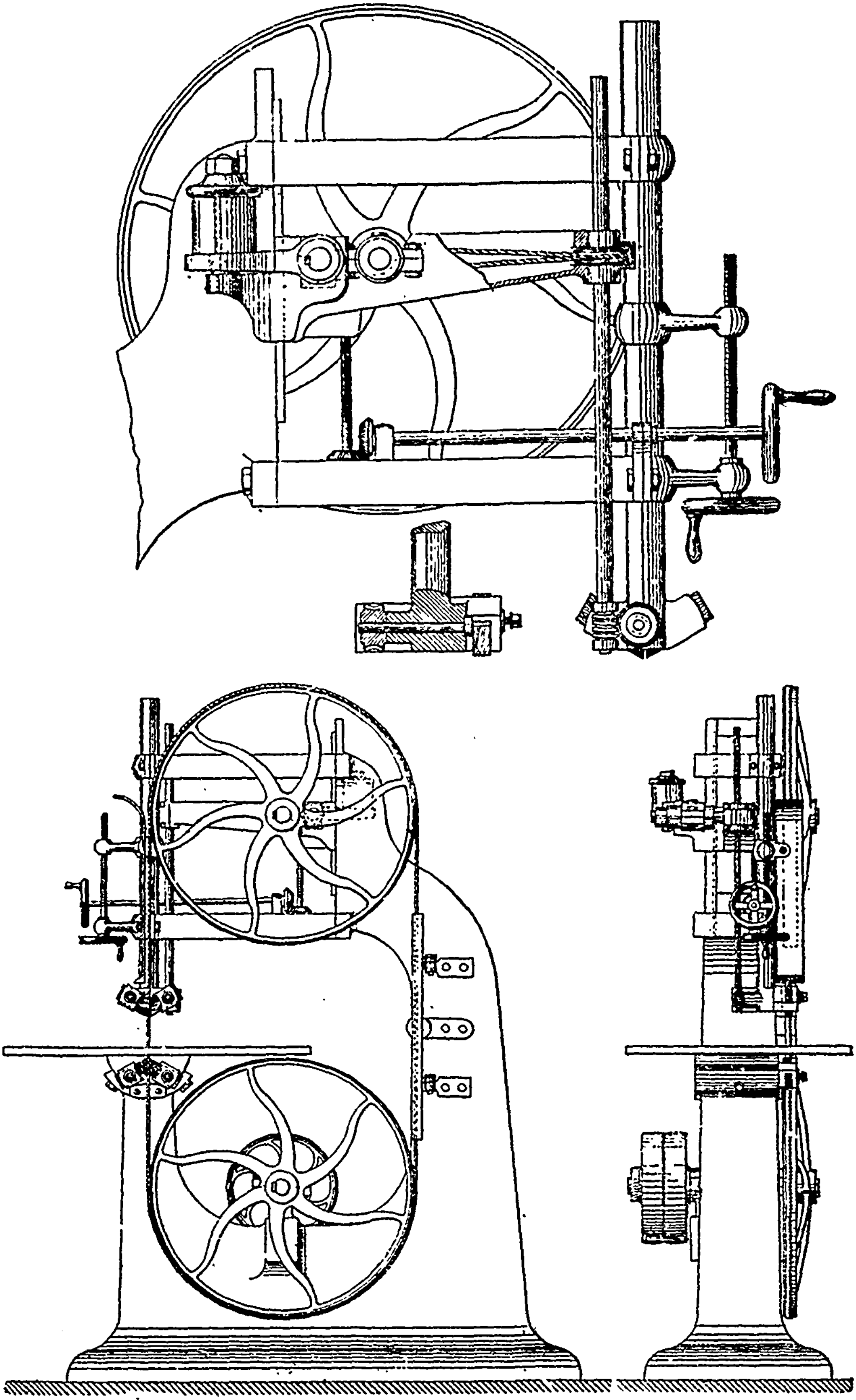
THE AMERICAN AND EUROPEAN METHODS OF PHOTOGRAPHING THE TRANSIT.

Some attention has recently been directed to the question of the relative advantages presented by the two methods of photographing the transit of Venus adopted respectively by the American and by the European observers. The managers of the American scheme of observations consider that the method which has so long been adopted at Kew, however excellent for securing beautiful sun-pictures, is not trustworthy enough for recording so delicate a phenomenon as the transit of Venus. In the Kew method the focal image is optically enlarged, and although the amount of enlargement—that is, the scale of the sun-pictures—is theoretically calculable, practical difficulties are involved which render the scale so determined not strictly reliable. Accordingly, the best estimate of scale, when this method is employed, may be regarded as derived from the picture itself, that is, from the measurement of the photographic disc. Inasmuch, however, as this disc is enlarged by photographic irradiation, it is manifest that an element of uncertainty is introduced, the amount of irradiation being variable under varying conditions. In the American method the focal image is used to give the photographic picture, and thus the scale of the picture is known at once, since it depends merely on the focal length of the object-glass. The centre of the photographic solar disc is determinable with great accuracy, no matter how great or how small the extent of photographic irradiation may be; so, also, the centre of the disc of Venus is accurately determinable, and hence in this method the distance of Venus from the sun's centre can be determined independently of the photographic peculiarities of the picture. The American astronomers maintain that their method is very much more trustworthy than the other, and their opinion would appear to be confirmed by the experiments on photographic irradiation which led Lord Lindsay to adopt Professor Winlock's method in preference to Dr. De la Rue's.

The steamers continue to bring in scrapers, ploughs, shovels, and other railroading paraphernalia for the Pembina Branch contractor, Mr. Whitehead, who has been advertising for men and horses to place on the works.



MOUNTAIN LOCOMOTIVE.—(See page 170.)



BAND-SAW WITH COMPENSATING BEARINGS.—See page 171.]

MOUNTAIN LOCOMOTIVE.

Ever since the majority of the best and most practicable routes for locomotive traffic at home were made available for that description of transport, the difficulty of constructing railways has been increased The same difficulty, although in a far greater degree, was experienced in foreign counties, and this difficulty in both instances mainly consisted in the impossibility of avoiding steep gradients and sharp curves. These, which are continually augmenting their objectionable features, are become the bugbear of the modern railway engineer, and all his efforts are directed towards ridding himself of the incumbrance What between radial axle boxes and bogies, the first of these impediments toward the construction of railways in an unfavourably situated locality, in an engineering point of view, is in great measure overcome, but the question of the gradients remains at present only partly settled.

Mr. Henry Handyside, of Derby, has contrived a very ingenious plan, by which loads can be taken up gradients of a character, so steep as 1 in 10, with the same ease as if the line were level. Briefly, the method consists in converting the locomotive for the time being into a stationary engine. It is not necessary to build engines especially in order to enable them to act in this double capacity. Any engine of the ordinary type can, Mr Handyside claims, by the proper additions and alterations, which are neither numerous nor expensive, be rendered capable of this useful conversion into a stationary engine at pleasure. We will first refer to our engraving on page 168, in which the principal features of the converted engine are shown, and describe them before passing on to the manner in which their efficiency comes into operation. On the outside of the engines are placed a pair of slightly inclined auxiliary cylinders in rear of the principal ones. Into the former, steam can be admitted and shut off from the boiler by a separate regulator and handle. The piston-roads of these cylinders are connected with a pinion which drives a drum placed underneath the foot plate of the engine, a view of which can be obtained by the driver through a grating in the footplate. The drum can be thrown in and out of gear with the pinion by simply shifting a lever backwards and forwards, and the revolution of the drum can be stopped by the application of a pair of clutches or pawls to the toothed wheels of the drum. The engine driver can effect this stoppage at will through the means of a lever within reach of his hand. The remaining addition necessary to convert our locomotive into a stationary engine is composed of a pair of jaws, or shoes, shown in the cut, which grip the rails with an amount of bite which can be increased to any extent which may be desirable. These jaws are attached to the frame of the engine by a couple of strong hinged bars, and can be raised and lowered by the lever at the side of the engine, as shown in the drawing. The jaws are made in three principal pieces—a centre piece, and two side pieces or wings. The wings are hinged on to the centre piece, and when let down on the rail—that is, when the lever handle is realised from its notch—they fall over the sides of the rail, and take their hold.

Let us now consider the *modus operandi* of this novel application of steam power. Premising that the chain, which it is intended shall be of steel, is wound round the drum, with one end attached to the leading truck or carriage, the following is the condition of affairs while the engine is acting as an ordinary locomotive:—The lever working the clipping shoes or jaws attached to the locomotive is in its notch, and the jaws are therefore suspended clear of the rails. Every second or third truck or wagon is also supplied with a pair of jaws, which may be either held clear of the rails similarly to those on the engine, or allowed to fall so near them, that on the attempt of the truck to run backwards they immediately grip automatically, and in fact act as brakes to stop the retrograde motion. The usual plan is to hold them in the latter position, so that in the event of the train parting, and a part of it running backwards down the incline, it would be arrested before any damage was done. Viewed merely in the light of brakes, these automatic clipping jaws would be very serviceable in the case of trains parting, of which several instances have occured lately.

Supposing the train to have now arrived at the foot of an incline of 1 in 10, or of any degree of steepness which did not allow the load to be hauled up under ordinary locomotive conditions. The driver releases the lever which acts upon the parts clipping the drum, and at the same time starts his engine alone up the incline, the chain in the meantime unwinding itself from the drum, now free to revolve. The wagons or carriages in the meantime remain at the foot of the incline; or if, as would probably be the case from the impetus given to the whole train, they have run a little way up it, the automatic jaws on their attempt to run down, hold them fast. When the engine has payed out all the chain to the length of about 300ft., that is, run to the length of its tether, the driver shuts off steam, and by realising the lever already alluded to, lets the clipping jaws down upon the rails. He then throws the drum into gear with the pair of auxiliary cylinders, and the winding of the chain commences, accompanied by the hauling up the incline of the train. When the engine ascends the incline by itself, it is immaterial whether the driver hitches up the jaws or allows them to trail, as in the case of the carriages or wagons. It is evident that the jaws, together with the rails, form the fulcrum upon which the whole of the haulage works These engine clips cannot pass their centres owing to a transverse check bar running transversely to the frame of the engine. In fact, the greater the amount of haulage required —that is, the greater the pull—the tighter the grip. When the train is hauled up to the engine, the engine starts by itself again, paying out the chain as before, and the operation is repeated until the summit of the incline is attained.

There are two contingencies in connection with this mode of ascending steep inclines which must be provided against. What would be the result if the chain were payed out too much, and also what would ensue if it were allowed to be overwound? In the former event the chain is so attached to the drum that it would simply fall to the ground, and the driver would be under the necessity of getting down and re-attaching it. A few experiments of this nature would soon teach him to take a look through the grating in the foot-plate at the drum, and stop his engine before the last coil was arrived at. The contingency of overwinding is provided against in a very ingenious manner as follows:—When the engine and train are separated by the length of the chain, and the hauling commences, the same movement of the regulator handle which opens the ports of the auxiliary cylinder, causes a rod carrying a small buffer at its extremity, to project from the buffer head a short distance in front of the ordinary rear buffers of the engine. Directly the leading wagon is hauled close up to the engine it strikes this buffer, pushes the connecting rod in. and shuts off the steam from the auxiliary or winding cylinders, as they may be termed. The drum then ceases to revolve, and, if it is not done before, is thrown out of gear in the manner already described.

There is yet one more consideration to be borne in mind, and the case it includes is satisfactorily accounted for. This case supposes the concurrence of a zigzag, in which a rising gradient is succeeded by another, but running in the opposite direction. As it would not be practicable to turn the whole train end for end, it is clear that if any of the wagons broke loose, that is if the train parted while the hauling operation was in process on this second incline, the clipping jaws would not act, but simply trail along the surface of the rails. An easy and simple plan of getting rid of this difficulty is to couple every alternate wagon with its ends reversed, compared with its neighbours, so that the jaws of each second wagon will be set in a contrary sense. As the action of these brakes in alternate wagons alone, would be more than sufficient to hold the train on an incline in ascending a zigzag, each successive separate pair of jaws would be brought into play alternately, one-half of the whole number trailing, while the other half were braking. The engine would have to be turned end for end at every change in the direction of the gradient, or it would not be able to get its jaws to act and obtain its haulage fulcrum on the rails. Another method of overcoming the change of direction in ascending gradients in which the train would virtually be turned end for end, would consist in the application of double brake shoes, the one pair set in one direction and the other in the contrary. Thus in ascending gradients having successively opposite directions, one set of shoes would always be trailing and the other always ready to act as detents. No turning of either wagons or engines would then be necessary. At present zigzags are not of very frequent occurrence, and this invention of Mr. Handyside is calculated to render them almost obsolete, so that so far as his system of ascending inclines is concerned, they may practicially be omitted from consideration, although we have alluded to them to show that there is no difficulty in overcoming them by his method.—*The Engineer.*

BAND-SAW WITH COMPENSATING BEARINGS.

We illustrate, on page, 169 a speciality in wood-working machinery, designed by Mr. Whitney, of Winchendon, Massachusetts. There are three points of details in this machine which entitle it to particular notice. The first of these consists in the introduction of concave spokes to the upper and lower wheels, in order to obtain a certain degree of elasticity to compensate for the contraction of the saw, and also to secure a bearing in the direct line of pressure from the blade. The second noticeable detail is the compensating motion adopted. The shaft upon which the upper wheel is keyed, rests in bearings which are free to turn around a spindle placed upon the frame of the machine, as shown. On the side opposite to the wheel is placed a bracket, upon which is an india-rubber block spring, the underside of which bears on a bracket attached to the main shaft before mentioned. The stiffness of the rubber spring always maintains the wheel in its proper position, and keeps the saw blade in tension, but upon any contraction of the latter, the upper wheel is drawn downwards, and the rubber yields sufficiently to allow for the reduction in length. The third and most ingenious detail constitutes an important improvement in the construction of band saws. It consists in the adoption of ingeniously devised bearings for the back of the blade above and below the table. The engraving of this detail clearly explains the arrangements. In the foot of the vertical bar, above the table, is a square socket, in which is placed the small box carrying the guides and back bearing. The former consists merely of wooden pieces, fitting into the face of the block, at a suitable angle, one on each side of the blade, with which they are in contact. Immediately behind, and bearing against the back of the blade, is a small steel disc mounted on a spindle, which passes through the block, projecting to the rear, and having at the end, opposite to the disc, a small bevel wheel, gearing into a second on a vertical shaft, which is carried by bearings attached to the vertical bar, and is driven by a small belt off the main shaft of the machine. The disc is thus caused to rotate rapidly, opposing a circular motion to the vertical motion of the saw, the blade of which bears hard against the disc, but in a line out of its centre. By this arrangement the injurious wear to the saw blade, and to the rear bearing, is entirely avoided, for it is evident that the wear of the disc must be perfectly uniform. Immediately below the table there is a similar revolving bearing driven off the shaft of the lower wheel. The table of the saw can be adjusted to any desired angle, as it works in a segment, and is held in position by set screws. Two adjusting motions are introduced, one for regulating the distance of the vertical bar upon the work, and the other for adjusting the position of the upper, with regard to the lower wheel, in order that blades which have been broken and rejoined, and which are in consequence shortened, may be again mounted.

SAND.

The following is one of the series of scientific and practical examinations into the qualities and effects of the various materials which constitute cements and mortars made by engineers and others in France.

Sand is generally produced by the disintegration of rocks having a granitic base, or of calcareous compounds. It is also produced by the action of water on deposits, and on the *débris* which it carries off.

The primordial element of sand is quartz. Rocks composed of feldspar and mica cemented together by natural affinity produce many varieties; some are derived from gneiss, protogine, or talcose granite, sienites, &c., or are entirely calcareous; lastly, others are mixed with volcanic sand, but which do not possess any of the qualities of puzzolana.

Sand is designated as coarse, middling, fine, and very fine.

It is considered coarse when the grains have a diameter of 2 to 3 millimètres; that is to say, 2-25ths to 3-25ths of an inch; it is called fine when the grains do not exceed 1 millimètres. That which exceeds the former diameter is called gravel.

