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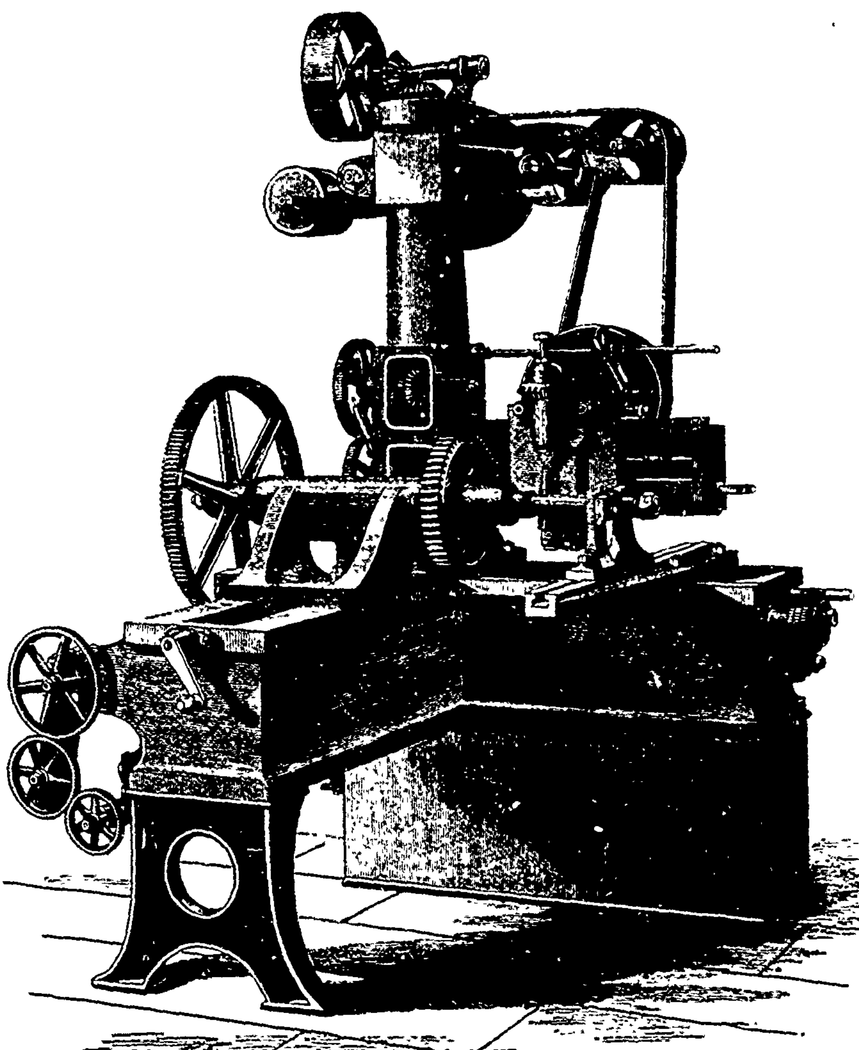


SELLER'S GEAR-CUTTING MACHINE.

SELLER'S GEAR-CUTTING MACHINE.

We illustrate, on pages 193, and 196, a gear-cutting and wheel-dividing machine, constructed by the well-known firm of Messrs W. Sellers & Co., of Philadelphia. The machine is arranged for cutting both spur and bevel wheels, and has a capacity up to 54 in. diameter of wheel, 12 in. face, while it will cut a number of small spur wheels of the same size at one time. The peculiarity of this machine is in its being entirely automatic. It performs all its work, after adjustment, without attention of workman, to the completion of the wheel being cut or divided. The division is obtained by a tangent wheel and worm in connection with a system of change wheels between the worm and the crank handle, so that the turning of the crank one, two or three times, as may be called for in connection with specified change wheels in the schedule of division, gives the number of teeth required. So far the machine is similar to many gears-cutters in common use, but in this machine the turning of the handle the proper number of times at proper intervals, as well as all other motions required, are automatic. Thus a blank wheel put in place, and the cutter adjusted to depth of cut, length of stroke of cutter head, &c., the cutter passes across the face of the wheel, cutting the space between two teeth, then returns at a quick pace to the starting side of the wheel, the blank is then turned to present a second space to be cut, and the cutter restarts its proper motion in another space, to the completion of the wheel, all without attention from the workman. While in method of dividing, speed, and power of cut, it may not differ from other well-made gear-cutters, yet, inasmuch as it loses no time between its cuts, but performs all the motions required promptly and as rapidly as possible, it is claimed by its makers to do one and a-half times the work that a skilful workman can produce on a gear-cutter operated partially by hand. In practice it has been found that one man can attend advantageously four of these machines, each machine doing more work than one hand machine, yet really using but one-fourth of the workman's time. An important feature in this machine is that the various movements required to do the work follow each other in regular sequence, each one being dependent on the completion of the motion which preceded it In our engravings we show the external appearance of the machine as arranged when cutting spur-gearing. The post A, with its projecting arm B, carrying the cutter-head C, is made to swivel or turn between its bare-plate and the cap which carries the driving pulley D, so as to set the arm B, either parallel to the axis of the wheel to be cut for spur gearing, or at an angle to it for bevel gearing. It is also adjustable to any required position on the bed. Motion is conveyed to the cutter-head spindle from the pulley D, by means of the bevel wheels to the cone pulley at top of post, and thence by belt over guide pulleys (one of which acts as a tightener) to the cone pulley back of the cutter-head, thence by bevel wheels to the spindle. The cutter-head slides back and forth on the arm B, driven by a nut on screw E, this screw is stationary, the nut only revolving, and the train of gearing, which moves the nut, or causes it to revolve, starts from the lower cone pulley, by bevel wheels, through a set of variable friction discs, to a shaft G, and by pinion G_1, through a sun-and-planet system of wheels H, to a gear wheel I, on the end of a shaft, which passes through the arm B, below and parallel to the screw, which shaft terminates in the square end (for handle) I. Spur wheels convey motion from this shaft to the revolving nut in the screw E. Upon the screw E, are two nuts K, L, which are adjustable on the screw E, and are readily clamped at any required position. These two nuts determine the length of stroke of the cutter-head, by means of a crank on the end of the screw within post A, the turning of the screw one way or the other through a small portion of a revolution operates clutches within the post, which determine the requisite motions in proper sequence. Thus the screw being stationary during the travel of the cutter through the wheel, the revolution of the nut on the screw causes the advancement of the cutter-head, we may say, towards nut L, when the revolving nut comes in contact with this stationary nut L, a tooth in the revolving nut catches with a tooth on the stationary nut L, and turns it, with it, the screw, and as both nut and screw are in consequence revolving in the same direction at the same time, the forward motion of the cutter head ceases and the rotation of the screw operates the device that is to start the next motion, namely, the running back of the cutter-head to its starting point. Here a, in it comes in contact with nut K, again ceases its lateral motion, and imparts a rotary motion backward to the screw, stopping the driving machinery last in operation, and putting in motion the machinery that turns the blank to present the next space to be cut; the completion of this last operation restarting the cutter into the work. Through the centre of the column A, is a vertical shaft which revolves continually in one direction The bevel wheels shown at M, are (by means of a clutch) held from turning, allowed to run loose, or are driven by the vertical shaft as required. We have mentioned the system of sun-and-planet wheels at H; the planet wheels are attached to a face plate N, this face plate to one of the bevel wheels at M. When the bevel wheels are held stationary, the sun wheel in the centre drives the outer wheel H, and thence the feed. If the bevel wheels run loose the feed stops, as there is no longer a point of resistance to drive it.

If a rapid rotation be given to the bevel wheels, they will drive the planet wheels around the centre one, and thus impart a rapid motion to the nut or screw E, to carry the cutter back to its starting point; but when it has reached this point the wheels M are cut loose from this driver, machinery is put in motion within the bed, that, by means of a crank, rack, and pinion at O, turns the crank handle P, lifting the latch Q, at each revolution. The number of turns of this handle are determined by a pin R, being placed in one or the other holes shown in the face plate, that controls a nest of gearing S. A cam on a shaft within the bed, upon the completion of the proper number of turns of the handle P, moves the clutch to clamp the bevel wheels M, and thus restarts the feed.

This completes the series of motions, a series that may have any one of its individual motions lengthened or shortened and yet not affect the others. The failure of any one to act merely prevents the next one from starting, so that no evil can result to the work being done. The devices used in this tool are, many of them, contrivances first arranged for other machines. Thus the variable friction feed T, is common to all machines built by Messrs Sellers where such a feed is advantageous; it is used on all their lathes as a turning feed, and on their drill presses and their boring machines. The sun-and-planet system is an outgrowth of their drill press feed. The stationary screw, with its nuts K, and L, was first used in their cotter drill, to enable a fixed length of stroke at a constant rate of progression possible, and the clutching device within the bed is taken from the feed motion of their planing machine. Thus devices familiar to them in other tools have been brought together and harmonized in this remarkable machine.—*Engineering.*

CASTING MIXED METAL.

When brass is ready to be poured, the zinc on the surface begins to waste with a lambent flame.

When this condition is observed, the large cokes are first removed from the mouth of the pot, and a long pair of crucible tongs are thrust down beside the same to embrace it securely, after which a coupler is dropped upon the handles of the tongs, the pot is now lifted out with both hands and carried to the skimming place, where the loose dross is skimmed off with an iron rod, and the pot is rested upon the spill-trough, against or upon which the flasks are arranged.

The temperature at which the metal is poured must be proportioned to the magnitude of the work; thus large, straggling, and thin castings require the metal to be very hot, otherwise it will be chilled from coming in contact with the extended surface of sand before having entirely filled the mould, thick massive castings, if filled with such hot metal, would be sand-burnt, as the long-continuance of the heat would destroy the face of the mould before the metal would be solidified The line of policy seems therefore to be, to pour the metals at that period when they shall be sufficiently fluid to fill the moulds perfectly and produce distinct and sharp impressions, but that the metal shall become externally congealed as soon as possible afterwards.

For slight moulds the carbonaceous facings, whether meal-dust charcoal, or soot, are good, as these substances are bad conductors of heat, and rather aid than otherwise by their ignition; it is also proper to air these moulds for thin works, or slightly warm them before a grate containing a coke fire. But in massive works these precautions are less required, and the facing of common brick-dust, which is incombustible and more binding, succeeds better.

The founder therefore fills the moulds having the slighest works first, and gradually proceeds to the heaviest, if needful he will wait a little to cool the metal, or will effect the same purpose by stirring it with one of the ridges or waste runners, which thereby becomes partially melted. He judges of the temperature of the melted brass principally by the eye, as when out of the furnace the very hot surface emits a brilliant bluish white flame, and gives off clouds of the white oxide of zinc, a considerable portion of which floats in the air like snow, the light decreases with the temperature, and but little zinc is then fumed away.

Gun-metal and pot metal do not flare away in the manner of brass, tin and lead being far less volatile than zinc, neither should they be poured so hot or fluid as yellow brass, or they will become sand-burnt in a greater degree, or rather tin and lead will strike to the surface. Gun-metal and the much-used alloys of copper, tin, and zinc, are sometimes mixed at the time of pouring; the alloy of lead and copper is never so treated, but always contains old metal, and copper is seldom cast alone, but a trifling portion of zinc is added to it, otherwise the work becomes nearly full of little air bubbles throughout its surface.

When the founder is in doubt as to the quality of the metal, from its containing old metal of unknown character, or that he desires to be very exact, he will either pour a sample from the pot into an ingot mould, or extract a little with a long rod terminating in a spoon heated to redness. The lump is cooled and tried with the file, saw, hammer or drill, to learn its quality. The engraved cylinders for calico printing are required to be of pure copper, and their unsoundness, when cast in the usual way, was found to be so serious an evil that it gave rise to casting the metal under pressure.