Besides river and sea sand, we have that which is found away from water sources, which are known as fossil sands, of the plain, or quarry sand; but these must be distinguished from the true fossil sands, which are called *arènes* in France.

Fossil sand is far more irregular is the grain than either river or sea sand; it is far more gritty when the grains are strongly compressed between the fingers; quartz and granite dominate in their composition.

Near the sea are found large dunes or hills of shifting sand; the most extensive of these deposits in France are near Dunkirk. In the districts near the coast there are also extensive plains in which the sand is mixed with various proportions of earth, and which form the sterile wastes known as the Landes. In addition to the department which takes its name from them, landes exit also in Sologne and many parts of Brittany.

In the composition of mortar, sand forms the inert matter; it exercises no chemical action on the lime, the puzzolanic constituents, and the mortars with which it is mixed; its action is purely mechanical, and consists in the aggregation of the grains by the aid of the lime and cements, which perform the part of mordants, or active agents of cohesion; it follows that the sand of which the grains are the most angular and the angles the sharpest are preferable to those with rounded grains, or of which the asperities are less numerous.

The various kinds of sand should be harsh to the touch, gritty to the fingers, exempt from earthy matter, which causes, disaggregation of the mortar by humidity; and for the same reason, though to a less degree, marly or clayey sand should be rejected.

In the case of sea sand, the first thing to be done is to get rid of the salt. The presence of salt, however, may be very useful in certain cases.

It is a great importance to take careful note of the various results obtained by the use of different kinds of sand found where works are being carried on; some kinds contribute powerfully to the cohesion of mortars, in combination with certain kinds of lime, while others are the causes of disintegration. Experiments of this kind cannot be too numerous or too carefully conducted.

M. Vicat instituted a series of experiments in order to determine the effect of the coarseness or fineness of eminently silicious sands, or the resistance of mortars, and arrived at the conclusion that for use with eminently hydraulic lime sands ranks as follows:—1, fine grain, 2, sand with mixed grain and sharp angles; 3, coarse sand; while in the case of moderately hydraulic lime the order is reversed, the coarse standing first, the mixed second, the fine grain last.

Results since obtained with other kinds of sand have fully borne out M. Vicat's conclusions.

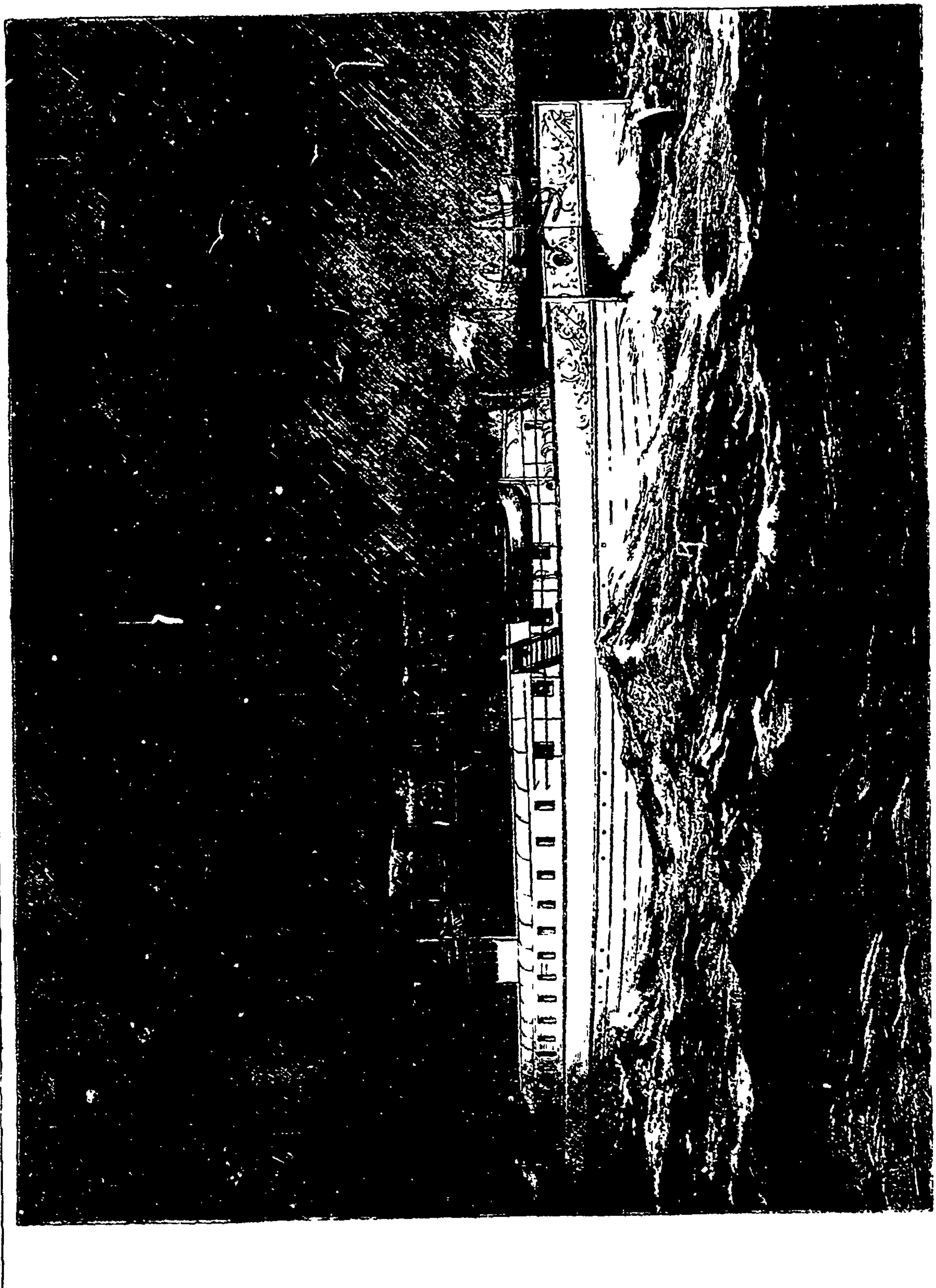
The mixture of lime and sand is the more complete, the aggregation the more intimate, in proportion to the roughness of the grains; river sand, which has been a long time extracted, and left on the banks for many months, and which has its surfaces corroded by the action of natural agents, are beyond all question the best; but those of the quarries, which are best when their composition is very silicious, offer much the same advantages in practice.

Mortar made from quick-lime and coarse sand is the most durable; fine sand acts best with hydraulic limes. In the case of hydraulic mortars, the definite setting with middling-sized sand being fixed at 100, the proportion will descend as low as 50 with gravel, and even lower when it is very coarse.

Quartose and silicious sands are insensible to the most powerful compression. This quality has caused them to be sought for paving-work; and they are preferred before all others for foundations, and in all cases where great pressure has to be considered.

THE "INDEPENDENZIA."—The Brazilian Ironclad *Independenzia* was successfully launched on the 11th, after lying partly on the slips and partly in the bed of the Thames since the 16th of July, the day on which her launch was first attempted. Several powerful hydraulic rams, camels, lighters, &c, were sent by the Admiralty from Chatham to Messrs. Dudgeon's yard at Millwall, and the weight of the ship having been decreased by the removal of some of her upper armour plates, she was at last floated into the river about a quarter to one o'clock. The vessel is believed to have sustained no injury that cannot in a short time be repaired.

The strike at the Pictou coal mines continues. The miners number about a thousand; they refuse to work themselves, or allow carpenters, blacksmiths and others to do so.



THE CASTALIA.

WATER-COOLER AT FINE ART EXHIBITION, PARIS.

Mechanics' Magazine.

MONTREAL, SEPTEMBER, 1874.

ILLUSTRATIONS :

Hand-worked slotting machine.................. 161
Life in the beehive...... 164
Insectivorous plants.... 165
Mountain locomotive.... 168
Band-saw with compensating bearings.... 169
The Castalia................ 172
Water-cooler 173
Chain-tug, Montreal Harbour.............. 176
Chain-tug, Montreal Harbour.................. 177
Iron ship-building yard, Barrow................. 180
Steel works, Barrow.... 181
Jute works, Barrow..... 184
Trying-up and four-cutter planing and moulding machine... 185
Ancient houses in England 188
Tournay Cathedral...... 189
Menier's hot air balloon 192
Roper's life raft 192

CONTENTS :

Hand-worked slotting machine 162
American centennial exhibition.................. 162
Life in the Beehive..... 162
Reasons why castings in iron ore are accurate copies of the mould.. 166
Photographing the transit of Venus.............. 167
Mountain locomotive..... 170
Band-saw with compensating bearings 171
Sand......... 171
The Independenzia 171
Iron and steel institute... 174
Insectivorous plants.. 174
Fine arts exposition at Paris 174
Products of Brazil 175
Boracic acid, manufacture of 178
Coppersmith, ancient work of..................... 179
Altitude at which men can live.................... 183
Engineering two thousand years ago............. 183
Trying-up and four-cutter planing and moulding machine 184
Miscellanea 186
Ancient houses in England 187
Tournay Cathedral......... 187
Isthmus of Suez............ 187
Roper's life raft............. 190
Menier's hot air balloon. 190
Care of china and glassware......................... 191
U. S. Centennial commission 191

THE IRON AND STEEL INSTITUTE.

The annual meeting of this influential English Association, has just been held at Barrow-in-Furness. Thirty years ago there was not even a village on the site of this now prosperous and rapidly increasing town, the present population of which is estimated at 35,000, almost double its population in 1871. Iron, the cause of this prosperity, has long been worked to a certain extent at Barrow, but it is only lately that it was discovered that coal could be got to work the ore. At the conclusion of the meeting the members proceeded to visit the different establishments in the town and neighbourhood, the most important of which are the steel works of the Hæmatite Iron and Steel Company, the Jute Works and the Iron Ship Building Yard. The first place visited by the most numerous party was the steel-rail rolling department, and the gentlemen witnessed with great interest the processes by which a large oblong block of steel was converted into a perfect rail, and afterwards cut by a steam saw into the requisite lengths for railway purposes. From this point the visitors proceeded to another part of the establishment, where a similar process was being carried on by means of reversible rollers. The facility with which the mills in this department were turned in different directions, and the consequent augmentation of the speed at which the rails were produced, excited great admiration. The other places visited were the steel-tyre mills, the blast engines, and the Bessemer converting sheds. The Flax and Jute works were completed in 1871, and employ now more than 2000 hands' chiefly Scotch girls from Dundee. The manufacture of Jute, into sacking, hessians, matting, &c., is carried on on an enormous scale, the Company importing annually 10,000 tons of raw material from Calcutta.

INSECTIVOROUS PLANTS.

The engraving on page 165, for which we are indebted to the London *Graphic*, will further illustrate this class of plants, the habits of which were so fully described in a recent number. At the meeting of the British Association at Belfast, Dr. Hooker stated that he and Mr. Darwin had closely investigated these plants. They found that when a fly or a piece of meat was placed on the leaf it was caught and dissolved in the digestive fluid just as in the case of animal gastric juice. On the other hand when a piece of a minerel was placed on the leaf there was no contraction. The analogy to animal structure was found to exist also in the manner of producing contraction, which was precisely similar to that of the contraction of a muscle, thus proving the existence of a nervous system. The different methods of securing the prey are shown in the illustration. The *Sarracenia*, the large plant on the left of the page, the *Nepenthes*, in the centre, and the *Cephalotus*, just below it, have lids which shut down upon their victims. The *Darlingtonia*, on the right, curls its leaf around them, the *Pinguicula*, in the right-hand bottom corner, shuts itself up and curls it leaves, the *Dionœa*, on the left beneath the *Sarracenia*, also shuts itself upon its prey, and the *Drosera*, in the left-hand bottom corner, has an arrangement of fine lines ending with little knobs, which it throws over its prey and thus secures it.

EXHIBITION AT PARIS OF THE FINE ARTS AS APPLIED TO INDUSTRIAL PURPOSES.

At the present day, when there is a great tendency to sneer at the art productions of the age, it is well worth while to note some of the art work which is really being accomplished. Great sculptors and painters are not so numerous as they have been at certain periods, but there is, undoubtedly, a very important branch which, steadily cultivated, is, perhaps, as flourishing now as ever in the history of art, its application to industrial purposes. We need only refer to the Gobelins, to Wedgwood ware, to the laces recently exhibited in Europe. In the cultivation of this branch of art, France claims a leading position, and the recent exhibition of specimens of industrial art at Paris will go far to establish it. At this exhibition the products of the goldsmith, of the jeweller, the bronzes, enamels, furniture, and other *objets de fantaisie* are said to have been in the very highest style of art. We are enabled to give an idea of the exhibits in a water-cooler of goldsmith's work, the product of the Chistofle establishment at Paris. This is a large amphora resting on a lion's-claw pedestal. Around it twines a branch of ivy in green gold exquisitely arranged. The arrangement of the female figures is also extremely graceful. This beautiful work was modelled by M. Eudes, statuary, and M. Leprêtre, sculptor.

We illustrate on pages 172, and 176, from *Engineering* the A. G. Nish, the chain tug built for the Montreal Harbour Commissioners and used for towing heavy vessels up the St. Mary's Rapids. We described the *Nish* in a previous number.

On page 177, we also illustrate the *Castalia*, the new twin-steamer built on the plan of Captain Dicey, and intended to serve as a ferry between France and England. The *Castalia* and the Bessemer saloon steamer, both of which have been previously described by us are now on the point of entering on active service, when a few trips in stormy weather will soon settle the question as to the possibility of avoiding sea-sickness, and will also decide the relative merits of the two steamers.

THE PRODUCTS OF BRAZIL.

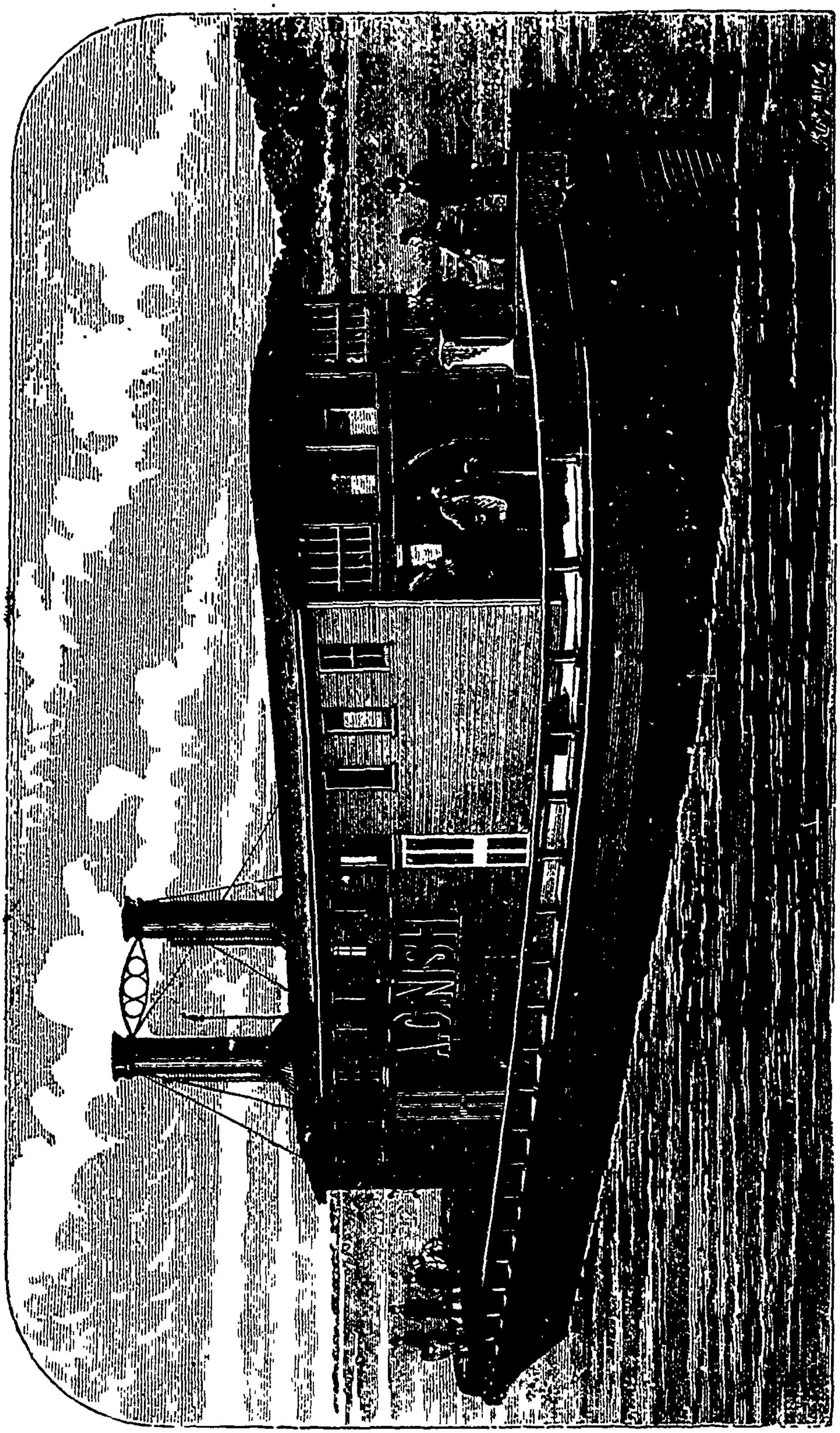
Brazil is a purely agricultural country, and manufactures can hardly be said to exist. Almost every one who has occupied himself with Brazil has spoken enthusiastically of the wonderful fertility of the country, and many have pointed it out as a field for European emigration. Consul Leno Hunt in a series of reports observes, that it is true that it is not possible to overrate the fertility of portions of the soil, but the tracts capable of cultivation are often separated from each other by dense forests and mountain ranges. The grazing plains and cotton-producing districts are, in the far interior, destitute of roads. The best cotton producing districts in the province of Pernambuco are 200 or 300 miles from the seaboard. The northern provinces are specially subject to drought, and sometimes not only the cattle but the inhabitants die of starvation. The farming population in such cases are obliged to send to Rio and other markets for farina to enable them to support their establishments, and those who can least afford it have to migrate to spots near the margin of rivers, thus seeking shelter from the fatal lot which pursues them. At other times, during the rainy seasons, there are cattle breeders who are left without a single head of cattle, and on some estates the losses incurred amount to a thousand head. From the same causes the maintenance of any roads is rendered impossible. The forests contain an immense variety of the most valuable timber, but fifty trees have to be cut down before the particular one required can be reached.

With the vast extent of territory possessed, it is somewhat curious that great difficulty exists in the purchase of land in good situations. It is principally in the hands of large holders, who cultivate but a small portion of their properties. One proprietor in the province of San Paulo claims 100 square leagues, a very small fraction of which is utilised. The legislative chamber is principally composed of landowners and their immediate connections, and any system whereby the land should be made to revert to the Government for distribution among persons offering guarantees for its cultivation stands but small chance of success. The former legislation of Brazil also appears to have operated most injuriously to the real interest of the planter. With a view to foster the establishment and maintain the integrity of estates, it was provided that no distraint could be made, or mortgage foreclosed, unless the debt in which the action was taken amounted to a sum equal to about two-thirds of the value of the plantation, which is always estimated at an amount greatly superior to that which it would bring if sold in open market. The planter had, therefore, a practical immunity from action for debt, but for this privilege he paid a high price. While the merchant on his personal credit alone, could obtain money at a rate of interest varying from 7 to 8 per cent. per annum, the planter, though offering the security of his land and buildings, was forced to pay rates varying from 12 to 24 per cent. per annum. Notwithstanding that this law has been abrogated, it served to load the planter with debt, and dealt a blow at his credit from which there are no signs of recovery. The excessively high export and import duties would alone be sufficient to check the production of native articles and the consumption of foreign products, but when they are supplemented by the numerous drawbacks which neutralise the great natural advantages of the country, it would not occasion surprise to find that there has been no accumulation of wealth. In testing this impression by the observation of facts, it will be found to be correct. A planter with an unembarrassed estate is as rare as a merchant who has acquired money in trade.

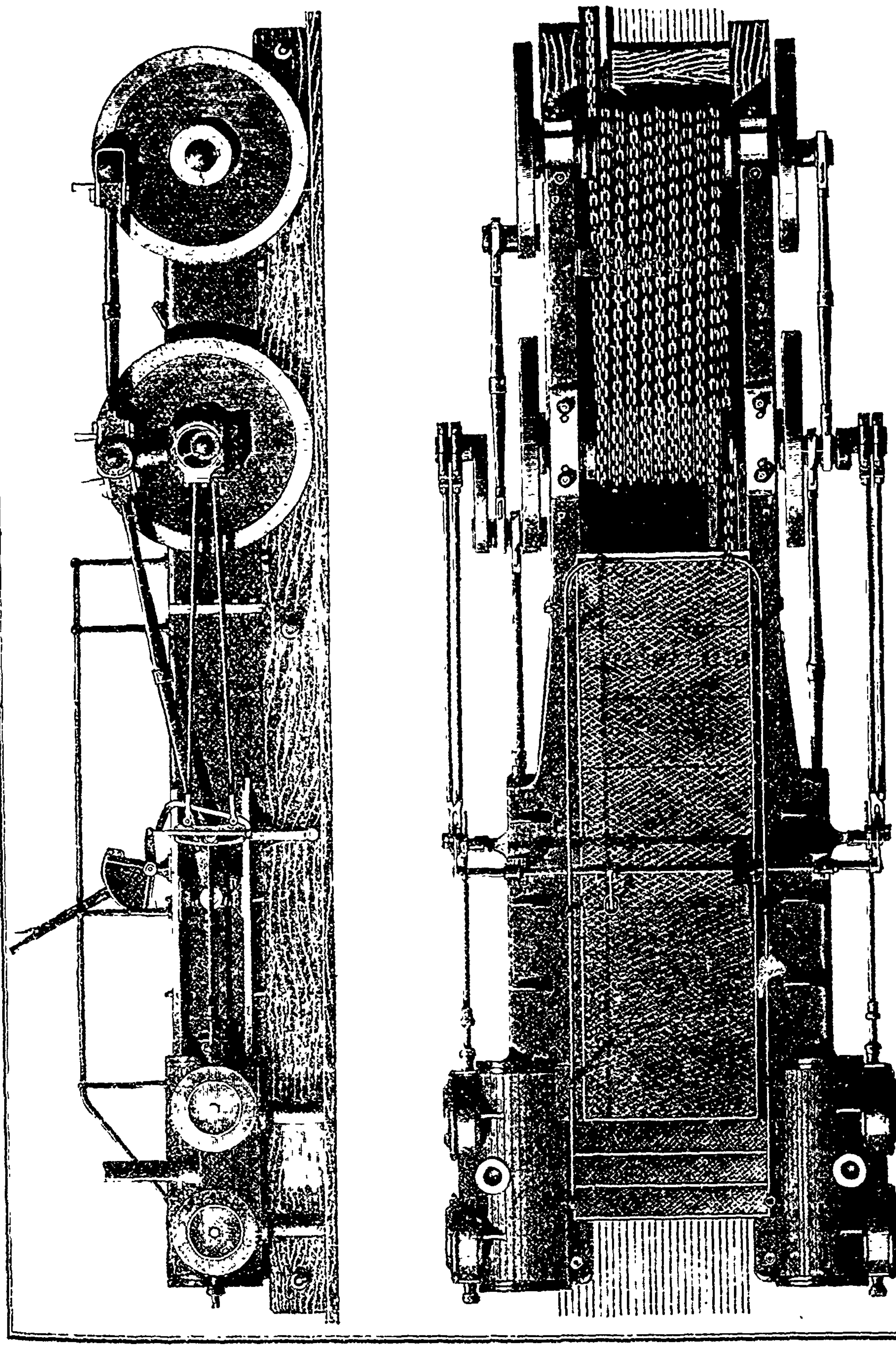
The principal productions are coffee, sugar, cotton, tobacco, cocoa, and india-rubber. Coffee and the cane represent £10,000,000 sterling out of a total of exports of every description of produce whatever of £17,000,000. The stimulus given to the production of cotton, which is of admirable quality, by the suspension of its cultivation in the Southern States of America during the late civil war, resulted in the production in 1872 of Brazilian cotton of the value of upwards of £3,500,000 sterling. The growers, however, now complain that, saddled with an export duty of 13 per cent., and the price having fallen at Liverpool for the best quality to between 8d. and 9d. a pound, it will no longer pay to produce it. This is true of all districts, except those in unusually favorable situations, where transport to a market is a matter of no great difficulty. But the local charges and prices in the foreign markets leave no margin of profit upon cotton coming from the distant table lands, where it grows in the greatest perfection, and the production of cattle will again become the more profitable employment, as it was prior to the United States war. The item next in importance is that of hides. With the fertile province of Rio Grande do Sul, enjoying a temperate clime, and large colonies of Germans, which alone have any claims to be considered successful colonies out of all that have been established in the empire, nothing of any importance has been realised. People do not starve, and that is all. In 1867-8 the export of hides, principally from this province, amouted to 15,000,000 milreis; in 1871-2 it was 16,000,000 milreis. Tobacco, next in order, was returned in 1867-8 at 13,000,000 milreis, and in 1871-2 at 12,000,000 milreis, and so on with regard to all the minor productions of the country. The abolition of the duty on coffee in the United States, and its reduction from 6d to 3d. a pound in England, have come as a most timely relief to the planter, and, with the largely incresed prices for it in those countries, will enable him for some time longer not absolutely to break down. Sugar and coffee require for their production organised systems of labour, and there is no prospect of results worth mentioning by their cultivation on the Metayer principle. The desultory labours of free cultivators of these products is not likely to lead to any important results. The picture thus drawn, Consul Hunt observes, does not agree with the general idea entertained by Europeans of this country. The name of Brazil conjures up visions of endless quantities of tropical produce, diamonds, and gold, the last to be obtained as the result of a very cursory washing. The exported amount of the latter is in reality insignificant. Almost all that has been created in Brazil has been produced by the negro, and with his freedom it seems likely that the organised system of labour in which he now figures will suffer materially. That he should work for 16 or 18 hours a-day, for 1s. 6d. or 2s, in a sugar-boiling house is not probable, when he has a country at his back which seems to have been created on purpose for the benefit of squatters of the African type.

The Government has squandered very important sums in the attempt to solve what in reality is to-day an insoluble problem, namely, to obtain good agricultural labour at a low price. It possesses little land worth having to distribute, and those lands that it can dispose of are not measured. The colonist is invited to become the proprietor of a wretched patch, the conditions of the occupation of which must load him with debt, should he survive the term of serfdom imposed upon him by the contract, and this in a land extending from latitude 4° north to 33° south, with a longitudinal range almost equally vast. What Brazil seems to be seeking is a substitute for the vanishing negro, not free men to people her solitudes, whose labour is to be used, not in their own interest, but in that of their importers. She must not be permitted to enter the labour market of Great Britain with these intentions. Beyond her southern frontier, there are two countries—the Republics of the Uraguay and Argentine Confederation—poor enough in the eyes of the naturalist, and uninteresting to the ordinary traveller, the beauties of scenery being entirely wanting; they offer in compensation, however, no natural difficulties. The climate is temperate and healthy, the soil is undulating, sparsely timbered, well watered over large tracts, and produces excellent grass, the rich and deep alluvium beneath which waits only the plough or the spade to grow nearly every European product. Such natural advantages could not remain hidden. Thousands upon thousands of Europeans have, in annually increasing numbers, spontaneously sought a home there, and the foreigner already counts for something in the politics of those countries.

The same physical aspect that may be perceived at once in the Province of Rio de Janeiro is equally apparent throughout large portions of the country. Great luxuriance of vegetation, valleys of inexhaustible fertility, mountain ranges covered with virgin forests and the thinnest layer of vegetable earth, and vast tracts of red clay, almost destitute of alluvial soil. The very small quantity of soil which suffices for some plants is quite astonishing to Europeans; rocks in which scarcely a trace of earth is to be observed are covered with cacti, orchids, ferns, and other plants, all in the vigour of life. The town of Rio is admirably lighted, has a good supply of water, and a large area of the town is well drained; it is paved with granite worked from quarries close at hand. The paving in some of the principal streets, which was well laid down, has been much damaged by street tramways that have been carried



CHAIN-TUG BUILT FOR THE MONTREAL HARBOUR COMMISSIONERS.



CHAIN-TUG MACHINERY.

through them, and this renders the transit in ordinary carriages extremely unpleasant, and at the same time expensive on account of the rapid destruction of the wheels.

The population is variously estimated between 420,000 and 500,000 inhabitants; the port, which may be entered at all times without a pilot, is inferior to no other in the world.

THE MANUFACTURE OF BORACIC ACID IN TUSCANY

By P. Le Neve Foster, Jun., C.E.

The production of boracic acid in Tuscany, from the hot boiling springs and jets of vapour called *soffioni* is certainly one of the most important branches of chemical industry in Italy. The curious phenomenon of jets of vapour issuing naturally from the ground is met with over an area of comparatively limited extent, situated between Massa Marittima and Voltera. The hill sides in many of the valleys of the tributaries of the River Cecina are studded with such *soffioni*, and numerous *lagoni*, or ponds of muddy blue water boiling vehemently, have been formed by the natural springs, acted on by these vents of vapour.

Towards the close of the last century (between 1770 and 1780) boracic acid was discovered in the springs of Monte Rotondo and Castelnuovo, by Hœffer, the chemist to the Grand Duke of Tuscany, and by Professor Mascagin, but no steps of any importance for utilising these springs for making boracic acid appear to have been taken until 1818, when Mr. François Lardarel, a Frenchman, established works on a small scale for the collection and extraction of this substance from the waters of the *lagoni* in the neighbourhood of Castelnuovo. At first his efforts were unattended with success, and, in a commercial point of view, may be said to have proved a failure, owing to the great expense in obtaining food for evaporating the water. At length the brilliant idea struck M. Lardarel of employing the heat of the natural steam jets to evaporate the weak solution from the *lagoni*, and this was the turning point in his fortunes. This method, which was first applied in 1827, had the effect of converting an unprofitable branch of industry into one of the most successful in Italy. At the present time there are no less than seven separate establishments belonging to Count Lardarel, all situated within a few miles of the little town of Castelnuovo, which may be said to be the centre of the boracic acid industry in Italy. These establishments are as follows:—

1. Lardarello, or Lagoni, of Monte Cerboli.
2. Castelnuovo, Val di Cecina.
3. Serrazeano, or the "Lagoni Solforei."
4. Lustignano, or the "Lagoni Rossi."
5. Sasso, or the "Lagoni di Acquavita."
6. Monte Rotondo, or the "Lagoni della Pianacce."
7. "Il Lago," where the works of San Federigo, San Edurdo, and La Collacchia are situated.

The works at Lardarello are the most important of all, and it is there that all the products of the other establishments are sent. The process by which the acid is extracted being precisely the same at each, it will only be necessary to describe in detail those carried out at Lardarello. This little colony, which was founded by the late Count, is situated at a short distance from the village of Monte Cerboli, on the torrent Possera, and shows what might be done in other parts of Italy for improving the social condition of the working-classes There is a neat square, "La Piazza dell' Industria," surrounded by blocks of buildings, which on one side include the offices, church, museum of mineralogy, and schools, and on the other, the model lodging-houses for the workmen, stores, workshops for various tradesmen, such as tailors, shoemakers, &c., and a weaving establishment for giving employment to the wives and daughters of the workmen.