Some persons judge of the heat proper for pouring by applying the skimmer to the surface of the metal; which, when very hot, has a motion like that of boiling water; this dies away and becomes more languid as the metals cool. Many works are spoiled from being poured too hot, and the management of the heat is much more difficult when the quantity of metal is small. In pouring the metal care should be taken to keep back the dross from the lip of the melting-pot. A crucible containing the general quantity of 40 lb. or 50 lb. of metal can be very conveniently managed by one individual, but for larger quantities, sometimes amounting to one hundredweight, an assistant aids in supporting the crucible, by catching hold of the shoulder of the tongs with a grunter, an iron rod bent like a hook.

Whilst the mould is being filled, there is a rushing or hissing sound from the flow of the metal and the escape of the air; the effect is less violent where there are two or more passages, as in heavy pieces, and then the jet can be kept entirely full, which is desirable. Immediately after the mould is filled, there are generally small but harmless explosions of the gases, which escape though the seams of the mould; they ignite from the runners, and burn quietly; but when the metal blows, from the after escape of any confined air, it makes a gurgling, bubbling noise, like the boiling of water, but much louder, and it will sometimes throw the fluid metal out of the runner in three or four separate spurts; this effect, which mostly spoils the castings, is much the most likely to occur with cored works, and with such as are rammed in less judiciously hard, without being, like the moulds for fine castings, subsequently well dried. The moulds are generally opened before the castings are cold, and the founder's duty is ended when he has sawn off the ingates or ridges, and filed away the ragged edges where the metal has entered the seams of the mould, small works are additionally cleaned in a rumble, or revolving cask, where they soon scrub each other clean Nearly all small brass works are poured vertically, and the runners must be proportioned to the size of the castings, that they may serve to fill the mould quickly, and supply at the top a mass of still fluid metal, to serve as a head of pressure for compressing that which is beneath, to increase the density and soundness of the casting. Most large works in brass, and the greater part of those in iron, are moulded and poured horizontally.

The casting of figures is the most complex and difficult branch of the founder's art. An example of this is found in the moulding of their ornaments in relief. The ornament, whatever it may be—a monumental bas-relief, for instance—is first modelled in relief, in clay or wax, upon a flat surface. A sand-flask is then placed upon the board over the model and well rammed with sand, which thus takes the impress of the model on its lower surface. A second flask is now laid on the sunken impression, and also filled with sand, in order or take the relief impression from it. This is generally termed the cope, or back mould. The thickness of the intended cast in then determined by placing an edging of clay around the lower flask, upon which edging the upper one rests, thus keeping the two surfaces at the precise distance from each other that it is intended the thickness of the casting shall be In this process the metal is economised to the greatest possible extent, as the interior surface, or back of the casting, is an exact representation of the relief of the subject, and the whole is thus made as thin in every part as the strength of the metal permits. Several modifications of the process just described are also made use of, to suit the particular circumstances of the case. What we have said however, is a detail of the principle pursued in all matters of a similar nature In conclusion, we will give a composition for cores that may be required for difficult jobs, where it would be extremely expensive to make a core-box for the same:—

Make a pattern (of any material that will stand moulding from) like unto the core required Take a mould from the same in the sand, in the ordinary way, place strengthening wires from point to point, centrally; gate and close your flask. Then make a composition of two parts brick-dust, and one part plaster of Paris, mix with water and cast. Take it out when set, dry it, and place it in your mould warm, so that there may be no cold air in it.

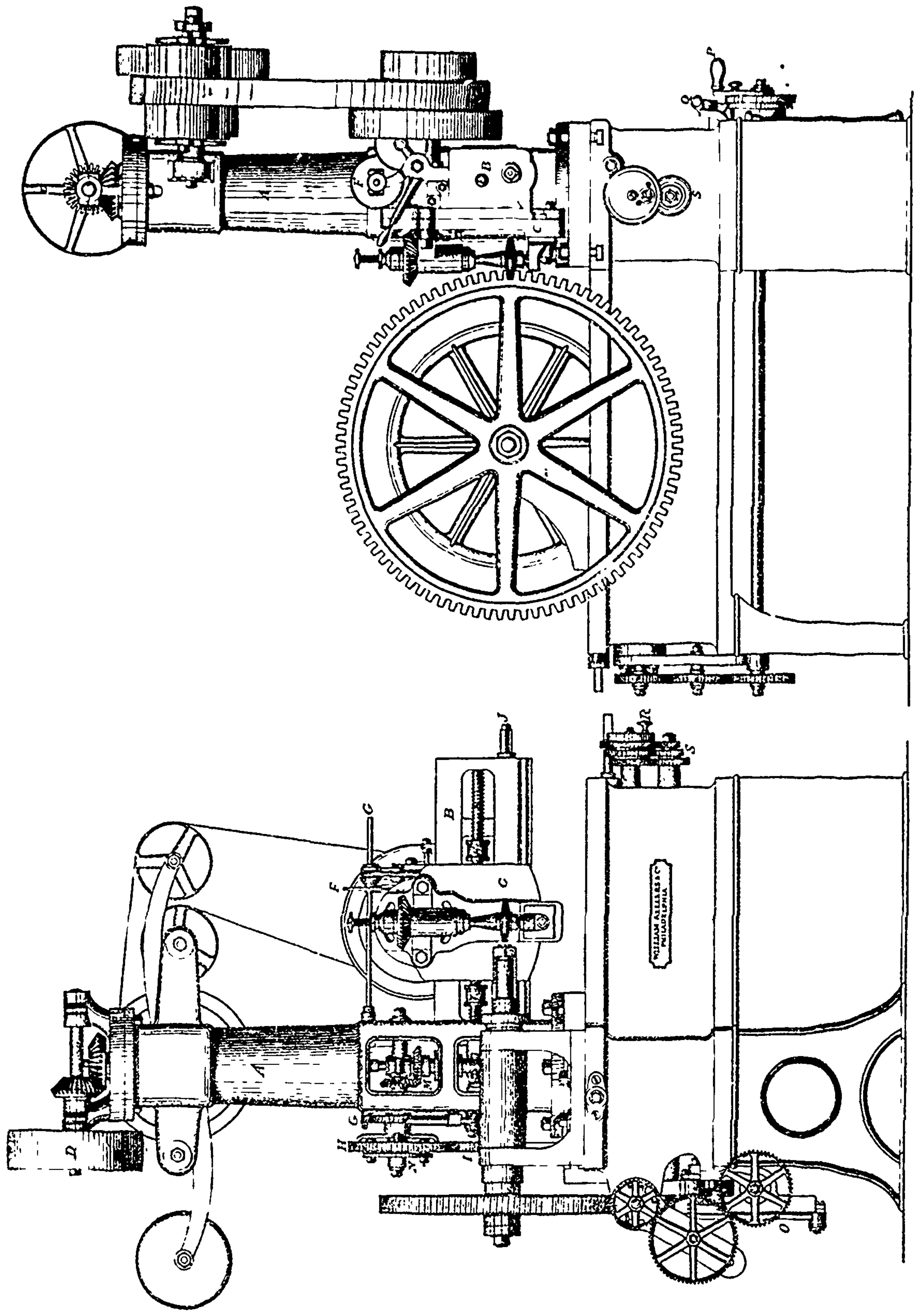
NOVA SCOTIA'S COAL PRODUCTION.

The returns received of the trade in coal during the nine months of this year ending September 30th, though exhibiting, as was fully expected, a certain decrease in the sales, do not show so great a falling off as would have been warranted by the dulness of trade. In the same period of time last year—January to September—the trade in coal amounted to 641,057 tons, this year it has amounted to 571,889 tons, being a decrease of 69,168 tons. The quantity of coal raised in the first nine months of 1873 was 763,523 tons, as against 750,746 tons this year, showing a decrease for 1874 of 12,777 tons. It must be remembered, however, in comparing these figures, that there are yet three months to run, and that the prospects of an improvement in the trade being very slight, it is likely that the decrease in the total returns for the year will be proportionately greater than it shows at present. The following statement exhibits the comparative trade for the period of nine months, by counties:—

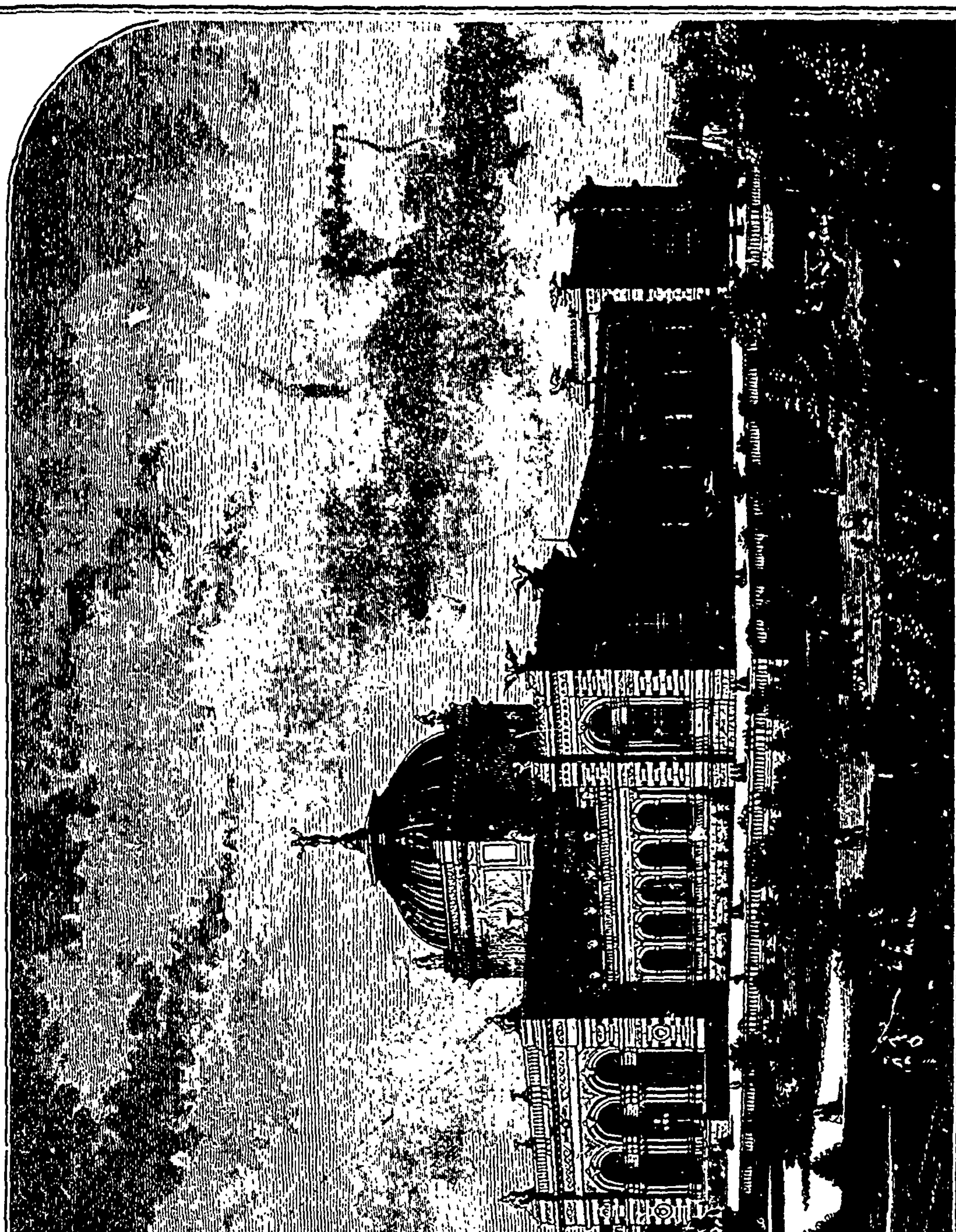
	1874.	1873.
Cumberland..........	35,151 tons.	16,835 tons.
Pictou	280,758 "	242,900 "
Cape Breton	252,812 "	381,226 "
Other counties	5,162 "	6 "
	571,889 "	641,057 "

The causes of this state of things are not far to seek. The United States, in ordinary times liberal customers, have imported this year 80,000 tons less than in 1873, and are not likely to import very much during this remaining quarter. Then the stock of coal has been large, and the consumption, reduced by the stagnation of trade, has been but small, leaving an unusually large quantity on the hands of owners. For the same reason the demand in Montreal and Quebec has been much lessened, and besides, the competition has been much closer in the little trade there was. Coal in England having gone down in price almost as quickly as it went up during the panic—misnamed famine—vessels sailing from the St. Lawrence ports to England, laden with timber, found it profitable to take return cargoes of coal, on which, carrying it even as ballast, they made a profit.—*Halifax Chronicle, Nov* 10.