The *lagoni* are situated to the south of this little village, and consist of artificial basins constructed of coarse masonry, large enough to contain several *soffioni*. At the present time most of these *soffiani* are obtained artificially by boring, and are lined with sheet iron tubes from 25 to 30 centimetres (10 to 12 inches) in diameter. These borings are found more manageable, besides giving out more vapour than those formed naturally. The basins, or *lagoni* are situated at different levels on the hill side, and the uppermost is supplied with water conducted by a canal from near the Bagno del Norbo. After remaining in this basin for twenty-four hours, during which time it has been kept in constant agitation by the subterranean vapours, and has become of a slate blue colour, the water passes into a canal, and is conducted to another basin at a lower level, where it remains another twenty-four hours, and in consequence takes up an additional quantity of boracic acid.

The water, after passing through a chain of *lagoni*, where it is brought up to a strength of about 9.50 per cent. of boracic acid, is then conducted to a large tank, about 20 metres (66ft) square and half a metre (1 foot 6 inches) deep covered by a tiled roof supported on brick columns. Here it is allowed to settle, the impurities held in suspension are precipitated to the bottom, and the water leaves the tank in a perfectly clean state.

The next operation is to concentrate this weak solution of acid. This is effected by evaporating it in long lead pans, ingeniously heated with steam from the dry *soffiani*. These pans are about 60 metres (200 feet) in length by 2.50 to 3 metres (8 feet 4 inches to 10 feet) in breadth, arranged usually in three parallel lines under one roof, supported on columns, the sides being open so as not to impede the evaporation. The pans are supported on beams over low steam passages, into which the vapour is conducted by pipes from the *soffioni*. Formerly a masonry arch was built over one of the natural springs, and the steam collected in this manner, but these buildings were liable to be undermined and attacked by the corroding influence of the vapours, and it is now found far more convenient to connect the pipes to the tube of an artificial boring, to say nothing of making a neater job and the arrangement being more under control. The pans have a number of divisions placed transversely across them, usually from 80 cent. to 1 metre (2 feet 7 inches to 3 feet 4 inches) apart. These divisions are 0.05 metres (2 inches) in height, and the pans are arranged so as to have a slight inclination from the end where the water is admitted towards the other, where there is a large and deep reservoir. The water is allowed to enter in a regulated quantity from the precipitating tank, and following from one division to another, it gradually evaporates, and after having passed over 50 to 60 divisions, it assumes a bright yellow hue, increasing in intensity as it approaches the end, where it runs into the tank or boiler. Every 24 hours this boiler is emptied, and its contents pumped up to the crystallising house, in which a series of vats about a metre (3 feet 4 inches) in diameter are placed. These vats being filled, the liquor is allowed to remain four days, during which time the boracic acid is deposided in crystals at the bottom and sides to a depth of a few inches, and the liquid that then remains is drawn off by removing a plug at the bottom, and conducted away by a drain to the evaporating house. Fresh liquid is then introduced into the water, and the same process is repeated until they are completely filled with crystals of boracic acid. As these crystals retain a large amount of water, they are, when removed from the vats, placed in large wicker baskets to drain, and are afterwards taken to the drying-house, where the contents are spread in thin layers on the floor, and stirred constantly with a wooden rake. It is then packed in barrels containing about 600 kilos. each (12 cwt.), and sent to Leghorn, where it is shipped chiefly for England.

The boracic acid manufactured in this manner contains about thirteen per cent of impurities, chiefly sulphate of lime, ammonia, alumina, and magnesia.

At the Lardarello Works there are 12 evaporating sheds, containing 35 evaporators. The average daily production is about 3,000 kilos. (3 tons), though some days as much as 4,200 kilos (4 tons) have been made. The Castelnuovo establishment averages 26 700 kilos. (27 tons) per month, and the production of the other works is still less. The total annual production of the whole of the establishments belonging to Count Lardarel is estimated at 3,000 tons.

Notwithstanding the extreme simplicity of the whole process, it is a matter of surprise to many who have visited these works, and it is much to be regretted in the interest of science, that Count Lardarel (whose method evidently is "rest and be thankful," instead of "progress") has not thought fit to employ a chemist at his establishment, and up to the present no progress has been made in this manufacture since the first application of steam by the late Count in 1827, although it is highly probable that, under the management of a scientific man, considerable improvements might be introduced.

M. Durval has an establishment for the manufacture of boracic acid at the Lake of Monte Rotondo, called also "Il Lago Solforei di Vecchiena," which has an area of about 18 acres. The waters contains about 0.002 of acid. The produce of these works is sent chiefly to France.

At Travale, an Italian company, called the Società Anonomia Borica Travalese, have an establishment for extracting the boracic acid which is found there, though in a far more diluted state than at the *lagoni* of Count Lardarel, and although the process by which it is extracted does not differ in principle from that previously described, certain very important modifications and improvements have been introduced. These springs, which are called "I Lagoni delle Galleraje," are situated at a short distance from the village of Travale, in the valley of the Sajo, a little stream flowing into the Feccia and Merse tributaries of the Ombrone. Here the boracic acid is associated with sulphate of ammonia, which is extracted from the waters of a series of *lagoni* by evaporating apparatus, heated by the natural vapours of the *soffioni*, but as the sulphate of ammonia is worth only 35 francs per quintal (14s. 7d. per cwt), whilst that of the boracic acid is 50 francs (£3 per cwt), and the cost of production is almost equal, there is very little profit attendant upon its manufacture. The water of these *lagoni* contain about 500 milligrammes (about 7 grains) per litre (1¾ bint) of sulphate of ammonia. All the *soffioni* at this place have been obtained by boring, and this company are possessed of excellent tools for this purpose, by means of which they are enabled to bore to a diameter of 40 centimetres (16 inches) These borings usually meet water at a depth of from 15 to 20 metres (50 to 70 feet), though in one place a depth of 168 metres (560 feet) was reached before tapping these subterraneous sources of heat, viz, in a boring called "Il foro Pietro."

Another boring ("Il foro Carlo"), 73 metres (240 feet) deep, furnishes a supply of water holding boracic acid in solution, which rises to the level of the ground, as in an artesian well its supply being equal to 600,000 litres (132,144 gallons) per 24 hours, of which only one-sixth part is at present utilised. This solution contains only 260 milligrammes (about 4 grains) per litre (1¾ pint) of boracic acid, which is given off at a temperature of 96° Cent. (205° Fah) Here there is no basin, as at Lardarello, the water being led away direct by cast-iron pipes from the bore hole to the precipitating tank, which is 18.50 metres (60 feet) in length, by 13.50 metres (45 feet) in width, and 0.50 metres (1 foot 8 inches) in depth. The improvement that has been introduced here consists in heating the water in this tank by pipes, through which the vapour from a dry *soffioni* ("Il foro Filippo") passes, and by this means a certain amount of water is evaporated in the precipitating tank, and thus brings up the degree of concentration of the solution to 400 milligrammes (6 grains) per litre (1¾ pint.) The boring that furnishes the steam is 65 metres (210 feet) in depth, and the temperature of the water in the tank is maintained at 94° Cent. (202° Fah.). This solution, which has a specific gravity of 11° of Baumé's areometer, is conducted in the usual manner to the evaporators, which are constructed in a similar manner to those at Lardarello, the water being kept at a temperature of 76° Cent. (169° Fah.), by the steam from "Il foro Filippo," and having traversed the entire length of the pans is received into the boiler at the lower end with a specific gravity of from 12° to 50° Baumé, and is crystallised, dried, and packed in the usual manner. The evaporating shed contains three rows of evaporators, 64 metres (207 feet) in length by 3 metres (10 feet) in width. The production is about 26 kilos. 200 grammes per day (5.-64 lbs.)

Placing Screw Propellers.—Mr. Betteley has patented a new method in screw vessels, and claims for his invention several important advantages. The screw as at present placed is in heavy weather at one time lifted almost out of the water and at another sinks many feet below its ordinary position. The result is that the engine is subjected to a series of severe and sudden strains. The position of the screw at the stern also causes the maximum of vibration, acting as it were at the end of a lever. Mr Betteley proposes to avoid these and other drawbacks by placing a double screw in a recess on each side of the vessel amidships—to make the screw occupy the same position as the existing paddle.

THE ANCIENT WORK OF THE COPPERSMITH.

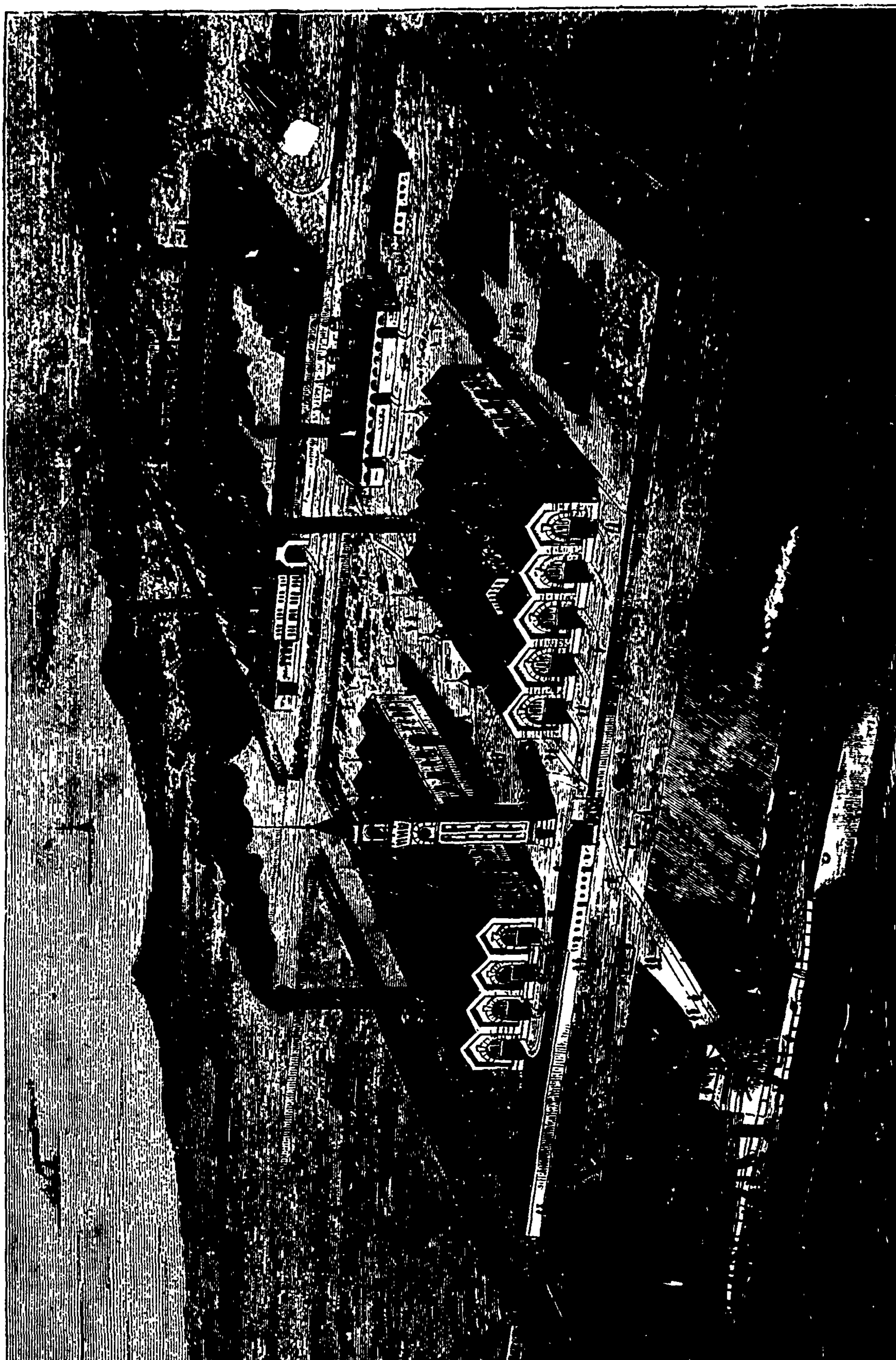
The subject of the earliest artificers' work in copper. is one that possesses extreme interest for many different reasons, and it is one as to which much further information than we actually possess is extremely desirable The chief difficulty that attends the commencement of the inquiry is this. As a general rule, in art, the simpler processes are more ancient than the more complex. Now the production of the working of a metal of any description may naturally be supposed to be more ancient than that of any alloy of that metal. But our earliest relics of any cupreous arms, tools, or other objects, are not, as a rule, of pure copper, but of some kind of bronze, or copper alloy. It is perfectly well known that certain alloys of copper are far more manageable by the workman, as well as harder and more available as tools or weapons, than is the pure metal. But we must regard it as probable that a considerable amount of skill had been attained in the smelting and casting of copper, before the ancient copper-smith thought of alloying the metal; and as utensils of bronze so very far precede, in the archæological series, any evidence of the discovery and the manufacture of iron, the commencement of this early metallurgic work seems to be pushed back into an almost unattainable antiquity.

The best source of light which we may now expect to gain on this point is the careful survey of the ancient world, including not only topographical information, but that accurate physical investigation which shall tell us of the source of the wealth of the future and of the traces of the industry of the past. Here archæological research joins hands with industrial inquiry. When we have ascertained, as we may properly hope to do, from what sources the various nations of antiquity, whose history we seek to trace, derived their metals, we shall have the first positive information as to the origin of the various descriptions of ancient bronze.

Copper occurs in a virgin or native state in many places, especially in out-crops. It also occurs in veins, and "pockets," or nodules, which the French miners call *géodes*; where it ramifies into crystals, and into delicate efflorescent threads. In Siberia is found the *cuivre oxydulé*, which resembles a dusky-red stone, sparkling with specks of metal. Black oxides, and blue and green carbonates, known as agarite and malachite, accompany native copper. Specimens of the former are found at Chessy, in France, of a lovely dark-blue, resembling, but darker than, that of the blue vases usually exhibited by chemists. Malachite occurs in the Oural mountains, and its use in Russia as an article of splendour is well known. The ordinary yellow *pyrites* is of frequent occurrence in Wales and elsewhere; and its little bright pyramids and parallelopipedons may readily be mistaken, by the unwary, for gold. The "peacock-copper" of Tuscany has iridescent colours. Like the yellow pyrites, it is a double sulphuret of copper and of iron The Fahlerz, or grey copper, of the Germans, contains besides copper and iron, silver, arsenic, and antimony. It is smelted for the sake of the silver and the copper; but is extremely difficult to manage, from the complex nature of the ore. But it is highly probable that in this grey copper we have an indication of some of those deposits of natural alloys, which fact suggested to the ancient metallurgists the production of bronze.

Tin,—which, with copper, constitutes true bronze,—is stated in the works on metallurgy to be unknown as a mineralogical neighbour of the latter metal. It is not known to occur in a virgin state. The Cassiterides, or tin islands of the ancients, whence this valuable metal was brought by the Phœnician navigators before the time of Homer, are as yet undetermined; though some authors have sought to identify them with our Cornish coasts. Tin is usually found as a crystallised oxide, of a chocolate-brown colour, and of a form closely resembling rock crystals. More rarely it occurs in what are called stanniferous sands, either yellow, rose-coloured, or translucent as crystal. It is found in India; supplies at present are derived from Banca and Malacca, as well as from Cornwall. It also occurs in Brittany. The island Vectis of the early navigators, has been explained to lie at the mouth of the Loire; to be the island Saint Michael; to be the Isle of Wight. From each new guess we come to the same result,—the importance of a better physical survey of the Old World.

There is little doubt that, on descending to historic times, tin was brought to the basin of the Mediterranean from India, from Gaul, and from Britain. The mineral was readily separated, by washing, from the sand in which it was found, and



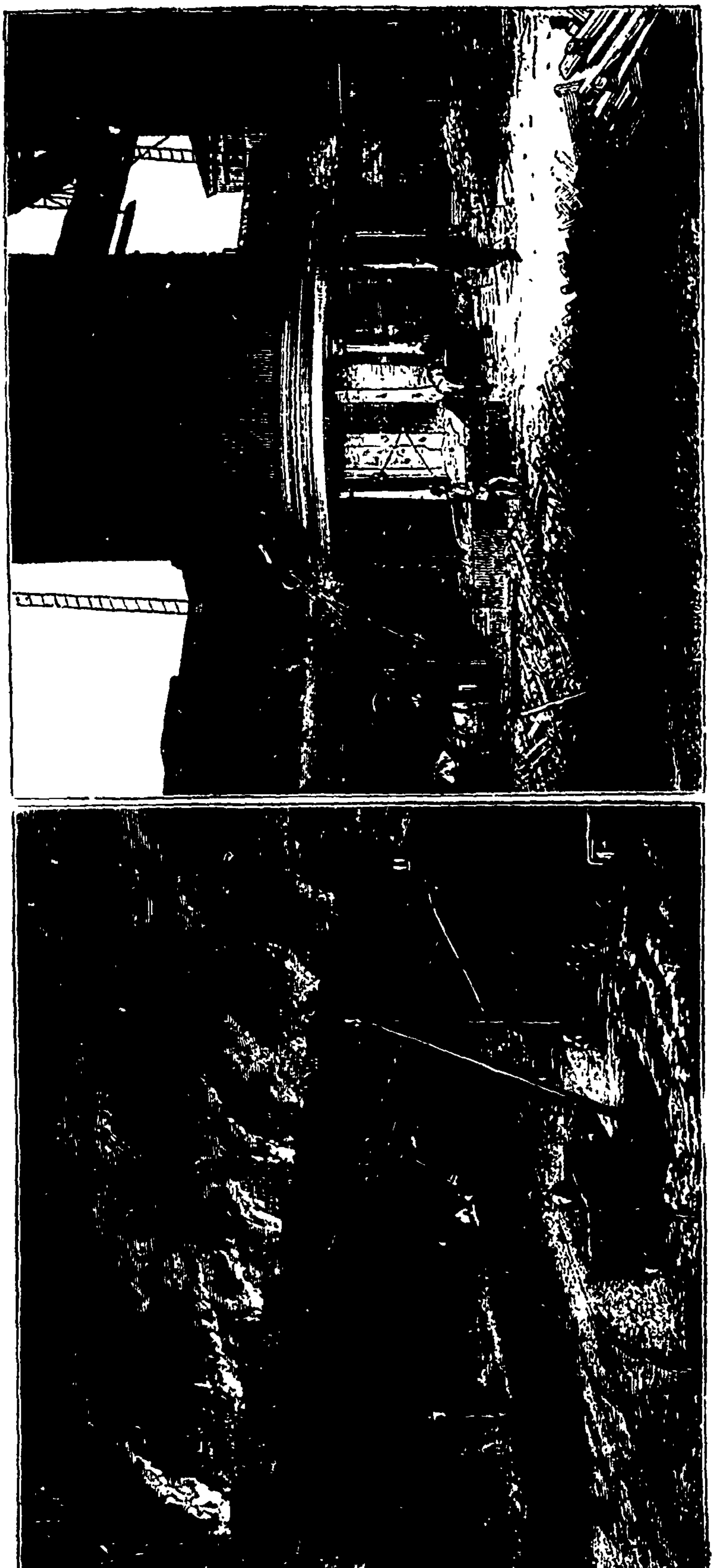
THE IRON SHIP-BUILDING YARD, BARROW.

then exposed to heat. As the ore is a compound of oxygen with tin, a charcoal fire will effect the reduction of the metal, so that the process has little varied, in principle, from the earliest date to the present time.

No ancient author speaks of bronze, the *æs* or *chalcos*, of the Classic writers, as if possessed of any acquaintance with its compound character. The hardening, tempering, and working of bronze is spoken of as we might now speak of the manufacture of iron. When not only the sword and the hunting knife, but the chisel, the needle, the axe, and the fish-hook were made of bronze, there can be little doubt that the early craftsmen studied and experimented how best to give to their work the hardness of the flint, combined with the elasticity or tenacity of bone.

Very recent discovery has thrown a ray of light on this difficult subject of inquiry. In the immediate vicinity of Sidon, in the ancient Phœnicia, have been recovered not only copper-mines, but a closely neighbouring lode of stanniferous crystals. It is also stated that coal sufficient to carry on the operations of smelting is in the immediate neighbourhood. A ridge of hills runs east and west in this part of Syria terminating chiefly on the coast. Steps are in contemplation for the reopening of these ancient mines. But their discovery is more important as an archæological than as an industrial question. It tends to show that Nature herself indicated the original mixture of bronze. The position of a source of this alloy in the very headquarters of the most famous mariners of antiquity is another most instructive fact Hitherto it has been utterly inexplicable why the tin of Cornwall or of India should have been sought in order to mix with the copper of the Mediterranean shores. But when the alloy had once been indicated, or casually found, by the smelting of contiguous ores, the search for the rarer metal would have been a natural result. Again, what occurs to Sidon may have occurred elsewhere, and the very earliest bronze may have been indicated by Nature herself.

Brass, which is an alloy of copper and zinc, is a much more modern alloy than bronze. We know but little of its existence before the Imperial age of Rome. We find that new brass coins were struck by Julius Cæsar, which Pliny says contained *cadmia* the from Livian mine, and were equal to the excellence of *orichalcum*, for *sestertii* and *dupondii*. *Orichalcum* is sometime spelt *aurichalcum*, as if it meant copper of a golden colour; but its etymology really denotes "mountain copper," and some native alloy was probably first intended. *Cadmia* is taken to mean calamine, or zinc ore. Strabo speaks of a "false silver," which, mixed with copper, became a *krama*, or alloy, which some called *orichalcum*. Copper is said to have derived



STEEL-WORKS, BARROW

its name from the island of Cyprus; and brass, or rather the Greek word chalcos, from Chalcis, in Eubœa. The Corinthian brass, which is occasionally mentioned as of extreme value, is generally taken to be the same as *electrum*, or a mixture of gold and silver. Specimens of an argentiferous gold, rich in silver, from Transylvania, are to be seen in the British Museum under the name of *electrum*, which attract attention from the sharpness of the crystalline forms. As the knowledge of metallurgy passed from a craft into a mystery, and especially when the expectation of b ing about to discover the secret of the transmutation of metals had seized the imaginations of men, tin was known by the sign of Jupiter, copper by that of Venus, gold and silver by those of the sun and the moon.

The specimens to be found in museums of ancient objects in bronze are numerous and important. We are not now referring to the statuettes and sculptural bronzes, amongst which may be found some of the most perfect specimens of ancient art anywhere extant. One of the latest additions to the bronze-room of the British Museum is a female head, of unrivalled beauty; and also of great interest, as showing much of the method of the ancient workers in bronze. But we rather call attention to such undated specimens as the bronze Etruscan krater, found at Capua, with mounted Amazons round the rim; and the draped female figure from Sessa, on the Vulturno, a town famed for the rare beauty of its women,—one of the most ancient and interesting examples of casting in bronze.

Ancient bronze has not the indestructible character of the precious metals. The disinterment of a vase, may, unless special care be taken for its preservation, lead to the rapid crumbling of the object into dust. At Baiæ, near Naples, is an ancient cemetery, in which the different orientation and structure of three super-imposed strata of tombs bear testimony to the successive occupation of the spot by three distict races. The Oscan, or Etruscan tombs, in this cemetery, which are built of square stones, with a pyramidal roof, not unfrequently contain large bronze vases, of nearly globular form, which are found bedded in a layer of perhaps not more than 6 in. of consolidated dust. The late Count of Syracuse opened many of these tombs, and recovered many interesting objects; amongst others, the dressing-case of a lady, with implements in bronze. It was his Royal Highness's custom to have the bronze objects plunged into boiling water immediately on being unearthed, which was stated to be the only known precaution against speedy decay.

An extremely interesting question is as yet unsolved as to the method of coinage in use in ancient times, not for copper alone, but for gold and silver. The subject is intimately connected with that before us, from the fact that the dies used in coining were exclusively of bronze or of copper. From the beauty and sharpness of many ancient coins it is evident, not only that the art of the die-sinker, as matter of graceful taste, was of a very high order, but also that the metallurgic or mechanical part of his craft must have been adequat ly advanced. That means of hardening bronze, with which we are not now familiar, formerly existed, seems hardly to be questioned. But our most accomplished numismatists speak with no little hesitation as to the process by which the impression of the die was communicated to the coin.

We are not, however, without some positive information on the subject, although more is still very desirable. The British Museum possesses amongst its numerous treasures an ancient Roman die. This is an iron implement, formed in two parts, one being a socket, into which the other fits. In the middle of the socket is a circular recess, into which a copper matrix is fitted. The plunger, or upper portion of the die, has a similar recess, fitted also with a copper die. The disc of metal to be struck must have been placed on the lower die, and the guidance of the socket served to bring the upper die into exact opposition to the lower. There is no collar in order to keep the coin centra on the die. It is possible that a loose collar may have been lost, but the probability is, that the metal instrument is complete as it exists. The reason for this opinion is the great irregularity with which many ancient coins are struck. It is rare to find the impression central. A peace of unstamped metal is often found on one side, while the device overlaps the metal on the other. This irregularity would, however, have been very natural, if the disc were simply placed on the die by the workman, without any collar to confine it. In the recent improved process for striking coins and medals, a loose steel collar is added, which at once gives a central position to the device, secures the exact roundness of the coin, and serves to mill or ornament the edge. The process may be watched any day at the International Exhibition at South Kensington. It is to be lamented that the modelling of the large gilt medal, which has been recently issued by the directors of that institution to the exhibitors, does not equal the mechanical excellence of the machinery by whsch it is turned out.

The question remains, of the mode in which force was applied to the dies. The word "struck" is still employed, although it is, in fact, a gradually increasing pressure which is brought to bear on the disc. In the earliest coins it is very possible that a violent blow was actually given to the die. The square depression on the reverse of many ancient coins seems to point to this method of formation. But the British Museum die has not been so treated. It is made of excellent iron, more closely resembling that of Styria than any now commonly made, but which we believe to have been procured from the Apennines. But the plunger, or upper part of the instrument, has no marks such as a series of violent blows would have occasioned. Our readers who are accustomed to the blacksmith's setts will understand what we mean. Nor is this freedom from foliation or crushing due to want of use. The copper dies inserted in the coin bear signs of considerable use.

We think that the inference is unavoidable, that the iron must have been inserted in wooden blocks; and that pressure must have been applied as it is in the oil-presses and the maccaroni-presses of Italy, at the present day, by the combination of the lever and of the screw. The habits of the peasants and lower classes of the Peninsula, especially in the wilder parts, as in the Abruzzi and the Calabrias, are wonderfully little changed since the imperial times. At Canosa, for example, the very same grittiness in the bread which Horace deplores in his journey to Brundusium still endangers the teeth of the eater. The mode of applying enormous pressure which is now in use is, there can be little question, as ancient as it is effective. Rude in its details, it is essentially in principle one with the latest machinery of our m nts.

The dies in the instrument which we are describing seem to be of copper, and bear marks of rough usage. But it can hardly be doubted that among the Greeks, and probably the Asiatic nations, hardened bronze was employed. Some of the vexed questions as to ancient coins hinge, to a great extent, on this subject of the hardness of the die. Thus when coins are found very closely resembling one another, but not *fac similes*, it is supposed that they are produced by different dies cut and used in the same year. This, of course, is possible, although it is also possible to ride such a hobby to death. Thus De Sauley figures, in his "Recherces sur la Numismatique Judaique," plates xiv. and xv., eight copper issars, or assarions, which differ very widely in their treatment of the palm-tree and the vine-leaf which they bear, in the arrangement, and even in the type or form of the letters on the field; and ascribes them all to the same year,—viz, 134 of the Christian era. This extraordinary attribution is only brought within the limits of possibility by the assumption of the use of numerous dies in the same year,—an assumption, however, that does not account for the artistic and palaiographic differences of the pieces in question. It has been clearly shown by a writer in an important contemporary publication (" Bible Educator," parts xiv. and xv) that the year II. on these coins refers to the second year of the seven, a constantly-recurring date, the distinction of which, on the coins used for sacred tribute, was important. Thus the absurdity of attributing 30 per cent, of all the known Jewish coins to at the outside 9, out of 184, years, will, it is to be hoped, not disfigure any further works on coinage.

The distribution of copper over the surface of the earth is wide and abundant. In the Old World it occurs in Asia Minor, Italy, Spain, France, Morocco, Algiers; as well as in Persia, Abyssinia, Congo, the Cape of Good Hope district, and Madagascar; and in England, Germany, Sweeden and Russia. It occurs on the shores of Lake Baikal, in China, and in Japan. It is found in Australia. In the New World it occurs in Canada, in the United States, in the Antilles in California, and in Chili. It tinges the promontory of Cape Farewell. These are only the best known and more conspicuous deposits, as they appear on the face of the map. In Russia, copper mines were worked, in prehistoric times, in Siberia, in the Bashkir land, and in the Kirghis steppes, by a people of whom we have no account. Early in the present century the now famous mines of Nijni Tagil were commenced; and soon after it was discovered that the whole of the eastern slope of the Oural, from Voskresenk in the extreme north, to near the village of Malvatina in the extreme south, abounded, more or less, in copper. Tin is also found in the Oural, though it is not now worked. The yield of the ore at Nijni Eagil, from 1814 to 1830, was above 3 to 4 per cent. In 1836 it rose to 5 per cent.; from which it has gradually dropped to half that proportion. The depth of the mines here is ninety fathoms. Near Simbirsk, in former times, it was found profitable to work a copper ore which contained only 2 per cent. of metal. Old clay pots have been found here, which were used by the early smelters and which indicate from their great rudeness, a richer ore, as no results could be obtained from the present ore by so rude a process. At the fair at Nijni Tagil copper ore sold in 1870, at from 2½ to 3 kopecks per pood, being equal to from 3s. 11d. to 4s 8d. per ton; so that the copper is made for 47*l*. 5s. per ton. The Oural Mountains yield, beside copper and tin, gold, silver, lead, sulphur, chrome ore, diamonds, jasper, marble, alabaster, talc, and steatite.

Spain was the great source of the supply of metals for the Romans, as well as for their rivals, the Carthaginians. Ancient mines have been discovered in the Spanish peninsula, some of which have been resumed with profit. Veins of copper and of tin, as well as deposits of lead, of iron, and of antimony, await the industry of the Spaniard, whenever the good time shall arrive when Spaniards become industrious.

In the Alpine districts, Piedmont is rich in metalliferous strata. The Val d'Aosta is rich in copper pyrites, as the Val d'Anzasca is renowned for gold pyrites. The mountains which water the Gulf of Genoa, are rich in copper. The hills of Modena, famous for their quarries of Carrara marble, contain copper as well as iron, lead and silver. In the north portion of Tuscany are found veins of argentiferous copper. From the mines of Campiglia the bronze of the ancient Etrurians is said to have been derived. In fact the whole western slope of the Apennine chain, running to the south-east from the shore of the Gulf of Genoa, is rich in metalliferous strata. The silver which formed the materials for the famous carriage of Syracuse, was derived, it is thought, from the Calabrian Apennines. From this hasty glance at the regions whence much of the metal used in the bronze period must have been derived, indications may be grasped which the advance of physical geography will convert into positive sources of knowledge. It would seem that copper, like gold, existed in a virgin state, and that the native lodes and the richer ores were successively exhausted, until the ore became too poor to repay the rude process of the ancient smelter. It also appears clear that, in certain places, as at Sidon and in the Oural, tin is even now found in close proximity to copper. In other places calamine, or zinc ore, is found near copper lodes. We infer that both bronze and brass were thus, in the first instance, the natural products of certain rich lodes or ores. As these, in the long lapse of time that preceded the use of iron, became exhausted, commerce, taught by metallurgy, sought the rarer metal, tin, in those spots whence it is now derived.

THE ALTITUDE AT WHICH MEN CAN LIVE.