The locomotive trade of the United States is in a bad condition. Work at the Grant Locomotive Works was, for the present, almost entirely suspended, October 17, about 700 men out of 850 employed having been discharged. Of the Russian order, twenty-two engines have been finished and shipped, and one of the reasons assigned for the suspension is that owing to the closing by ice of the port to which they are shipped, no more could be delivered until spring.



SELLER'S GEAR-CUTTING MACHINE



THE ART GALLERY FOR THE CENTENNIAL EXHIBITION.

THE BUILDINGS FOR THE CENTENNIAL EXHIBITION.

The Commissionners who have charge of the arrangements for the Centennial Exhibition, to be held at Philadelphia in 1876, have recently given to the public definite details of the buildings to be erected in Fairmount Park for the purpose The structures are five in number, the Main Building, the Art Gallery, and the Machinery, Agricultural, and Horticultural Halls. We publish on page 197, from the *Scientific American*, a view of the Art Gallery.

The Main Building is to be 1,880 feet long and 464 wide, covering 20.02 acres of space. The whole will consist of one floor only, except in the projections and towers, where galleries, giving additional space, will be provided, adding 1 45 acres to the available area. The great length of the building has rendered advisable the breaking of the roof lines by the addition of three transepts or cross avenues. The roof is chiefly of the height of 70 feet from the ground, the towers at the corners being 75 feet high. The central portion, 184 feet square, rises to an elevation above the rest of the building, and is surmounted by four towers 120 feet high. The central avenue will be 120 feet wide, with another, 100 feet wide, on each side of it. The passages for promenade, between the long lines of exhibited articles, will be mainly 30 feet wide.

The foundations for this structure, which promises to be admirably light and convenient, as well as graceful in appearance, are to be piers of masonry, the superstructure consisting of wrought iron columns, with roof trusses of the same material. The columns are to be of rolled channel bars, with plates riveted to the flanges, and the roof trusses are straight rafters, with struts and tie bars. The columns are to be 24 feet apart; and timber paneling, to the height of seven feet, is to be filled in between the outer colums. Above the paneling, glass sashes are to rise to the top of the building, portions of the sashes being removable for the purpose of ventilation.

The engineers and architects of the structure are Messrs. Henry Pettit, Consulting Engineer of United States Centennial Commission, and Joseph M. Wilson.

Every product exhibited in any part of the entire Exhibition will be considered as belonging to one of the following ten departments - 1. Materials in their unwrought condition, mineral, vegetable, and animal. 2. Materials and manufactures, the result of extractive or combining processes. 3. Textile and felted fabrics. Apparel, costumes, and ornaments for the person. 4 Furniture and manufactures of general use in construction and in dwellings. 5 Tools, implements, machines and processes. 6. Motors and transportation. 7. Apparatus and methods for the increase and diffusion of knowledge. 8. Engineering, public works, architecture. 9 Plastic and graphic arts. 10. Objects illustrating efforts for the improvement of the physical, intellectual and moral condition of man.

In the main building will be located portions of all of the above departments. except No. 6, which will be placed in the Machinery Hall, and No. 9, to which the Art Gallery will be especially devoted.

The departments will be arranged in parallel zones lengthwise of the building, the zones being of different widths, according to the bulk of the products exhibited in the particular department. The States and countries exhibiting will be arranged in parallel zones crosswise of the building, these zones also being of different widths, according to the amount of space required for the exhibits of each country. Between each department and each country will be passage ways distinctly marking the limit of each. The result of this dual system will be that any visitor or student, desiring to compare products of the same kind from different parts of the world, may do so by passing through the building lengthwise, keeping in the zone devoted to the particular department, and any one desiring to examine only the products exhibited by any particular country or State may do so by passing through the building crosswise, in the zone devoted to the particular country or State.

THE ART GALLERY.

is of a highly ornate design, and is intended to be the best and handsomest building yet erected on this continent for the purpose. It is to be constructed of granite, glass, and iron, and will be thoroughly fireproof. Its dimensions are 365 feet long, 210 feet broad, and 72 feet high, with a dome, surmounted by a figure of Columbia, rising to 150 feet from the ground. The Central Hall will be 95 feet long, and the Pavilions, one at each end of the building, will be 45 feet. The Pavilions will be connected to the Central Hall by arcades, each 60 feet long by 40 feet high.

The lighting arrangement, the most important point in the construction of an art gallery, appears to be thoroughly efficient. From the east and west sides of the Central Hall extend the galleries, each 98 feet long, 48 feet wide, and 35 feet in height. These galleries admit of temporary divisions for the display of paintings. The center hall and galleries will, altogether, form one grand hall 287 feet long and 85 feet wide, capable of holding eight thousand persons, nearly twice the dimensions of the largest hall in the country. From the two galleries, doorways open into two smaller galleries, 28 feet wide and 89 feet long. These open north and south into private apartments which connect with the pavilion rooms, forming two side galleries 210 feet long. A corridor 14 feet wide opens into a series of private rooms. Mr. H. J. Schwarzman is the architect, and Mr R. J. Dobbins the contractor.

HEAT WITHOUT COALS.

If there be one principle of industrial economy more firmly established, and of more universal application than another, it is that which insists on the economic advantages of a division of labour. In every department of industry we find the division of labour and its logical sequence, the specialisation of manufactures, carried out to an incredible extent and with unfailing success. Everyone is familiar with, and appreciates the results of, that minute sub-division of trades (upwards of a hundred in number), each confining itself to the elaboration of a single portion of that wondrous complex of mechanism, and marvel of cheapness—a modern chronometer; but there seems a certain reluctance in accepting in its entirely the proposition that, if any product, whether material or dynamic, is in daily requisition by a large number of individuals congregated within a small area, their requirements will be most efficiently and economically supplied, by handing over the whole business of supply and manufacture to a single individual or corporation, whose whole attention can be concentrated on perfecting the means of production and distribution. This once fairly stated seems, however, so obvious an axiom that it is unnecessary to insist on it, further than to point out, as instances of the practical embodiment of this idea, the system on which water and gas are supplied, and refuse removed in our towns. With the advantages of these forms of centralisation we are now so familiar that no one would be guilty of the folly of rejecting their use and depending on his own isolated exertions. It requires an effort even to conceive the possibility of every householder in the metropolis, for instance, being obliged to fetch his own water (or buy it at the door), to make his own gas, and undertake the removal of his household refuse independently of his neighbours. Such a state of affairs would be considered intolerable, and rightly so, by the present generation, since it has experienced the benefits of an arrangement which brings to, and distributes through, our houses light and water in a constant and automatic supply, while superfluous matter is removed with a minimum of trouble and inconvenience. In the matter of *heating*, however—a service in as universal request as a water supply—we find existing provision utterly behind the requirements of the age in every particular, and, indeed, in no better condition than they were a century, nay, several centuries, ago.

Though the home-manufacture theory has been exploded in every other department of urban social life, here it reigns supreme, and every man still may boast not only of being his own heat-manufacturer, but of having in each room, a separate factory in which the whole process is carried on—but at what a cost!

The raw material is indeed brought to the consumer's door, but in the most inconvenient form, and by a system of transport at once extravagant and inefficient; its solid condition rendering the pneumatic or hydraulic methods of distribution inapplicable, So that, in place of being able to draw at any moment from an unfailing reservoir, a supply exactly adequate to the varying requirements of the individual, it is necessary to store up sufficient for many weeks' consumption, locking up capital and wasting space, while, owing to the fluctuating character of a small consumption, one's calculations are pretty sure either to fall short of, or exceed, actual requirements.

In view, then, of the superiority of a well-arranged system of pipe-distribution, as compared with the existing primitive apparatus of coal-waggons, cellars, and scuttles (which are in a measure necessitated by the use of a solid fuel), any fuel which does not admit of being so carried should have very great compensating advantages to justify its use. The question then arises, is coal so much the best available form of fuel as to overbalance the drawbacks of want of portability, weight, and bulk, inseparable disadvantages from which a combustible gas would be free?

If it were possible to effect the complete combustion of coal, and in addition to utilise the whole of the heat produced, the thermal value of a fair average coal would be nearly, or quite, equal to that of any practicable substitute, the calorific power of hydrogen being for ordinary purposes purely illusory. But it would be Utopian to expect ever to attain to such a result on a small scale, and even with the special contrivances and constant attention which can be afforded only in a large establishment, it could only be approximated to; as it is, the use of coal in an average fireplace implies the loss of at least 50 per cent. of the total potential heat. It should be borne in mind that the heat absorbed by the products of combustion may be considered as lost for all purposes of sensible thermal effect, unless elaborate devices be resorted to for its recovery, whence it by no means follows those bodies which have the highest calorific power, have a corresponding value in the scale of fuels for domestic purposes. That the *theoretic* calorific intensity, or sensible temperature, resulting from the combustion of coal, varies between 2200 deg. and 2400 deg C., that of carbonic oxide is variously reckoned at from 2100 deg. to 2800 deg. and upwards; while that of hydrogen, owing to the high specific and latent heat of its product of combustion, and notwithstanding its higher "calorific power," is little over 2000 deg. C.; the best sorts of dried peat give a temperature fully equal to that of hydrogen, but wood has a much lower thermometric effect. It may be said that these figures show coal to have as high a value as carbonic oxide, for instance, but they represent not the actual temperatures, but only the maximum theoretical possible capabilities of the respective bodies, without making any allowance for loss, and on the assumption that the combustion takes place in the minimum of time. It is when these two factors of time and loss, which play an all-important part in the practical application of fuel, are taken into account that the palm must be yielded to combustible gases in preference to solids.

It may seem to some that an allowance of 50 per cent. is an excessive estimate of the waste of a coal fire, but far from this being the case, it is probably too low a percentage. The main causes of waste are imperfect combustion, the necessity of keeping up an excessive draught and the quantity of air required to be drawn though a coal fire to maintain its combustion. The loss under all these heads with a well arranged gas fire is almost *nil*. The loss from imperfect combustion is due; first, to the escape of volatile hydro-carbon vapours; secondly, to a portion of the carbon being burnt only to carbonic oxide; and thirdly, to the loss in coal-dust and clinker: of a total of 80 per cent. carbon, 20 per cent. is frequently lost under the first and third of these forms. A gas such as carbonic oxide, or carbonic oxide mixed with hydrogen, would be entirely exempt from the waste arising from imperfect combustion, as, owing to the mobility of its atoms, the air has free access to every separate particle of the fuel, under conditions the most suitable to promote active chemical union. This same property of mobility allows of perfect combustion taking place when only just so much air is passed through the fire as suffices to supply the exact quantity of oxygen necessary for combination with the fuel, while a coal fire requires at least double the supply of air that the chemical exigences of the fuel would call for, on account of the difficulty the air experiences in permeating the solid lumps of which the firing consists. Yet a further squandering of calorie occurs in the chimney, which has to be kept at an excessive heat to enable it to draw this superfluous bulk of air through the fire, on its way to dissipate its heat-burden in the atmosphere.