There has been a great deal of discussion, says *Chambers's Journal*, as to the altitude at which human beings can exist, and Mr. Glaisher himself can tell us as much about it as anybody. In July, 1872, he and Mr Coxwell ascended in a balloon to the enormous height of 38,000 ft. Previous to the start, Mr. Glaisher's pulse stood at 76 beats a minute, Coxwell's at 74. At 17,000 ft. the pulse of the former was at 84, that of the latter at 100. At 19,000 ft. Glaisher's hands and lips were quite blue, but not his face. At 21,000 ft. he heard his heart beating, and his breathing became oppressed; at 29,000 ft. he became senseless; notwithstanding which the aeronaut, in the interest of science, went up another 8,000 ft., till he could no longer use his hands, and had to pull the strings of the valve with his teeth. Aeronauts who have to make no exertions have, of course, a great advantage over members of the Alpine Club and those who trust their legs; even at 13 000 ft. these climbers feel very uncomfortable, more so in the Alps, it seems, than elsewhere. At the monastery of St. Bernard, 8,117 ft. high, the monks become asthmatic, and are compelled frequently to descend into the Valley of the Rhone for—anything but a breath of fresh air; and at the end of ten years' service are obliged to give up their high living, and come down to their usual level. At the same time in South America there are towns, such as Potosi, placed as high as the top of Mont Blanc, the inhabitants of which feel no inconvenience. The highest inhabited spot in the world is, however, the Buddhist cloister of Hanle, in Thibet, where 21 priests live at an altitude of 16,000 ft. The brothers, Schlagintweit, when they explored the glaciers of the Ibi-Gamin in the same country, encamped at 21,000 ft, the highest altitude at which a European ever passed the night. Even at the top of Mont Blanc, Professor Tyndall's guides found it very unpleasant to do this, though the Professor himself did not confess to feeling so bad as they. The highest mountain in the world is Mount Everest (Himalaya) 29,000 ft., and the condor has been seen "winging the blue air" 500 ft. higher. The air, by the bye, is not "blue" or else, as De Saussure pointed out, "the distant mountains which are covered with snow would appear blue also;" its apparent colour being due to the reflection of light. What light can do, and does, is marvellous; and not the least is its power of attraction to humanity.

ENGINEERING TWO THOUSAND YEARS AGO.

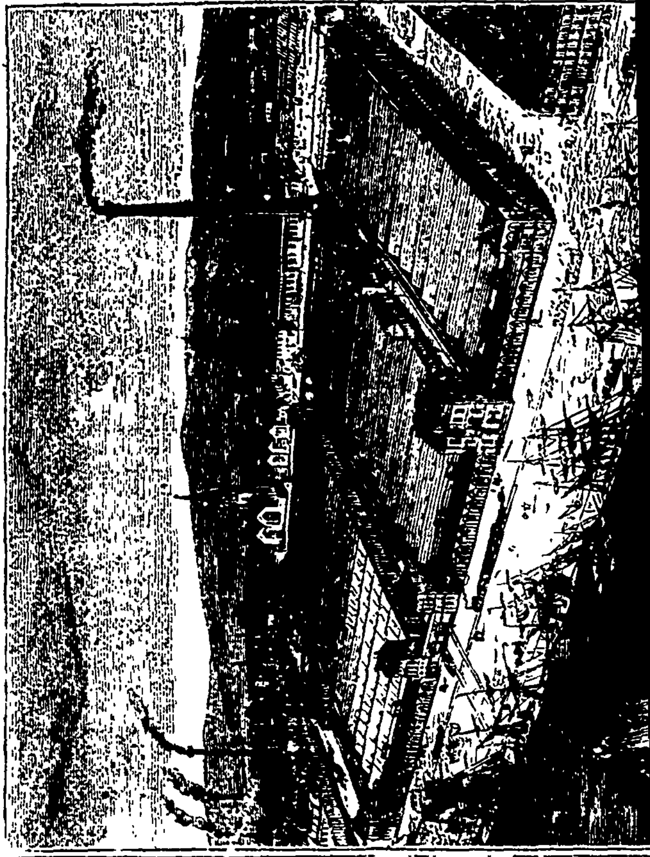
Perhaps some of the most remarkable remains of ancient engineering are those which were discovered by excavations made some ten or twelve years since, a short distance from Rome, and near the ruins of the ancient city of Alatri. This city was surrounded by massive walls, and located on a mountain, or elevated point, and ill provided with water. About 150 years before Christ, as we learn from a Roman inscription, an immense aqueduct was built to bring water from a neighboring mountain better supplied with that element. We are furthermore told that this aqueduct was 340 feet high, supported upon arches and provided with strong pipes. The topography of the country, moreover, assures us that the water supply could not have been conducted into the city, even over such high supports, except by pipes—as inverted siphon—the lowest point of which must have been some 340 feet below the point of delivery, or under a pressure of at least ten atmospheres, 175 lbs. per square inch.

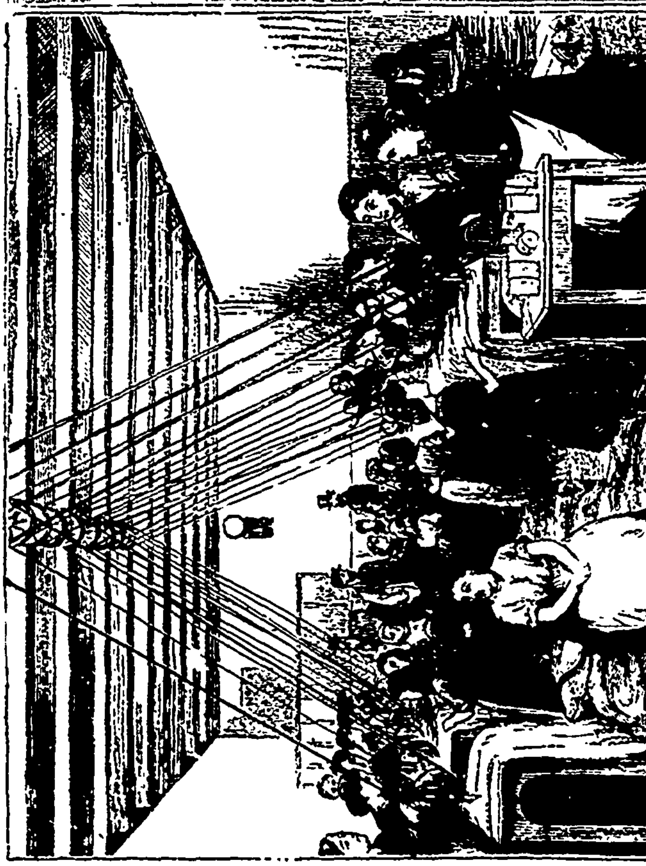
The excavations already alluded to show that the aqueduct must have been of large size, as the piers of the arches are not less than 5 feet 9 inches in breadth, while the total length of the siphon must have been between four and five miles. The question naturally arises: How, and of what material, was this syphon built? As iron pipes of large dimensions, if of any dimensions at all, were not known at that era, we can look only to masonry or woodwork for the material of such construction Possibly a clue has been found to the mode of their construction by a subsequent discovery, near the same locality, of a field, supposed to have been the site of an ancient parade ground near this old walled city of Alatri. A complete system of underground drains has been revealed at a depth of about 7 feet below the surface of the field, effected by a well constructed system of pipes made of fire clay, each about 18 inches in diameter. It is possible that such a pipe, of larger dimensions, and strengthened on its exterior by a strong and massive bulwark of masonry, may have been the means of conveying the water into the city. But however that end might have been attained, the work was certainly a most wonderful feat of engineering, considering the condition of the mechanic arts of that early day The excavations and discoveries thus brought to light, and so fully confirming the truth of the ancient inscription, were conducted by order of the present Pope, and under the immediate supervision of the well known Italian scientist, Father Secchi.—*Iron.*

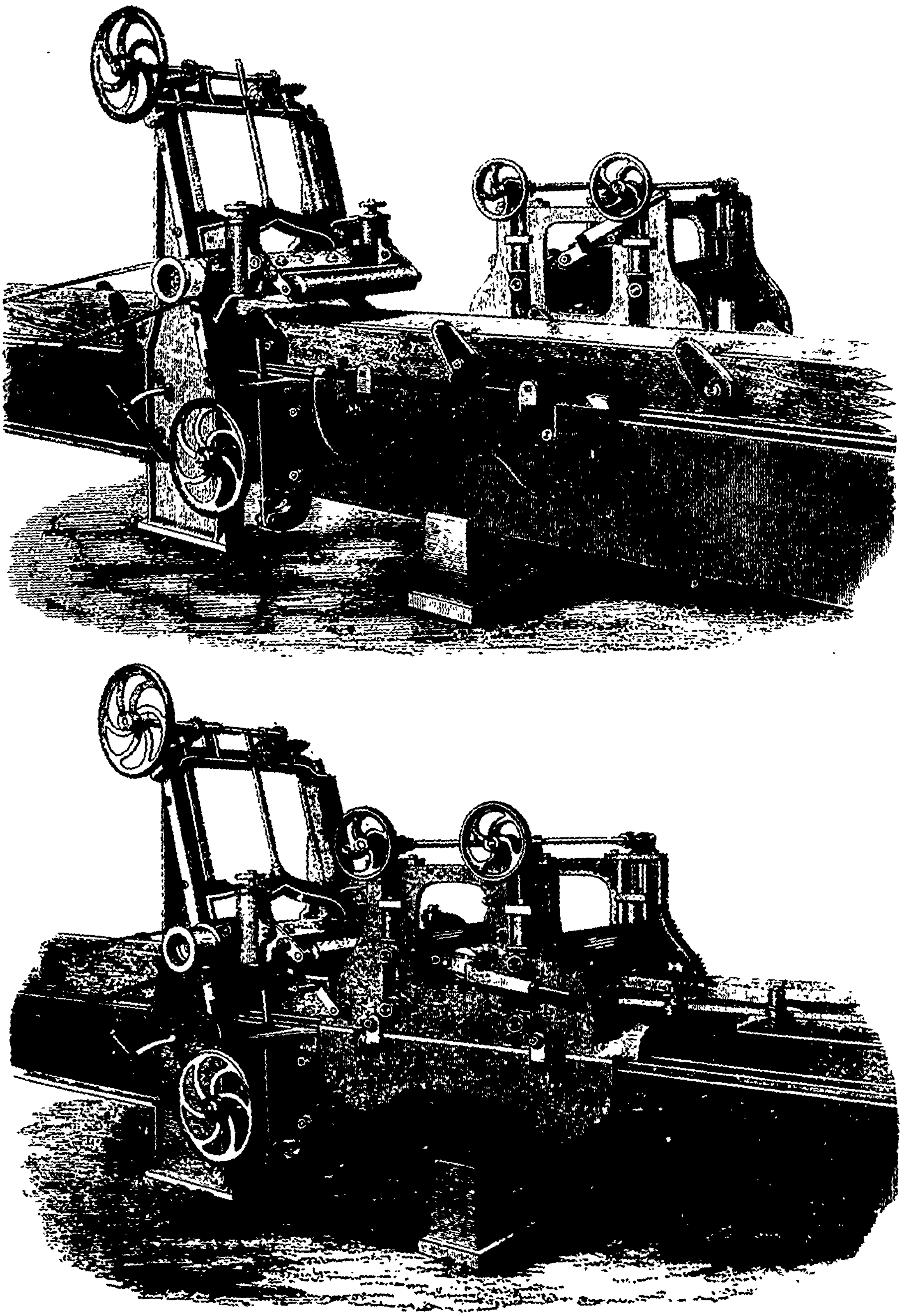
The miners lately on strike at Vale Colliery have accepted the reduced wages and will go to work. The miners at the Albion mines have accepted the reduction provisionally and go to work under protest, they having agreed to submit their grievances to Mr. Coxon, director of the Halifax Company. The strike still continues at Drummond, Acadia and Black Diamond Collieries.

TRYING-UP AND FOUR-CUTTER PLANING AND MOULDING MACHINE.

We illustrate on page 185 from the *Engineer*, a new wood planing and moulding machine justi ntroduced by Messrs. Wm. Furnese and Co., wood-working machinists, Globe Ironworks, Liverpool, for the combined purposes of dimension laninpg. or trying up, and planing on all four sides, timber of any length, and up to a width and thickness given. In our first illustration, the machine is shown adapted for trying-up or planing perfectly level and out of winding, a piece or pieces of timber up to 20ft. long. 20in. wide, and 16in. thick. This is done in the ordinary way by revolving horizontal cutters, driven by two bands, noe on each side of the machine thetable with the timber travelling under the cutters at the desired rates of feed, a quick return motion being provided for bringing back the table. The novel of part the machine consists in the feed works, which are here shown to be behind the table. These feed works are formed of four calender rollers powerfully geared, between which works the bottom cutterhead driven from a countershaft fixed to the framing of the machine. The side cutter-heads are in advance of the second pair of feed rollers, an^d are also part of the feed works. One side cutter-head is a fixture, and the other is worked in or out on slides by means of a screw. It will thus be seen that the feed works comprise the feed rollers and necessary driving gear, bottom and side cutter-heads, and pressure rollers, &c. The whole is carried by four grooved friction rollers, running on two turned rods supported by the framework of the machine and a bracket at the back. When it is desired to use the feed works for tongueing and grooving, moulding, or planing all four sides of the timber at once, the table of the machine is run forward till the end is almost under the top cutter-head, when the feed works can be easily drawn a cross the frame-work of the machine, as shown in our second illustration. It fixes itself in V slides, and the hands for bottom and side cutter-heads having been placed on their res pective pulleys—which are fixed on the ends of the spindles, so that no lacing or fastening is required —the machine is ready for work. It will work any size of timber up to 4in. thick and 12in. wide. By the removal of the side cutter-heads, which is a very simple operation, surfacing or panel plaiuing can be done by the top cutter-head alone up to 20in. wide. A very important feature of the machine is the rapidity with which the feed works can be removed when the machine is required for trying-up purposes, about five minutes being required. A great advantage, and worthy of attention, in this combination of two efficient machines, is that they only occupy the same space as one machine, and only require one pulley upon the shaft of the mill to drive them.







TRYING-UP AND FOUR-CUTTER PLANING AND MOULDING MACHINE.

MISCELLANEA.

The Cunard Steamship Company control a merchant-marine nearly twice as large as the German Imperial Navy. Their fleet consists of 49 steamers of 60,000 tons, and of 15,000 horse power. They shipped and discharged throughout last year 42,000 sailors, and employ on the average about 6000 men. The German Imperial navy consisted last year of 41 steamers of 37,000 tons and 6600-horse power, manned by 3500 men and boys.

A Singular incident occured at the Bolton Iron and Steel Works on Thursday. About three o'clock in the morning, while the works were in full operation, it was found that the ordinary supply of water for cooling and steam generating purposes had suddenly stopped. Efforts were vainly made to ascertain the cause, and, as the water in the boilers was getting low it was deemed advisible to allow the furnaces to cool. One of the officials of the Corporation Waterworks department was sent for, and upon his taking off the iron lid of one of the large water meters he was startled by a large eel, bounding out of the meter upon the floor. The eel, which measured 2ft 8in long by 9in. in circumference, had, it is supposed, got into the mains from the Heaton reservoir, and had made its way through a 4in. supply pipe into the meter. The works were stopped for a couple of hours by this incident.

The curators of the Anatomical Museum of the *Jardin des Plantes*, in Paris, have found that spirits of turpentine is very efficacious in removing the disagreeable odour and fatty emanations of bones or ivory, while it leaves them beautifully bleached. The articles should be exposed in the fluid for three or four days in the sun, or a little longer if in the shade. They should rest upon strips of zinc, so as to be a fraction of an inch above the bottom of the glass vessel employed. The turpentine acts as an oxidising agent, and the product of the combustion is an acid liquor which sinks to the bottom, and strongly attacks the bones if they be allowed to touch it. The action of the turpentine is not confined to bones and ivory, but extends to wood of various varieties, especially beech, maple, elm, and cork.—*Scientific American.*

A Large Gasometer.—The new gasometer of the Boston Gaslight Company, now building in Swett Street, will be the largest lifting gasometer in the world. The iron tank receiving the gas will be 200 feet in diameter and proportionately high, and will not be covered over with a brick structure, as is usual in this vicinity, but will be fully exposed to sight so far as it rises above the water in the reservoir.

An Oil Flood.—The tunnel through which the Southern Pacific Road will pass out of and into San Fernando valley, Los Angeles county, will be nearly a mile in length, and will run through a range of hills out of which coal oil is constantly oozing. Experienced old miners are confident that the tunnel will tap so many small veins of oil that a considerable quantity of crude petroleum will run steadily from its mouth.

Coal in India.—The coal lately discovered on the Dehra Ghazee Khan frontier is not so plentiful as was expected. The Government geologist reports the coal to be good, but says that though the seams extend for several miles, they are not thick enough for remunerative working. Coal boring operations on the banks of the Godavery, in the Nizams' dominions, have been attended with very promising results, and there seems every prospect that large deposits of coal will be discovered.

Improvements in the operation of welding copper are claimed by Messrs. Rehbein, Roberts and Brocchus of Baltimore, United States. The two pieces of copper to be united, having previously been prepared, so that the surfaces form a lap or other suitable joint, prepared borax (biborate of soda) is applied on and between the surfaces of the joint, which are heated and hammered. The borax is prepared by being heated until all the water of crystall sation has evaporated, when the residuum is pulverised for use. After being hammered while hot, the joint is futher heated to a white heat, and sprinkled over with a chloride, magnesic, sodic (common salt) or other equivalent compound, suitable for the exclusion of the oxygen, and then finally welded, or during the welding operation a stream of chlorine gas may be directed upon the heated copper joint.

A beet-root sugar manufactory is talked of for Georgetown.

The Bessemer Steel Works of A. Meier and Co., St. Louis, has a capital of $1,000,000. The property embraces 100 acres of land. There will be two blast-furnaces each 50 feet in height 17 feet at the boshes, and 30 feet at tunnel head. The works are expected to be in operation early next year, and will employ 250 hands.

An extraordinary account has appeared in a French agricultural journal, to the effect that straw forms admirable lightning conductors. It had been observed that straw had the property of discharging Leyden jars without spark or explosion and some one in the neighbourhood of Tarbes had the idea of constructing lightning conductors, which were formed by fastening a wisp or rope of straw to a deal stick by means of brass wire, and capping the conductor with a copper point. It is asserted that the experiment has been tried on a large scale around Tarbes, eighteen communes having been provided with straw conductors, only one being erected for every sixty arpents, or 750 acres, and that the whole neighbourhood has thus been preserved from the effects, not only in lightning, but of hail also. The statement comes from a respectable source.

Among the most singular sources of industrial production in the world are the leech ponds of Holland. Most of these are owned by a regular organized company. The marshes of the land, "which, if moored to its shore," are admirably adapted to the unlimited cultivation of the leech; and the trade in them is larger than is examined. A good fat leech, of powerful suction, is not a thing to be contemned. Brockklein is the town most interested in this strange trade, and owns stock in the company mentioned above to the amount of 1,000,000 florins, and an immense reservoir has been constructed in which to breed millions of voracious leeches, fine brown-backed fellows, warranted to hold on like aquatic bull-dogs. The leech deposits its eggs from May to September, in the mud of shallow waters, from whence they are taken and transferred to artificial ponds constructed expressly to hatch them. What will make the experiment a profitable one is the fact that the demand for leeches has of late years exceeded the supply. The marches and streams of Central and Southern Europe are nearly exhausted. The Dutch leech is superior to the Swedish, which is now most generally used. The American species used here comes principally, we believe, from Pennsylvania, where many hundred thousand are caught annually.

How to Soften Hard Putty.—A correspondent of the *Garden* says:—After many trials, and with a variety of differently shaped tools with various success, I at last accomplished my end by the simple application of heat. My first experiment was with a soldering iron, when, to my great delight, I found the putty become so soft that the broken glass could be removed by the fingers and the putty be easily scraped away. All that is required is a block of iron about 2½ in. long by 1¼ in. square, flat at the bottom, and drawn out for a handle, with a wooden end like a soldering-iron. When hot (not red) place this iron against the putty or flat on the broken glass, if any, and pass it slowly round the sides of the square. The heat will so soften the putty that it will come away from the wood without difficulty. Some of it may be so hard as to require a second application of the hot iron, but one experiment will give sufficient instruction to meet all difficulties.

An interesting experiment, says *Nature*, was recently made by MM. Bertrand and Mortillet, directors of the St. Germain's Museum in the Champ de Manœuvre. The war implements constructed from designs of Trajan's Column were tested, when it was found that the catapult threw arrows a distance of 300 yards The mark was hit regularly each time up to 180 yards The same can be said of the *onager*, which sends stones to a distance of 180 yards with astonishing precision, although weighing 1½. The initial velocity was calculated to be more than fifty metres per second, as the time taken to reach the mark is not more than seven seconds, and sometimes less than five. All these apparatus are to be tried at a public exhibition to be given in the beginning of next October. We may add that elaborate descriptions of the catapult, ballista, &c., may be found in "Rollins' Art of War." From experiments which we have ourselves carried out it would appear that the catapult was a powerful engine of destruction superior in many respects to the earlier cannon.

ANCIENT HOUSES IN ENGLAND.

Our illustration on page 188, represents some old houses at Weobly, in Herefordshire, England.

The place is inconveniently situated for trade, the nearest railway station being nine miles off; the streets are lifeless and grass-grown, and abound with small houses and remains of houses of very ancient date. Some of these structures are in the very last stage of dilapidation and ruin, and a few are tenantless. Here and there a window is seen little larger than one's palm, and door ways 5 ft high, that one must stoop to enter. Some parts of the town irresistibly remind the spectator of the extraordinary pictures seen in very ancient illuminated MSS. The town is now fast being pulled down and modernised so that shortly many of the ancient structures will be no more. Already in the middle of the town a number of houses have been levelled with the ground and replaced by structures resembling those loved by the little jobbing builders of the outskirts of London. Nothing but a visit to the town can give an adequate idea of its very ancient aspect, the extreme smallness and ruinous state of its houses, and its evident antiquity.

TOURNAY CATHEDRAL.

Belgium does not possess a finer example of Gothic architecture than the choir of the cathedral at Tournay, and it is strange that so very little should be known as to the history of this very remarkable work; even the date of its erection is involved in doubt. Hovelant, a local historian and archæologist, says that this choir was commenced in the latter part of the eleventh century! Schayes, that it was begun in 1100, and completed in 1242; Kugler, that it was completed in 1338. Now none of these dates are in accordance with the architecture of the building, which, from the great similarity it bears to the choir of the cathedral at Beauvais (erected 1240-1250), is probably a building of the latter half of the thirteenth century. There is no probability of the Belgian church being of an earlier date than the French one, because if we compare contemporary buildings in the two countries we find that the French were half a century in advance of the Belgians. The choir of Tournay Cathedral is so far superior in point of detail and construction to anything else in Belgium, that it may be doubted whether, after all, it was not the work of a French architect. There is an entire absence of that heaviness of detail and clumsiness of construction so apparent in Belgian buildings of the thirteenth century, nor are any of the "building" contrivances by which the Mediæval builders in Belgium overcame their difficulties to be seen in this church Here the arches set down properly on to the capitals, and the capitals are set properly on the shafts or columns, and the whole work seems to have been carefully set out before it was erected, a thing not to be found in any other early church in Belgium.

The choir of Tournay is of grand dimensions; it contains seven bays in length, exclusive of the apse. The asiles are very large, and have shallow chapels opening into each bay; the entire length, exclusive of the lady-chapel at the east end, is 190 ft.; the height to the vaulting, 111 ft.; and the width, exclusive of the chapels, 100 ft. The arrangement of the chevet is singular: the centre compartment alone opens into a chapel, the other four compartments are bowed out into apses. The effect of this is to give great space in the part of the aisle which surrounds the high altar; and as this space is available for congregational purposes, it is a remarkably good arrangement for High Mass and other grand ecclesiastical functions, especially when, as is the case at Tournay, there is a very solid rood-screen at the west end of the choir.

With the exception of Beauvais no more daring exploit in the way of construction was ever attempted in the middle ages than the erection of the choir of Tournay; of course it was too daring. The Gothic architects succeeded in supporting a stone vault upon the smallest possible substructure, but they could not succeed in supporting it upon nothing, and hence we find that at Beauvais they were obliged to subdivide the arches and add supplementary piers, and at Tournay the buttresses have had to be enlarged, and the whole building tied up with iron rods. It is said that these ties were not added till the time of Louis XIV; but fractures and settlements seem to have taken place even before the work was completed, for in one of the small apses, forming the chevet, a window is about 8 in larger at the bottom than at the top. No settlements, however, seem to have taken place lately, and the opening of the triforium some thirty years ago, which had been blocked up during the last century, has had no bad effect upon the stability of the building, while it has added greatly to its beauty. There are several peculiarities in the design of this choir which we will now point out. In the first place, the piers are not arranged like columns, but are placed with their axes at right angles to the choir like buttresses. Secondly, the triforium, instead of being arranged as a continuous arcade or a series of arches equally subdivided, consists of two Gothic openings of lights each, with a smaller opening of one light between them. This centre light, in addition to being much narrower than the other openings, is also lower, and the large space above it is pierced by two cusped circles. In the apse, where the compartments are narrower than at the sides of the choir, this central opening is omitted. And thirdly, the clearstory windows, which are very high and lofty, are also singular: they are of three lights, and as the two outer lights are made to coincide with the larger openings of the triforium below, and the centre light with the smaller central opening of the triforium, the centre light is very much narrower than the two outer ones. Outside the effect of this is not satisfactory, but internally, the stained glass has been skilfully arranged so as to subdivide the two larger lights into three compartments each, and thus the awkward look has been avoided.

This choir has been well restored. None of the furniture is old except the rood-screen, which is a magnificent example of early Renaissance work, constructed of marble and alabaster, and covered with sculpture. The high altar is composed of white marble and bronze gilt, and was brought from the now-destroyed church of St. Martin. It is poor in design, and although its material is costly, it looks mean and undignified. The stalls, bishop's throne, and side-screens are all unworthy of this noble choir; in fact, the whole of the furniture and nearly all of the monuments were destroyed by the soldiers of the French Republic. A new altar has been put up in the lady-chapel,—it is of stone with an arcaded front, but is too poor for its position. All the windows of the choir and apse have been filled with very rich modern stained glass; and although the colours are a little crude, the windows are excellent in design, and the general effect is decidedly good. We believe these windows are by Capronier; probably a few years will take off the metallic look in some of the colouring.—*The Builder.*

THE ISTHMUS OF SUEZ.—The following interesting points in M. Ferdinand De Lesseps' communication, says *Galignani's Messenger*, deserve mention. It appears that the engineers of Ptolemy II. advised him not to cut a canal across the isthmus, because the land, being lower than the level of the Red Sea, would be laid under water; but that prince turned the difficulty by causing flood-gates to be erected at proper points, so as to keep back the waters of the sea at high tides, and those of the canal at low ebb, so that navigation became possible both ways. Now this opening, in as perfect state of preservation at certain places, according to M. De Lesseps, as it was in the eighth century, really forms part, to the extent of four kilometres, near Shaloof, of the present canal, which opens into the Red Sea by means of sluices having a fall of three metres (9ft), being the altitude of the mouth above the average level of the sea. This proves that eleven centuries ago the latter was about the same amount higher than it is now, so that the isthmus has indeed experienced an upheaval. At the time the Hebrews quitted Egypt the rock of Shaloof, the last offshoot of the Geneffay Hills, must have been entirely under water. When by the gradual rising of the land the top of this rock emerged from the water, it became covered with an accumulation of earthy or sandy matter brought by wind and tide, until a barrier was formed which could only be swept over at high water. The lakes were consequently precluded from experiencing any ebb or flow. The slow upheaval of the soil continuing, the *terra firma* of Shaloof assumed a permanent shape, and the requirements of navigation led to the idea of cutting a canal. Herodotus speaks of it as having been open in his time; this fixes its date at 450 years B.C. It was repaired under the Ptolemies, improved during the Roman domination by a supply of water from Cairo, dredged by the Caliph Omar in the seventh century, and abandoned to decay in the eighth.

High Street.

ANCIENT HOUSES IN ENGLAND.

TOURNAY CATHEDRAL, BELGIUM.—The Choir: Thirteenth Century.

ROPER'S LIFE RAFT.

It would appear that shipowners are disposed to consider the advisability of adopting life rafts in addition to boats as a means of saving life at sea. As a rule all such expedients are unwieldy, costly, and in the way on board ship; but there can be little doubt that they would prove eminently useful in many cases of sudden disaster. We illustrate from the *Engineer*, on page 192, a life raft which has attracted some attention in Liverpool, and appears to get rid of many of the objections to the use of the life raft system to which we have referred. The invention consists in placing rafts across ships above the bulwarks extending from side to side of the ship, in similar positions to that occupied by the captain's bridge. Any number of these rafts may be provided according to the size of the ship. For small vessels one raft amidships might suffice; for troop transports, emigrant ships, and ocean-going passenger steamers, there might be one in the middle, and two others close to the poop and forecastle; and it is claimed that they may be constructed of ample dimensions to provide accommodation for every person on board the largest and most crowded ocean-going ship, in whatever service employed. These rafts may be constructed of steel plates, or of wood, but an essential principle of their construction must be that they are cellular, so as to give great buoyancy. The cells may be filled with cork, or other light material, so as to secure greater buoyancy. The deck is of wood, and the raft is provided with the usual bridge fittings; it rests upon iron beams furnished with friction rollers. These beams will form the launching ways in case of need; the raft may be launched on either side of the ship, and the bulwarks are so constructed as to open to the width of the raft, and form an extension of the launching ways.

The raft is fitted with stanchions of 4ft. high all round, with an iron netting at the bottom for half that height; it is furnished with a rudder, masts, and oars, or sweeps, that are lashed to the stanchions. Round the deck of the raft are water-tight lockers accessible by screw caps that may serve as seats, and furnished with sails, provisions, water, rockets, compass, signal flags, and other necessaries for a voyage. Sockets for the masts are provided in the deck of the raft, and the iron rails that surround it are furnished with rowlocks for the sweeps. The raft will be lowered by rack and pinion, or an arrangement of friction gear. The simple action of a lever is intended to release the fastenings and open the bulwarks, and if all goes right the raft glides into the water freighted with passengers, whose weight gives it an impetus that assists it in clearing the wreck.

In the engravings, Fig. 1 is a fore and aft elevation of an ocean-going steamer, showing the positions of the rafts. Fig. 2 is an elevation of raft, showing brackets for supporting the stanchions. Fig. 3 shows one way in which the raft may be supported. The stanchions *b* carry a sliding block *c*, containing a shackle *d*, for fastening a chain passing over the wheel *e*; *a* is the beam passing from side to side of the ship and forming the launching ways. In this beam are the friction rollers, and there is a drum, round which the chain passes. Figs. 4 and 5 show part elevation and part plan of a steel raft, with a deck in two thicknesses, showing also the lockers and general mode of construction. Fig. 6 shows a raft constructed of a series of thin steel cylinders. Fig. 7 shows the raft equipped for service. A is a method of lowering, at B another method is shown; *a* is the beam, *b* the stanchion, *c* the sliding block, *d* is a plate fitting round the stanchion on deck, *e* is a piston on the end of stanchion, *r* is a hydraulic cylinder, supplied from the pump as shown, and *g* is the outlet for the water when the raft is to be lowered. The dotted lines show the bulwark let down, and the raft in process of being launched. Figs. 8 and 9 show worm and pinion arrangement for lowering; the worm is worked by the lever *f* and the hand wheel *h*; *e* is the pinion.