That gas produced at a distance from the furnace in which it is burnt can be substituted with the best results for the direct use of the fuel which gives rise to it, has been proved to practical demonstration by the Siemens' furnace, which is heated by gases only some 40 per cent. of which are combustible.

We have before us a proposal for heating towns by "pyrogen" gas, which consists of a mixture of nitrogen and carbonic oxide, three-fourths by weight of the mixture consisting of the latter gas. This mixture is said to have a temperature of combustion of 2700 deg C., and it is suggested it should be used to heat some good radiating substance, such as fireclay, in an ordinary grate, by which means heat would be radiated out as in the present coal fire. A fact which must always militate strongly against the use of carbonic oxide, without special precautions to prevent leakage, viz., its poisonous character, would probably render it more expedient to confine the actual combustion to a single apartment, trusting to air traversing heated pipes of *earthenware* (to prevent the possibility of carbonic oxide diffusing though) for the equable transmission of the heat through the house. One can hardly fail to speculate on the applicability of this new pyrogen to lighting as well as heating whether by making the lime-light a commercial possibility, or by the addition of a small proportion of a volatile oil, which would cause it to yield a light as bright as that of coal gas, at a much less cost. Such a consummation as that our light and warmth should be derived from the same source is indeed one to be devoutly wished for, and is in entire accord with the teachings of science.

The scheme we have alluded to is confessedly only tentative, and its author, an F.R.S not unknown in the domain of practical metallurgy, will doubtless make such modifications in his process as the practical trials about to be made may suggest.

We are chiefly concerned in pointing out in a general way the superiority of a well-selected gaseous fuel in crowded centres, and are far from adopting the defence of any particular system. The proposal more immediately under consideration appears to us, whether rightly of wrongly to be defective in the following points. The noxious properties of carbonic oxide are ignored; the proposed method of gas generation would not produce nitrogen and carbonic oxide alone, but in addition a not inconsiderable proportion of carbonic acid; no sufficient allowance is made for the absorption of heat during the vaporisation (or solution) of carbon during the deoxidation of the carbonic acid—how considerable this absorption may be, is evidenced by the decrease of temperature in that zone of the blast-furnace in which a similar reduction takes place; the heat of combustion is also probably overstated; and, finally, the suggested method of regenerating the manganese by throwing the Mn_3O_4 into water, or passing air over it, till manganic dioxide is reproduced, is, to say the least, a startling novelty. Nevertheless, we believe the vitality of the idea is strong enough to surmount the defects we have indicated, and the magnitude of the proposed revolution in practical thermics is so great that a satisfactory solution could hardly be hoped for except at the expense of numerous failures and disappointments, yet the importance of the subject may well reconcile one to its difficulties.

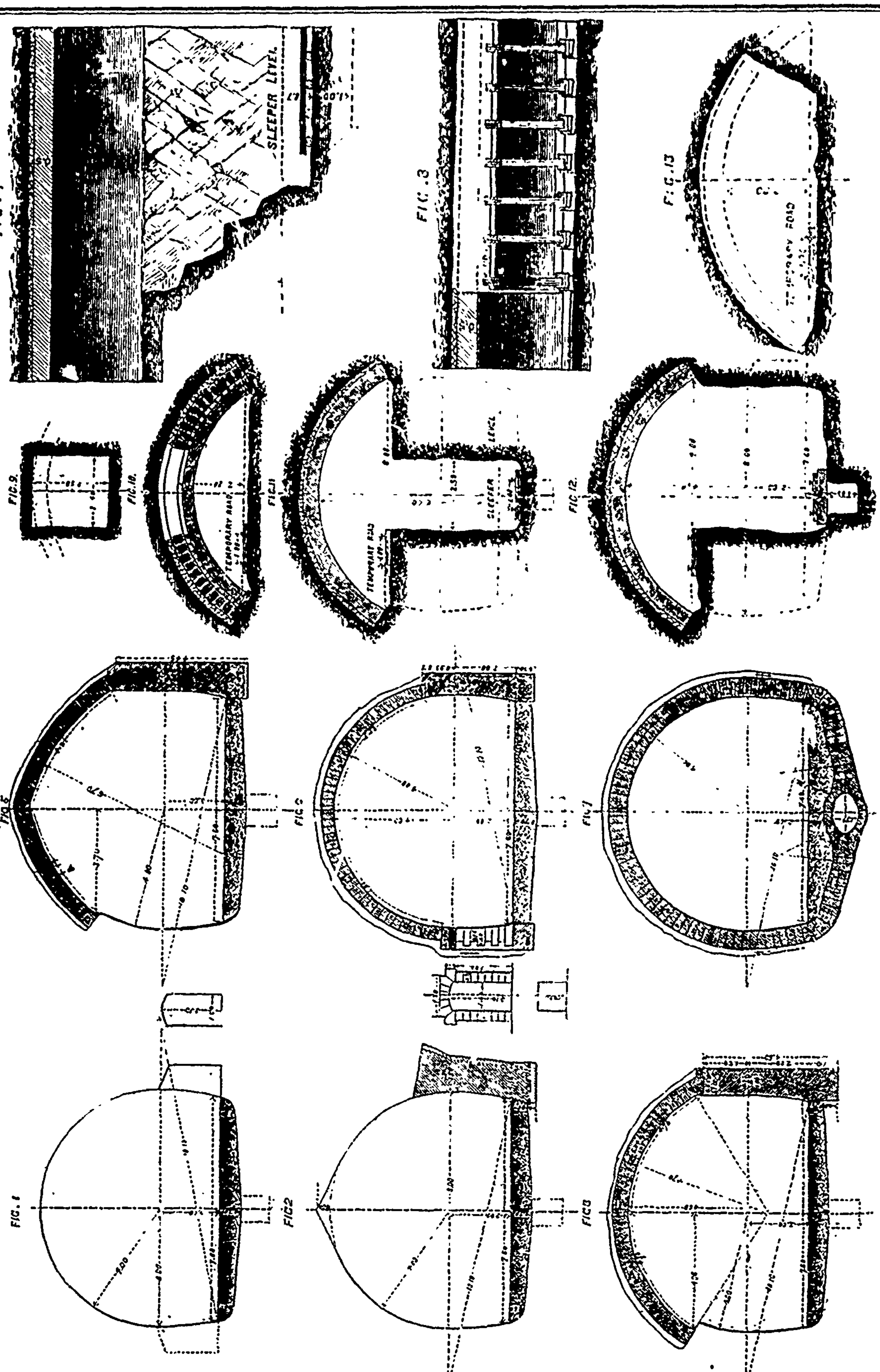
The new proposal is thus contrasted with the present system in its application to London:—

"Five millions of tons of coal (and coke) are at present carted to every man's door by means which are rude, cumbrous, inconvenient to the public, and involve a needless waste of vital and of labour. When arrived there, three fifths of it totally wasted.

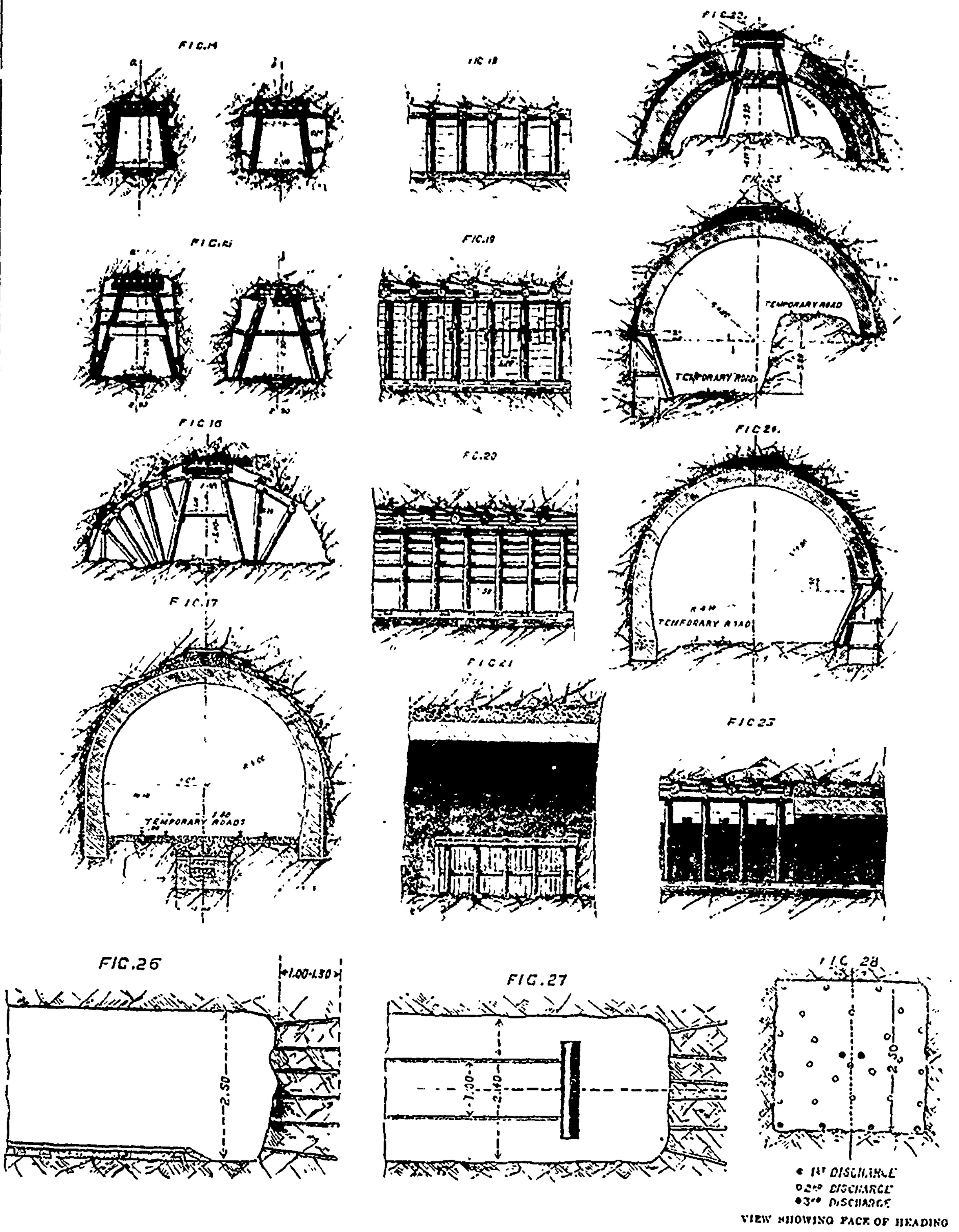
"Instead of this, not quite seven millions of tons of gas are conveyed by steam-power along what is in effect a railroad, not only to every man's door, but to every man's fire-place, and at a comparatively nominal cost.

"Every combustible particle of it, that is, two-thirds of the whole, is efficient in producing heat, which heat may be further utilised and distributed down to its lowest unit above the mean surrounding temperature, in warming and in ventilation The products of combustion, instead of poisoning the air and darkening the sky, give nourishment and vigour to vegetation, and having by it been in turn partially transformed, are evolved in the oxygen of respiration, to give fresh life and vigour to man."—*Iron*.

According to the *Scientific American*, the Canadian way of measuring a tree is said to be as certain as it is grotesque. You walk from the tree, looking at it from time to time between your knees. When you are able to see the top of a tree in this way, your distance from the root of the tree equals its height.