The raft, in case of ships foundering, would be self-floating, and in fires, or circumstances of sudden emergency, could be launched in a few seconds.

The United States Centennial Commission announces its readiness to receive applications for space in the International Exhibition of 1876, at Philadelphia. It is important that it should be known with the least possible delay what space will be required in each of the departments of the Exhibition by American exhibitors, in order that it may be determined what room can be assigned to foreign nations.

MONSIEUR MENIER'S HOT-AIR-BALLOON.

An invention for inflating captive balloons with hot air, originated by M. Menier, a Frenchman, and which has been submitted for the consideration of the Balloon Committee at the War-office, with a view to its being introduced into the army for signalling, reconnoitring, or other purposes, is now exciting a considerable degree of interest in military circles. Before, however, proceeding to describe the nature of M. Menier's invention, it may not be out of place briefly to glance at the history of hot or rarefied air ballooning.

The idea of sailing through the air existed at a very early age, and crude attempts were made to do so, the accounts of which have descended to us all more or less distorted by fiction, but passing over these traditions, we find that the first notion of a real balloon was suggested by the Jesuit Francis Lana, in 1670. He proposed "to raise a vessel by means of hollow metal balls, strong enough when exhausted to resist the pressure of the external air, but so thin as to be under such circumstances, lighter than their bulk of air." His suggestion was never attempted to be put in execution. Practically we are aware, of course, it could not have been done. Thus, singularly enough, the first thought was to raise a balloon by means of rarefied air. The introduction of hydrogen or coal gas for this purpose was of later date. Although Cavallo in 1782 made some ineffectual trials with hydrogen, he only succeeded in raising a soap-bubble. In the present paper we shall not, however, touch upon the subject of gas balloons.

Two brothers, Stephen and Joseph Montgolfier, proprietors of a paper manufactory at Annonay, in France, were the first experimentalists who actually prepared and sent up a balloon. It was made of prepared linen cloth; a fire was kindled under it, which was fed with chopped straw. In five minutes it was completely inflated, and being let go, ascended to an elevation of about a mile. No attempt was made to replenish the fire by any apparatus whilst in the higher regions, no one of course, ascending with it. The experiment was made in June 1873 A few months later Pilatre de Rosier and the Marquis d'Arlandes had the courage to undertake an aerial ascent in a "smoke" balloon, as it was then called, and after rising to an altitude of 3000ft. the two adventurers descended in safety. Two years later the unfortunate Pilatre de Rosier, and his companion, Romain, were killed by the bursting of a gas balloon, in attempting to cross from France to England. They were precipitated to the ground from a height of several thousand feet. The employment of hydrogen or coal gas for the inflation of balloons soon, however, superseded that of rarefied air, and though from time to time experiments of this nature have been made, no great development of the system has resulted. Some years ago several persons ascended from Cremorne Gardens, in a fire balloon which was fed with bundles of straw through a large aperture in the side of the furnace, and they accomplished their journey in perfect safety.

The object of M. Menier's scheme is to employ a balloon filled with hot air, in a captive condition only, as a means for obtaining observations from a considerable altitude for an army upon the line of march; and experiments are at present being instituted at the Royal Arsenal, Woolwich, with a balloon of gigantic size, which has been constructed under the supervision of the well-known aeronaut, M. Simmons, for this purpose, the paraffine lamp for heating it being, we understand, the exclusive invention of M. Menier. The accompanying sketches will give the reader an idea of the proportions of this balloon, and of the apparatus employed for heating it. In Figure 1 the general view of the balloon is given. It is nearly circular, 70ft. in diameter, the aperture at the neck being almost closed by a tin diaphragm which separates the balloon from the car, suspended 4ft. beneath, by cords surrounding the balloon. The car is of wirework, with a wooden hoop round the top and bottom, and runs upon three light carriage weeels, by means of which it can be transported from one place to another with the whole of the balloon and its attendant gear packed upon the top. The wheels remain attached to the car during an ascent. The heating apparatus, which consists of a huge paraffine lamp with a copper chimney, the whole being 25ft. high from the ground, rest upon the tin diaphragm, being supported by light girders of wrought T iron crossing the ring round the diaphragm—see Figure 2 for the girders. The furnace for the lamp, the details of which will be described presently, rests within a tin cylinder projecting beneath the diaphragm, being supported by bent rods of iron crossing the cylin der. It has four feed-pipes leading into it, and communicating with two oil cisterns suspended from the diaphragm ring, two to each cistern. The cisterns are filled from cans of oil, by means of small force pumps and a supply pipe—a waste pipe being also attached to each, leading away into an empty can. The furnace is immediately beneath the chimney, which is constructed of thin sheet copper, having a bulb at the bottom 6ft. in diameter. The chimney is divided into several portions, as may be seen in the drawing, which take to pieces, and are capable of packing into a small piece for easy transit. At the top is a head of open wirework, crowned with an asbestos mat or damper to prevent the heat striking directly upwards and burning the roof of the balloon. The substance of the balloon is French cambric, an excessively fine fabric, with a double crossed woof, so as to be impervious to the air. It is slightly heavier than the silk usually employed for balloons, but requires no preparation or dressing of any kind to render it air-tight. The furnace or burner—see Figure 2—is of annular character, constructed of copper, hollow, with a bulge round at the bottom to contain the oil. At the junction of the bulge and the walls of the furnace, on both sides, is a ring of wick—see A A. At the summit of the burner or furnace are numbers of perforations piercing into its interior. A wall or ring of metal is erected on the top to direct the flame upwards. The action of the apparatus is as follows. Upon filling the bulge with oil and lighting the wicks, the walls of the furnace are quickly heated, the surface of the oil inside being rapidly converted into inflammable gas as its body becomes hot. The gas escapes at the perforations before alluded to, and very shortly ignites outside the burner with a loud roar, continuing to burn fiercely until the cisterns are exhausted. These are, of course, replenished from the tin cans carried in the car, as previously explained. The average heat generated throughout the balloon is about 100 deg above the surrounding atmosphere, a higher temperature than that being considered dangerous for the fabric of the balloon. It has been found, however, experimentally, that a temperature of 22 deg, above the surrounding atmosphere will actually lift the balloon off the ground.

The actual lifting power of M. Menier's hot air balloon can very easily be calculated. Air when heated from 50 deg to the boiling point, viz, 212 deg., expands to the extent of 33 per cent. beyond its original bulk. Assuming then the average temperature of the surrounding atmosphere up to a short distance from the earth's surface, say 300 yards, to be 50 deg., we should expel from the balloon by heating it to 150 deg., of heat, about 20 per cent. of its original contents. Now a globe of air 1ft. in diameter weighs is nearly as possible $\frac{1}{25}$th of a pound and as Menier's balloon is very nearly spherical, its contents would weigh in pounds, $70 \times 70 \times 70 \times \frac{1}{25}$, or 13,720 lb., because the contents of spheres as directly proportional to the cubes of their diameters. Hence, by the above process we should reduce this weight by 13,720 ÷ 5 or 2744 lb. This then would be the total lifting power of the balloon, or exactly 23½ cwt., and deducting 13 cwt. for the weight of the entire apparatus, we find that 10½ cwt. is the excess of lifting power arrived at. Occupants, freight, and ballast to that extent could therefore be carried in M. Menier's balloon.

The notion of employing ballons for purposes of military reconnoitring is by no means of late origin. It has been tried with varying success on more than one occasion. The victory with Jourdan obtained over the Austrians, at Fleurus in 1794 was ascribed to the knowledge obtained of the enemy's movements by means of a balloon. Moreover, in the late American war, attempts were made to utilise balloons for purposes of military observation, but owing, doubtless to the indifference in the nature of scientific appliances possessed by the army of the North, no good results were obtained. In the year 1863 a series of experimental trials was instituted at Aldershott with a view of intercepting the movements of a brigade sent out on purpose, by placing an officer of the Quarter-master-General's Department to watch its movements from a high altitude in a balloon, but he failed in following the various manœuvres of the opposing troops. This was, however, very possibly due to the very elementary knowledge possessed by the military authorities of the heights, &c, at which bodies of troops could be distinguished. The late Franco-Prussian war has thrown an immense amount of light upon the subject of military aeronautics. Under any circumstances, M. Menier's balloon possesses the qualifications of portability and simplicity of action in a very marked degree, which qualifications we should say are a *sine qua non* in articles of war *matériel* required for rapid movements or upon the line of march. The rope employed for restraining it is of the strongest possible description, being of steel wire, and tested up to four or five times the utmost strain that will ever be put upon it.—*The Engineer.*

ON THE CARE OF CHINA AND GLASS WARE.

Very few are the causes more prolific of domestic discord than the continuous breakage of cherished crockery. To sufferers from such mishaps we commend the following practical suggestions from the Boston *Journal of Chemistry.*

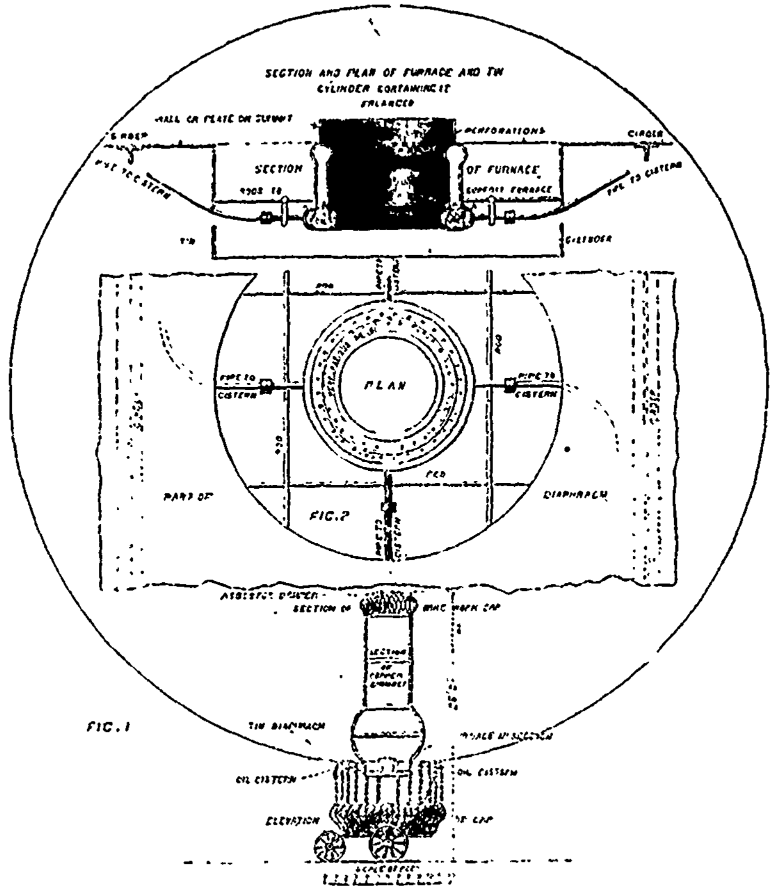
One of the most important things is to season glass and china to sudden change of temperature, so that they will remain sound after exposure to sudden heat and cold. This is best done by placing the articles in cold water, which must gradually be brought to the boiling point, and then allowed to cool very slowly, taking several hours to do it. The commoner the materials, the more care in this respect is required. The very best glass and china is always well seasoned, or annealed, as the manufacturers say, before it is sold. If the wares are properly seasoned in this way, they may be washed in boiling water without fear of fracture, except in frosty weather when, even with the best annealed wares, care must be taken not to place them suddenly in too hot water. All china that has any gilding upon it may on no account be rubbed with a cloth of any kind, but merely rinsed first in hot and afterwards in cold water, and then left to drain till dry. If the gilding is very dull and requires polishing, it may now and then be rubbed with a soft wash leather and a little dry whiting; but this operation must not be repeated more than once a year, otherwise the gold will most certainly be rubbed off and the china spoilt. When the plates, etc., are put away in the china closet, pieces of paper should be placed between them to prevent scratches on the glaze or painting, as the bottom of all ware has little particles of sand adhering to it, picked up from the oven wherein it was glazed. The china closet should be in a dry situation, as a damp closet will soon tarnish the gilding of the best crockery.

In a common dinner service, it is a great evil to make the plates too hot, as it invariably cracks the glaze on the surface, if not the plate itself. We all know the result—it comes apart; "nobody broke it," "it was cracked before," or "cracked a long time ago." The fact is, when the glaze is injured, every time "the things" are washed the water gets to the interior, swells the porous clay, and makes the whole fabric rotten. In this condition they will also absorb grease; and when exposed to further heat the grease makes the dishes brown and discolored. If an old, ill used dish be made very hot indeed, a teaspoonful of fat will be seen to exude from the minute fissures upon its surface. These latter remarks apply more particularly to common wares.

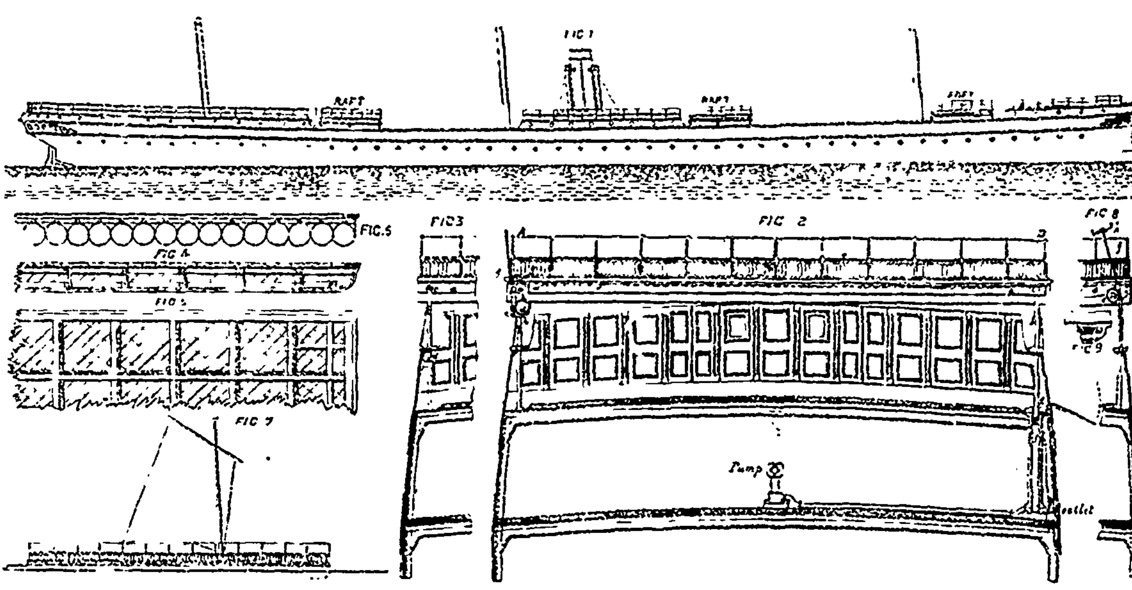
As a rule, warm water and a soft cloth are all that is required to keep glass in good condition; but water bottles and wine decanters, in order to keep them bright, must be rinsed out with a little muriatic acid, which is the best substance for removing the "fur" which collects in them. This acid is far better than ashes, sand, or shot; for the ashes and sand scratch the glass, and if any shot is left in by accident the lead is poisonous.

Richly cut glass must be cleaned and polished with a soft brush, upon which a very little fine chalk or whiting is put; by this means the lustre and brilliancy are preserved.

VICTORIA RAILWAY.—The engineering party in charge of Mr. Hogg, engaged in the extension of the Victoria Railway to Haliburton, have arrived here, after completing their preliminary line. They report very heavy rock cuttings for the first six miles, and lighter through the remainder till near Haliburton, where they met a large gravel bed. The land is very good on both sides of the line. Mr. Ross, the Chief Engineer, has been experimenting here with dualin and dynamite. It is the intention of the company to put on steam drills in their granite cuttings. The Icelanders have been paid promptly for their work, and seem satisfied with their treatment.



MENIER'S HOT-AIR BALLOON.



ROPER'S LIFE RAFT.