THE ST. GOTHARD TUNNEL.



THE ST. GOTHARD TUNNEL.

THE ST. GOTHARD TUNNEL.

When the Mont Cenis Tunnel was being made, the greatest interest was taken in the progress of the work by English engineers, and even the columns of the non-scientific journals abounded with notices of the undertaking. Much of this interest was no doubt due to the circumstance that many authorities, more or less competent, held that the difficulties which would be encountered in the construction of the tunnel would prove insurmountable. Such anticipations, as we all know now, fortunately proved groundless — the skill and inventive faculties of the engineers overcame every obstacle. The St Gothard Tunnel is, in several respects, a much more remarkable work, but no one ventures to say that it will not be carried to a successful termination, and English engineers have, possibly in consequence, paid, as we think, too little attention to what is in all respects the most gigantic tunnelling operation ever undertaken. We propose, therefore, to place before our readers a short summary of the history and progress of the work, and some details of the system of construction adopted, premising that for our data, as well as for the drawings which we publish this week, we are mainly indebted to the English edition, now regularly published in London, of the *Revue Universelle des Mines*—a very admirable publication to which there is no purely English parallel, and of which we shall probably have more to say at another time.

The St Gothard Tunnel is intended to permit the passage through the Alps of a line which shall unite the German and Swiss railway systems with that of Italy, and so facilitate communication between the north-western portions of Europe and Brindisi. The tunnel starts from Airolo, on the southern, or Italian side, and runs to Goschenen, on the northern, or Swiss side of the Alps. The total length of the work will be 9·674 miles. The line was set out by M. O. Gelpke, C. E. No direct measurements could be obtained, but the possible error in length amounts to only about 2 ft. either way. The tunnel will be approached at the Goschenen end by a rising grade of 1 in 40, on a line to be made from Altorf, on the Lake of Lucerne, by way of the valley of the Reuss. Just outside the tunnel will be a short bit of level. The line then rises at the rate of 1 in 171·8 to a point not far from the centre of the tunnel, where another short piece of level will connect the rising grade with one falling to Airolo at the rate of 1 in 1000. Then comes a short length of level on a line now in course of construction from Airolo to Bellinzona, which will establish communication with the Ticino Valley. The road will be double through the tunnel and perfectly straight, with the exception of a curve 14 chains radius and 475·73 ft. long, near the southern, or Italian end. The total length of the tunnel proper, not including the cuttings at either end, will be 14,-[illegible] metres, or 9 miles 455 yards—a length greater than that of the Mont Cenis Tunnel by about 1¼ miles. The highest portion will be 378 ft. above the level of the sea. To assist the ventilation it is proposed to construct a shaft at Andermatt, which will be about 310 yards deep, and will enter the tunnel about 3½ kilos, or 2·17 miles, from the Goschenen end. Our readers have now before them all the data required to enable them to form an adequate idea of the precise locality and purpose of the tunnel, and we may now proceed to glance at its history before giving details of the method of construction employed.

On the 10th of October, 1871, an international association was formed to supply what is known as the St. Gothard Company with the funds they required for the construction of the tunnel. The capital was fixed at 102,000,000 fr, or £4,080,000. Of this, £1,360,000 was raised by shares, and the remaining £2,720,000 by bonds. The International Association consisted of three groups, that of Germany, which found 34,000,000 fr, that of Italy, which supplied 34,000,000 fr., and that of Switzerland, which furnished the remaining third. The groups consisted solely of bankers and finance companies, and among the names may be found such houses as Rothschild, Oppenheim, &c., &c. The final formation of the St. Gothard Company was completed in December, 1871. The primary surveys had, however, been made by Mr. Gelpke as early as 1869. The final staking out of the ground — a work of great difficulty, as may be imagined when we state that no fewer than fifteen stations were required, many of them in situations all but inaccessible — was satisfactorily accomplished. The work was begun at both ends, and the lines met with an error of but 4 in. in the middle, which we regard as a triumph of trigonometrical surveying, bearing in mind the difficulties to be overcome. It was finally decided that the dimensions of the tunnel should be nearly identical with those of the Mont Cenis Tunnel. The height to the crown of the arch is to be 6 metres, or 19·68 ft.; maximum width, 8 metres, or 26·24 ft., and minimum width, 21·94 ft. Various systems of construction are adopted according to the nature of the ground.

The work were let by contract to M. Favre, of Geneva, in the summer of 1872. Seven tenders were received. Of these, two were withdrawn; a third did not supply satisfactory information as to the system of construction the contractor proposed to adopt; and of the remaining four, two were struck off the list. Only two competitors remained — M. Favre and the Italian Company of Public Works; but the latter required nine years to make the tunnel, and M. Favre only eight, and whereas the Italian Company would only forfeit the caution money—£320,000—if the work was not complete in eleven years, M. Favre consented to pay it over at the end of nine years. Again, the Italian Company wanted about half a million sterling more than M. Favre. The work began in June, 1872, at Goschenen, and at Airolo on the 1st of July in the same year.

We have no intention at present of doing more than sketching the history of the work, and the method of its execution. We must refer our readers to other sources of information for details of the monthly progress and the geological features of the strata pierced. It will suffice at the moment to describe briefly the methods of working adopted. The rock to be pierced consists at the Goschenen end for the most part of a hard granitic gneiss, much fissured, but free from water. At the Airolo end, gravel, sand, and pebbles were first met with, and then yellow limestone. Gypsum, talc, and mica-schist were also found; finally a dolomite. This did not last, however, and at about 286 ft. from the end a bed of schist was pierced, which discharged torrents of water, and was only traversed with the utmost difficulty. Our illustrations show, as we have said, the methods adopted in dealing with the strata pierced through. It need hardly be said that the work is carried on by drilling holes by machinery worked by compressed air, and exploding charges of dynamite in these holes. Figs. 26, 27, and 28, annexed, show very clearly the way in which the holes are disposed. Up to the present time, or, at any rate, until very recently, the drills were worked by temporary steam engines which supplied the compressed air required; but three turbines, worked by a fall of 279 ft., will be erected at Goschenen to drive the compressers. These turbines are, we believe, by Messrs. Escher, Wyss & Co., of Zurich, and will work to 600-horse power. At Airolo three other turbines will be put down, which will each work under a head of 541 ft, to 210-horse power. Each turbine will actuate three Colladon compressers, supplying per minute 2258 cubic feet of air at seven atmospheres. Thus, in all, at least 1200-horse power can be brought to bear on the works.

It would appear that the St. Gothard Tunnel presents magnificent opportunities for the patentees of rock drills, every system of any promish being tried — McKean's, Burleigh's, Dubois and François', and others, all being used with various results. About thirty holes, a metre deep, are bored at one operation, and then charged with dynamite, and fired in the order shown in our illustration, Fig. 4, the drill-carriage being withdrawn eighty or ninety yards, and defended by a shield from flying fragments of stone. Figs. 9, 10, 11, 12, page 200, and Figs. 14, 15, 16, 17, &c., page 201, give illustrations of the progress of the works at the north and south ends respectively. These show the driving of the heading, the enlargement of the same, the turning of the masonry arch, the subsequent excavation, and the drain, and the final completion of the tunnel.

Fig. 1, is a section of the tunnel in very solid rock, without masonry lining. Fig. 2, is another section in much the same kind of rock, but it will be seen that on one side a masonry wall has been introduced, to make up for a deficiency in the rock. Fig. 3, is a section in solid fissured rock. The roof is of masonry, sometimes with and sometimes without side walls, as shown. Fig. 4, page 200, explains itself. Fig. 5, shows a section in many respects identical with Fig. 3. The rock is solid, but fissured. Fig. 6, shows the section in friable or treacherous rock, the tunnel being lined throughout. Fig. 7, is the section adopted in soft strata, liable to yield to lateral pressure. Fig. 8, page 200, shows a portion of tunnel lined with masonry. Fig. 9, is the heading. Figs. 10, 11, 12 and 13, on page 200, show the system on which the excavation proceeds, and explain themselves.

Fig 14, shows the heading timbered *a*, in moderate good ground, *b*, in fissured rock Fig. 15 shows the heading enlarged, *a*, in moderately good ground, *b*, in fissured rock. Fig. 16 shows the heading enlarged, *a*, in moderately good ground, *b*, in fissured rock Fig 16, shows the timbering of the widened tunnel *a*, and *b*, denoting ground and fissured rock, as before.

Fig 17, shows the masonry of the tunnel complete. Fig. 18, is a longitudinal section of *c*, Fig. 14. Fig 19, is the same as *a*, Fig 15 Fig 20, is a longitudinal section of Fig. 16. Fig 25, is a longitudinal section of Fig. 22, while Fig. 24, is a similar section of Fig 23 Fig. 24, explains itself. Fig. 26 page 201, gives a vertical section showing the arrangement of the shot holes Fig 27, is a horizontal view of the same, while Fig 28, gives the face of the heading. We may add that the dynamite is generally used in iron cartridge cases.

We cannot better conclude this article than by the following tabular statement, which shows the progress of the works up to January, 1874. We may add that since that date they have progressed steadily, at, so far as we can learn, about the same average rate :—

State of the Works on the 31st of January, 1874.

Description of Work for Comparison.	Northern (Goschenen) mouth. State at the end of Dec.	Progress per month.	State at the end of Jan.	Southern (Airolo) mouth State at the end of Dec	Progress per month.	State at the end of Jan	Total at the end of January.
	Linear metres.	Linear metres.	Linear metres.	Linear metres.	Linear metres.	Linear metres.	Linear metres.
Heading	600·2	72·0	672·2	596·0	51·7	647·7	1319·9
Enlargement (complete and partial) of ditto	520·0	70·0	590·0	87·0	45·0	[illegible]	[illegible]
Masonry of arch.........	—	—	—	145·0	—	145·0	145·0
" east side wall	—	—	—	101·9	—	101·9	101·9
" west " ..	—	—	—	141·6	—	141·6	141·6
" drain for carrying off the water........	—	—	—	115·3	—	115·3	115·3

Workmen Employed during the past Month.

Mean number	625	— 9	634	521	— 57	581	1215
Maximum do	732	— 46	686	581	— 31	612	1298

From a recent report made to the Swiss Federal Council it appears that, at the close of June, the contractors had completed nearly one-seventh of the whole distance. The progress made during July was about evenly balanced, but the advance on the Goschenen side was rather more rapid than that effected on the Airolo side.—*Engineering*

A Frenchman, M. de la Bâtie, has found a means of rendering glass almost malleable, and is going to start a manufactory for the working of it. He uses a particular bath whilst the glass is just on the point of fusion, by way of tempering it. This operation, without rendering the glass malleable cold, increases its strength of resistance about forty times. A 5-franc piece has been let fall from a height of two metres upon a sheet of ordinary glass thus tempered without doing it the least damage.

INCRUSTATION OF BOILERS

Those of our readers who are employers of boiler-power will appreciate at once the world of loss and trouble that is signified in the above title. To non-professional readers, it may seem a small matter that, during the continuous evaporation of ordinary hard water, a gradual hard scale of calcareous matter is being deposited upon all the surfaces of the metal between the frame of the fire-box and the water. But when these latter will further consider that this scaly deposit is a most perfect non-conductor, they will soon appreciate the fact that its formation seriously affects the economy of evaporation, and increases the danger of burning the plates, and hence of explosion. It is evident, then, that, to keep a boiler in anything like proper condition, this deposition must either be prevented, or the boiler be frequently cleaned out. This latter operation, we may remark, is no slight one, but necessitates thorough stripping of the boiler, and the scale is usually so hard and so firmly adherent, that it must be chipped off with hammer and chisel, at a considerable expenditure of labour and time. We have already mentioned this subject in these pages, as we consider its importance very great, as bearing on the two vital points to users of boilers—economy and safety, and that it is much ignored.

The arrangements for preventing the deposition of these deposits by the use of boiler compositions or by preliminary heating are but comparatively little used, and in the latter case are often very dangerous to the boiler. There remains, then, the most practical alternative of using some innocuous substance which shall prevent the adhesion of the deposit as a scale on the heating surfaces, but shall cause it to be thrown down as a mud which can easily be got rid of through the blow-off pipe. We have already recommended such a substance in glycerine—practically introduced by our ingeneous neighbours in France—and we hope that some of our readers may have practically benefited therefrom. We are pleased to be able again to bring before our readers another very ingenious and simple remedy against this bugbear.

One of the engineers on board the transatlantic steamer, *Saint Laurent*, accidentally left in the inside of his boilers an ingot of zinc before his departure from Havre. Upon his return, proceeding to examine his boilers and remembering his forgotten ingot of zinc, what was his surprise to find no scaly deposit whatever on the heating surface of the boiler, and further no trace of the zinc ingot. Thinking, on consideration, that the zinc might have prevented the formation of the scale, he again placed in the inside of the boiler an ingot of zinc weighing 80 kilos. On after examination, he found the phenomenon repeated, the zinc disappearing, and no scale being formed, the only residue being a black mud at the bottom of the boiler, easily washed out. This incident was repeated by the user of a boiler of 20 horse-power at Angers, who used the water of the Loire. He then inserted some kilogrammes of zinc turnings, and found that the disappearance of the zinc was in this case as effectual as in the case of the salt water, in preventing the formation of any scale on the heating surfaces.

It only then remains to give some feasible reason for this most valuable phenomenon, and we think that it is not very difficult to find. The two metals, zinc and iron, being in contact with one another, would constitute the two poles of a battery, being positive and negative to one another. The hot water in which they are immersed would always contain sufficient acid to set up chemical action, and we have thus the boiler tranformed into a gigantic pile, completely circulated by electric currents. Now it has been definitely proved by Mr. Field that electricity is an admirable agent to prevent the deposition of a scaly deposit or to remove it after deposition. We have thus a very simple explanation of the phenomenon, which is identical in its character to the action of a zinc plate let into the copper of ships' bottoms to prevent the adhesion of barnacles

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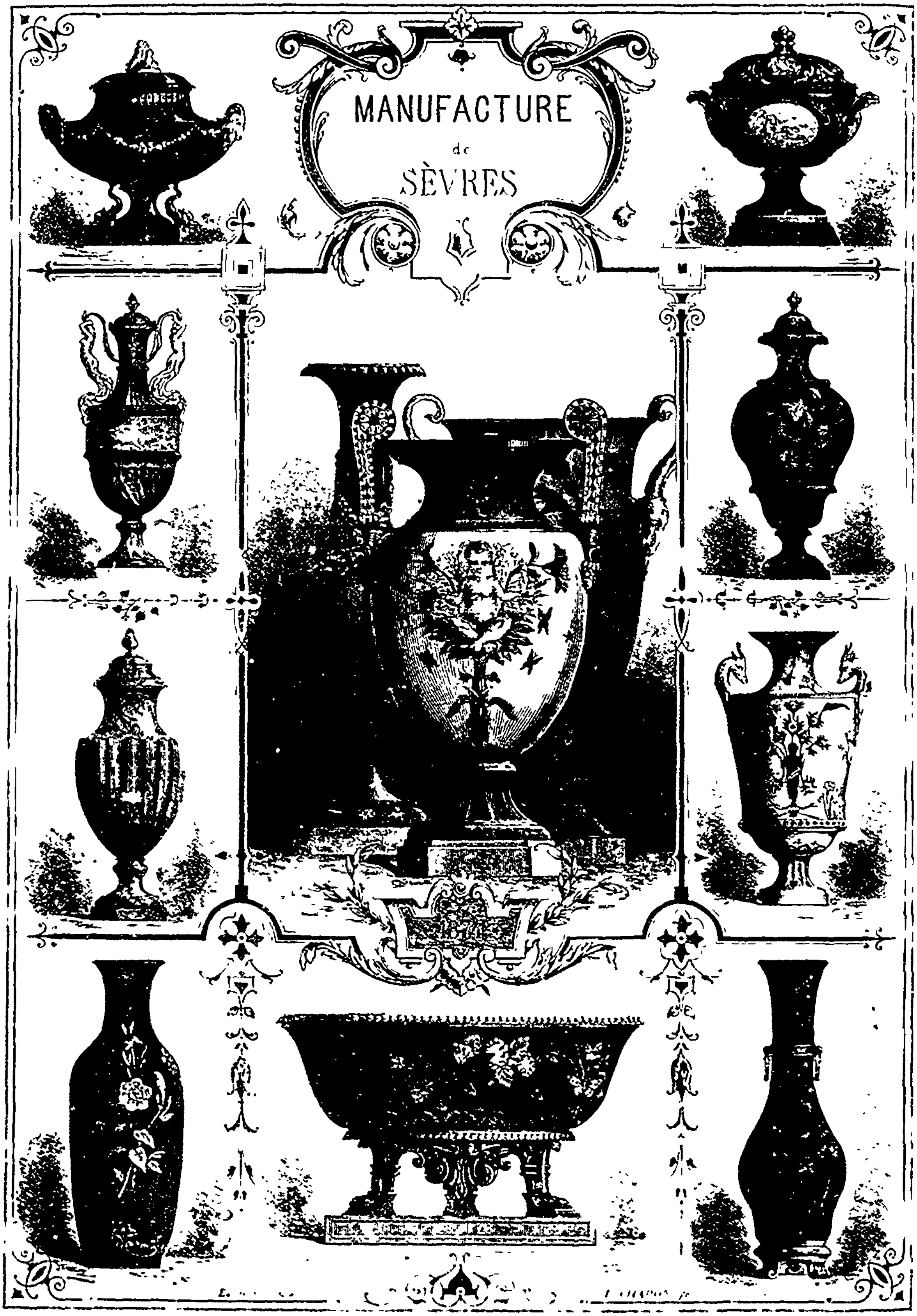
An arrangement which has been nearly completed, has in view the carriage of the mails between the large cities of the United States in rapid trains to be used for no other purpose, and to which the freight and passenger traffic would alike give way. By this means it is expected that letters will be carried between New York and Chicago in 24 hours communication with Cleveland, Cincinnati, &c., would also be greatly accelerated.



PRODUCTS OF PORCELAIN FACTORY, SÈVRES.

MANUFACTURE OF GUNPOWDER.

MECHANICS' MAGAZINE.

MONTREAL, OCTOBER, 1874.

ILLUSTRATIONS:

CONTENTS:

PUBLIC BATHS.

We have, already, alluded to the great need, in Montreal, of public baths. The immense amount of sickness which prevails in the city has been referred to from our pulpits and our preachers have called upon us to wash and be clean. This is not so easy, especially in winter, for a part of our population whose houses are not furnished with baths. Even our more wealthy population would, we are sure, however, delight in the possession of such a public swimming bath as that we illustrate on page 217, and which has recently been erected for the Commissioners of the St. Marylebone Vestry, London, England.

The length of the bath-room is 85 ft., and the width 41 ft., the height being 28 ft. from the platform round the bath to the apex of the roof. The dressing-boxes, averaging 4 ft. 3 in. long, and 3 ft 6 in. wide, are contained along the sides of the room in recessed arched openings. All the fittings of these boxes are of ebony, and the metal work is electro plated. The arcading is continued along the end walls, but the recesses here are filled in with ornamental tile work. The piers of the arches have each three panels, filled in with blue hand-painted tiles, with variously designed representations of birds, fishes, and water-fowl. The roof is supported by cast-iron semi-elliptic ribs, ornamented with gilded scroll work panels.

The size of the bath itself is 26 ft. by 73 ft., and the depth of water 4 ft. 6 in., shelving down to 6 ft. The spring diving-board is 4 ft above the water, but there is another diving-board 5 ft. higher than this one.

The bottom and sides of the bath are covered with glazed tiling, in variously designed patterns, and the hand-painted tile border above the water-line, 21 in. wide, represents the appearance of an aquarium, with fishes and rockwork.

The whole of the interior of the building is decorated with Pompeiian ornament.

It would be hard to overestimate the hygienic value of such a bath in Montreal in our winter season, and we commend the action of the vestrymen of St. Marylebone to the notice of our city fathers.

Considerable interest has lately been excited by the report of the successful trial of a new swimming apparatus, the invention of Mr. Merriman, an American citizen. The performance we allude to was that of Captain Paul Boynton who embarked from New York in the "Queen" for Queenstown. It is stated that when about 200 miles from the American coast he wished to be left adrift with his apparatus to take the chance of being picked up by some inward bound ship. This proposition the captain, in view of the inclement season, is said to have wisely refused. Captain Boynton was, however, when about 7 or 8 miles from the coast of Ireland allowed to step overboard, and he succeeded in landing, by means of his apparatus, in spite of a heavy gale which was blowing at the time, although he had to travel as much as fifteen or twenty miles on account of the wind and tide.

Our illustration from the *Illustrated London News,* on page 208, shows him exhibiting his apparatus at Queenstown, when he remained two hours in the water, during which time he ate and drank and fired off rockets, &c. His clothes on landing were perfectly dry and he was not exhausted. The apparatus is a complete body costume manufactured chiefly of india-rubber, in two pieces which are united at the waist. The pantaloons include covering for the feet, with strong soles, drawn on over the wearer's ordinary dress, usually of blue flannel, and kept in position by strong suspenders passed over the shoulders and buckled to the inside of the waist. The waist is fitted with a steel ridged hoop, which is a protection to the wearer's person and furnishes a water-tight joint to the upper portion of the dress, which is drawn down to meet it. This upper garment is a jacket and head-piece, with gloves for the hands, all in one piece. At the waist its elastic material is strained tightly over the hoop of the pantaloons, so as to exclude the water and keep in the air, and its adjustment is preserved by another belt or strap buckled over the joining. It hangs loosely all over the person, except at the hands and feet; but in a few minutes, by blowing through the fine tubes attached to the outside of its different parts, air is introduced into the chambers, which lie between the outer and inner skin of the costume When inflated the apparatus will sustain in the water a weight of 300 lbs. in addition to the weight of the wearer. The latter can maintain himself in any position he chooses in the water either erect or recumbent, when erect the waist belt is even with the water line. A store of provisions is carried, sufficient for ten days, in a water-tight bag which floats along-side or is towed by a string. This bag which is also provided with air chambers contains, in addition to food, a small lamp with bull's eye, a long sheath-knife, an axe and perhaps a book or two. The means of propulsion is a small double bladed paddle to which if wished a small sail can be rigged.

A very important part of the invention is the arrangement of the air chambers so that in case a hole should be made and water admitted to any one or even two sets, the apparatus would still keep the wearer afloat as the other chambers being unconnected with these former ones would still contain a considerable quantity of air. The invention is considered a great success.

It is no easy matter to transpose at sight and play piano music. Only the most accomplished accompanists and skilful musicians are able, when an accompaniment is at all complicated, to pay it at sight, transposing it into the key suitable to the voice of the singer. To overcome this difficulty pianos have long since been constructed whose key-board could be altered one or two half tones. This, however, was found not be sufficient and, moreover, this arrangement of the key-board was found incompatible with precision in the mechanism and solidity in the instrument. A new means of overcoming the difficulty has been devised by Mr. Wolff, of Messrs. Pleyel, Wolff & Co. He has invented a detachable key-board (see Fig. page 209), which can be easily applied to the piano over its own key-board, and which being movable over the keys of the latter permits of transposition into all the keys of the gamut. The music may then be read and played on the upper key-board as written, the lower one produces it in any key whatever according to the position of the upper key-board. The invention was by no means an easy one to complete as any one will realize who is acquainted with the manner in which the different intervals of tones and half tones occur in the different scales. In spite of this, however, the invention is stated to be perfect in its results and, what is of great importance also, to be neither cumbersome nor difficult of application to ordinary pianos.

SÈVRES.

At the recent exhibition of the products of the French national manufactures the exhibits from the porcelain factory of Sèvres showed that the high position held so long by the French in this art, in which they are really unrivalled, is not falling off, but year by year becoming higher and higher. This progress moreover is not merely industrial but also artistic. One of the most important improvements of late has been the perfecting of new decorative processes which are now called in to aid the brush of the painter, hitherto almost the only decorative instrument employed.

The first of these processes is called pâte sur pâte, *crust over crust* and depends upon the partial transparency gained by the white crust when exposed to high temperature. This white crust is placed in relief over a coloured base, and, in proportion to the thickness of the crust, very varied and beautiful effects are produced. The second process consists in the use of metallic oxides which are capable of resisting the high temperature of the porcelain oven. In this latter case the artist is at once a painter and a sculptor and produces his effects either by colouring a flat surface or by the use of relief. These two scientific processes are said to have enabled the artists to produce some new and very striking effects. Much credit is due to those in charge of the factory for having in the recent troublous times, and in spi[t]e of a diminished grant from Government, not only held th[eir] own, but actually made marked progress.

ARTILLERY ELEPHANTS.

The power of adaptation to circumstances is one of the most remarkable characteristics of the Anglo-Saxon race, and one without which that race could never have attained the position it now holds as the civilizing race *par excellence*. Our illustration on page 221, of the employment of elephants in the artillery service in British India is a new exemplification of this power of adaptation. The drawing is from a photograph by Major Harcourt who commands the elephant battery stationed at Gwalior. The elephants are said to be more suitable to the service than horses in that climate and especially so in certain localities. They are procured by the Government in Ceylon, in the north of Assam, in the jungles east of Bengal and in the forests at the foot of the Himalayas, at a cost of about $500 each. A central depot of supply called a Khedda has been established at Dacca.

FURTHER RESEARCHES ON EOZOON CANADENSE.

Dr Carpenter, in the course of a lengthened address at the recent meeting of the British Association, contended that the hypothesis of the foraminiferal origin of *Eozoon Canadense* entirely accorded with the features alike of the general and of the minute structure of the best preserved specimens of this body, and that it is the only hypothesis which fits all the facts of the case; whilst the hypothesis of subsequent metamorphic change, which has every probability to recommend it, fully accounts for all the appearances on which the anti-Eozoonists rely as evidence of its mineral origin, which, in the face of the new evidence he adduced, was to his mind utterly "unthinkable." Until these facts shall have been disproved by the examination of the specimens which he was ready to submit to any or all of his opponents, he must claim to withdraw from a controversy which cannot be carried further to any advantage without a "comparison of actual specimens." Whilst he admitted to the full every evidence of mineralisation adduced by Professors King and Rowney (of Galway), they did not admit the evidence of organic structure which they had not seen, but which he had expressed his willingness to place before them, with the parallelisms presented by recent foraminifera. He was endeavouring to engage his Canadian associates in the preparation of a joint monograph on *Eozoon Canadense*, to be offered to the Palæontographical Society, with a request that before determining either to accept or to decline it, the council would appoint a committee of "experts," qualified by their knowledge of micro-palæontology and micro-mineralogy to judge whether what they held to be organic structure could be possibly regarded as the product of any kind of physical or chemical action.

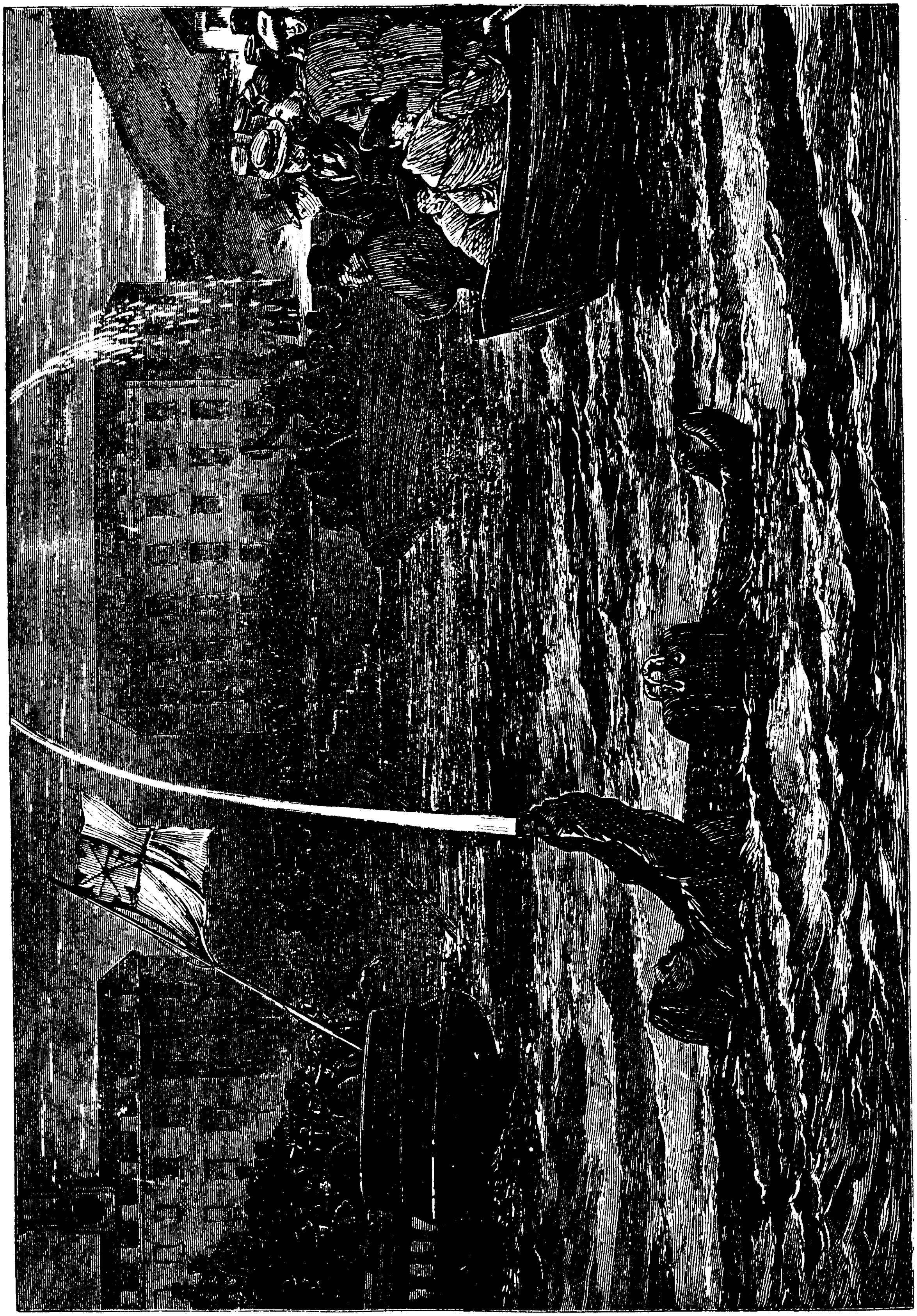
THE SALT BEDS IN HURON AND BRUCE.

A visitor to the Seaforth salt wells writes as follows: — A very thick bed of rock salt seems to underlie this whole section of country. The wells are bored to the depth of ten or twenty hundred feet; the water from the springs that are penetrated in the downward passage is allowed to flow down upon the bed, and having the salt in solution is again pumped up into the reservoirs. Such wells are put down at Clinton and Goderich and Kincardine. In some cases the salt rock itself has been penetrated about 100 feet, and not yet pierced entirely through. The stratum of this wonderful thickness seems to extend many miles east and west, and to have a considerable breadth north and south, so as to indicate an inexhaustible supply of this great preservative.

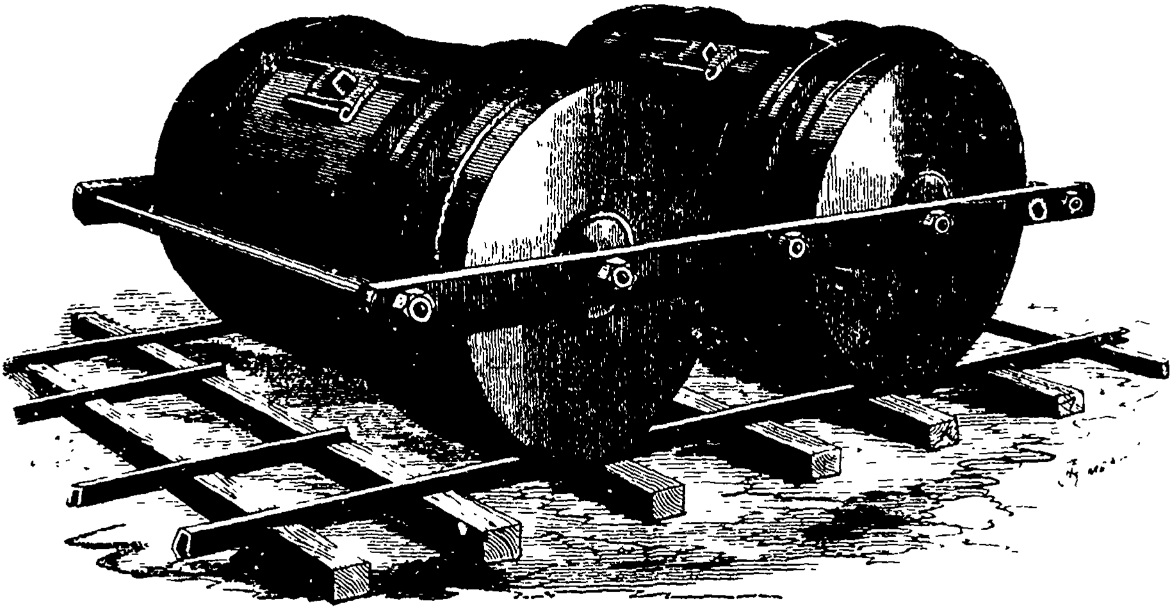
At Seaforth there are only three wells, but they continually supply eight huge evaporating establishments. These are wooden enclosures from 120 to 150 feet in dimension. They have shallow pans from 20 to 30 feet broad, running their entire length, in which the brine is run from tanks to the depth of 6 or 8 inches. Here the evaporation is effected either by furnaces under the pans, which are covered, or by steam pipes passing through the water in them. The salt falls to the bottom as the evaporation proceeds, and is then thrown into great piles in the drying and packing houses, where one may see heaps of salt, reminding one of February snow banks.

Slow evaporation produces a coarse salt; and quick, a finer article. For our table salt the coarser product is dried in a heated rolling cylinder, and then ground like flour with a stone and hopper. In the room in which this is done the air is laden with a salt dust which one may taste readily.

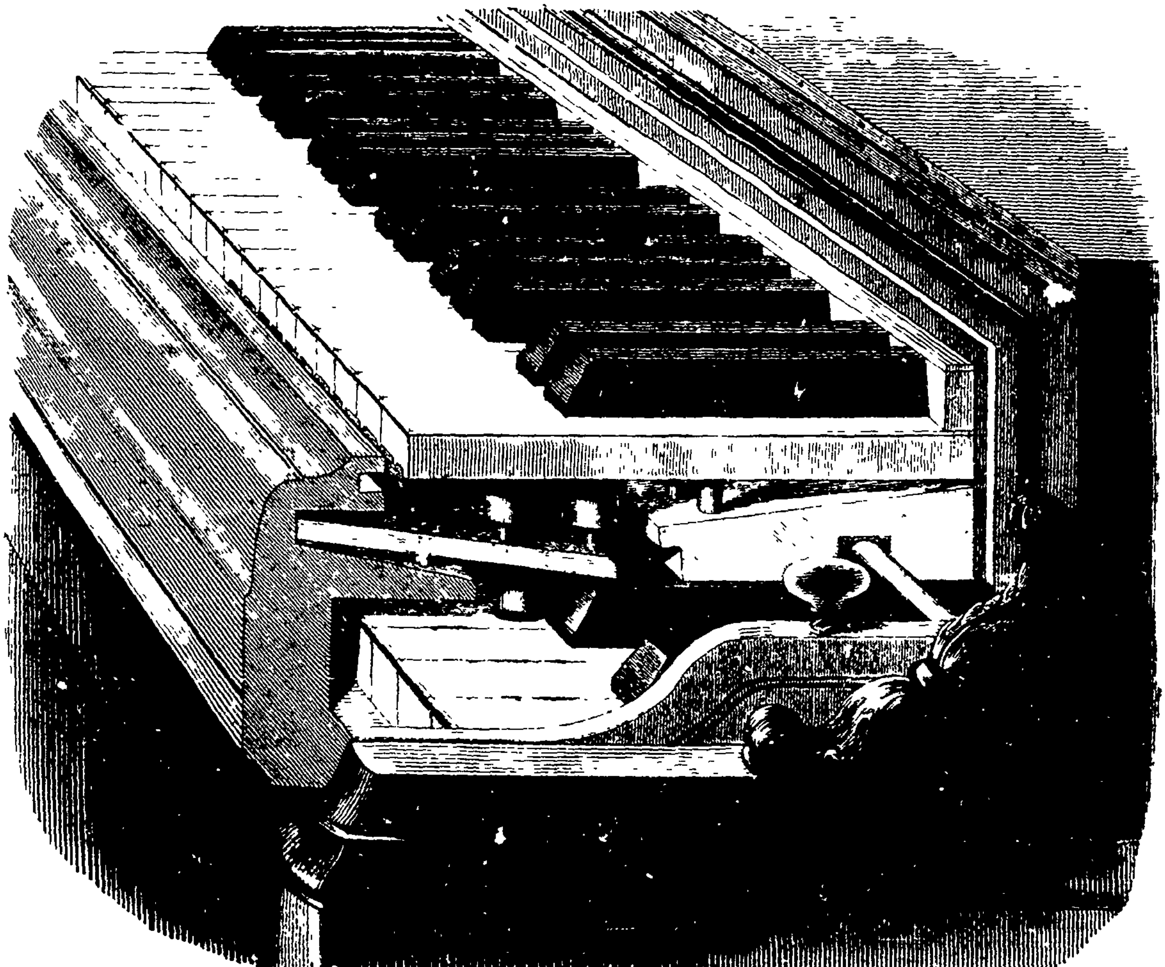
The Seaforth wells produced about 120,000 barrels of salt last year; this year it is expected they will produce about 150,000. The Goderich, Clinton and Kincardine works are also sending out their hundreds of thousands. The damaged product is used as a fertilizer, and soon the whole country can have it for such a purpose.



EXHIBITION OF SWIMMING APPARATUS IN CORK HARBOUR.



WALKER'S PATENT ROLLING CARS.



TRANSPOSING KEY-BOARD FOR PIANOS.

THE MANUFACTURE AND STORAGE OF GUNPOWDER.

The terrible gunpowder explosion which occurred lately in London on the Regent's canal has excited considerable interest in the subject of the manufacture and transport of an article so terrible in its power. An idea of the principal processes in its manufacture will be readily gained from our illustration on page 205, for which we are indebted to the London *Graphic*.

Gunpowder is composed of three ingredients, charcoal, sulphur, and salpetre, incorporated with each other in the relative proportion of about 13, 11, and 76, in a powdered state. Great care has to be exercised in obtaining the right kind of charcoal, as also in purifying the sulphur. — "Giving up Matches at the Entrance" explains itself.—Our next illustration shows the grinding of the sulphur and the charcoal, which are reduced to a fine powder. This is carefully sifted into a "dusting reel" to remove any vestiges of grit or impurity which might otherwise find their way into the powder, and cause an accident in the course of the subsequent stages of the manufacture. Saltpetre, also, when not refined on the premises, is subjected to the same process. — Our next sketch shows the "Incorporating Mills," where the composition, having been roughly mixed in the proper proportions, is incorporated by being ground, in a wet state, under edge runners, each weighing from four to six tons. This grinding is continued for a longer or shorter time, according to the quality of the gunpowder to be produced. This process is somewhat dangerous, and it is this which most frequently causes those minor explosions to the sound of which all persons residing near gunpowder mills are more or less accustomed. The powder thus completely pulverised leaves the mill in small lumps, being too friable to be conveniently granulated, it is therefore taken to the "Hydraulic Press" and pressed between copper sheets by hydraulic power until it is sufficiently hard to bear the granulating process without crumbling to dust.—Next we come to the "Corning" or "Granulating House," where the cakes of powder from the hydraulic press are broken into grains by being passed between brass rollers, the grains being sorted into different sizes by falling over sieves which are set at a pretty steep incline, and kept shaking in order to free their meshes from the grains. —In our next illustration we are still in the "Corning" House, where "Hand Sifting" is going on. In cases where it is desirable to obtain a very carefully sized powder, the grains are again sifted, this time by hand, in circular sieves placed on a frame fixed to a revolving shaft having a crank at the point where it passes through the frame. — The next process is the "Glazing," or giving a polish to the grains, by causing them to revolve for some hours in closed barrels containing three or four cwt. each, a small quantity of black lead being added when a very high degree of polish is required, as in the case of blasting powder, which is intended to be used in damp localities. After being polished the powder is dried in a stove, warmed be steam or hot water pipes.—The final process before weighing the powder into barrels is the "Dusting," or removing any fine particles of powder which may still adhere to the surface of the grains. This is accomplished by passing the powder over sloping sieves if "large," or through hollow cloth cylinders if "small grain." — In the Packing House, the powder is weighed into parcels under five pounds each, and packed into tin canisters for the "sporting" trade. —The "Expense Magazine" is a store-house for gunpowder before it has undergone the final process, if there is any reason to delay the completion of the manufacture. It is built in the water, and is provided with a lightning conductor. — The "Charge House" is also surrounded with water, and has a water tank on the roof. Here the finished powder is stored in bags on shelves, about a foot from the ground. So much for the manufacture of gunpowder, but we may add that all people connected with the works, and any one entering them, have to be "shed" with large leather shoes, with nails of copper, lest a spark from an unwary heel might fire the powder-charged air. All the bearings of the machinery are also of copper. As regards the transport of powder much has been said of late respecting the terrible and culpable negligence of Canal and Railway Companies, who treat it with the same nonchalance they would display towards barrels of pickled pork. At these works, however, the utmost precautions are taken, the whole internal carriage, from the time the powder leaves the incorporating mills until it is ready to be sent away, is conducted by barges, each sufficiently small to be propelled by one man with a punt pole at a speed of about two miles an hour. These boats are, of course, kept entirely for powder work. For the shipping trade the powder has to be carted to a spot in Dartford Creek, not far from its entrance to the Thames. It is there transferred to barges which proceed to the spots in the Thames where the authorities permit powder to be shipped. For the home trade the powder is carted direct from Dartford to the railway or canal which will carry it to its destination. We may conclude our remarks by stating that according to law, it is forbidden to carry more than 25 lbs. by land, or [illegible] lbs. by water at the same time, and that any one smoking on board a vessel laden with powder is subject to a fine of [illegible]. Illustrations—1. Giving up our matches at entrance. 2. Sulphur grinding. 3. Incorporating mills. 4. Hydraulic press. 5. and 6. Corning house. 7. Shod for the occasion. 8. Glazing house. 9. Charge house. 10. Expense magazine.

WALKER'S PATENT ROLLING CARS

The revolving cylinders invented by Mr. Walker for bringing down cheaply the produce of a country to its seaports have been already introduced to public notice, and we now supply from *Iron* on page 209, an illustrative figure of the apparatus, with an ingenious adaptation, enabling it to pass a break of gauge without points or crossings, or even, if necessary, without stopping the trains.

The rolling cars are cylindrical, and made of boiler-plate iron, with a covered opening for loading, &c. They are stiffened at the centres of their ends, in which small axles are fitted; they may be further strengthened by angle or T-iron riveted to them. These cylinders may be divided into two parts by a horizontal diaphragm, in which case a covered opening in the cylinder will be required for each compartment. Around the outside of the cylinders, at the required gauges, metal rings, called "tire-rings," are tightly fitted. These tire-rings are similar in section to the tire of a locomotive-engine wheel, perform the duty of ordinary wheels, and run upon the rails, passing with perfect ease and safety from one gauge of railway to another and different gauge without stopping or any adventitious aid, as will be clearly understood on inspecting the engraving.

Mr. Walker proposes to run his rolling cars in pairs, and consequently mounts two of them in a light framing, which is supported and carried by the axles of the cars.

The cylindrical car and its load, being practically one rolling body upon the rails, a comparatively small engine will be sufficient to convey trains composed of them to the coast. The cars can also be fitted with self-acting brakes, to prevent them running back down inclines. They may be made of any reasonable size, according to the character of the produce to be carried, and, when made water-tight, may be beneficially employed for the conveyance of water in seasons of drought.

The principal object in this invention is to provide the means for the easy, economical, and safe conveyance of the general goods and produce of large and thinly-populated countries, such as India, to the ports of shipment. As these cars require neither wheels, axles (to carry the carriages and their loads), springs, nor tarpaulings, the cost of outfit and maintenance is reduced to a minimum. Goods and produce may be thus conveyed for any distance without risk from rain or fire, giving the additional advantage of reducing the cost of insurance. The lightness of this form of rolling-stock is also an evident advantage in reducing the tear and wear of the line. The invention has been very favourably considered by the Government authorities of India, where it is likely to come into extensive use.

The engraving shows the general arrangement of the rails at the point of junction of two railways of different gauges. The sleepers are grooved true to gauge by suitable machinery and afterwards creosoted when desired. The rails, which are fitted therein, are formed of timber cased with rolled iron and are further secured to the sleepers by pins or bolts.

A Correspondent of the *Scientific American* says. I have run a piece of machinery in rawhide boxes for fourteen years without oil, it is good yet, and runs at 4500 per minute. I put it in while soft, and let it remain until dry.

PRINCIPLES OF SHOP MANIPULATION FOR ENGINEERING APPRENTICES.

By J. Richards, London.

BELTS FOR TRANSMITTING POWER.

The traction of belts upon pulleys, like that of locomotive wheels upon railways, being incapable of demonstration except by experience, hindred for a long time the introduction of belts as a means of transmitting motion and power. I mention motion separately because with many kinds of machinery that involve high speed, such as wood machines, the transmission of rapid movement must be considered it well as power, and it is only by means of belts that such high speeds may be communicated from one shaft to another ; so that at least in practice, belts alone are at this time employed for high speeds.

The first principle I will point out in regard to belts, distinguishing them from shafts as a means of transmitting power, is that the power is communicated by means of tensile instead of torsional strain, the power during its transmission being represented in the difference of tension between the driving and the slack sides of the belts.

In the case of shafts, their length, or the distance to which they may be extended in transmitting power, is limited by torsional deflection, and as this torsional strain is avoided with belts, we may conclude that, unless there are other disqualifying conditions, belts are better than shafts for transmitting power through long distances.

Belts suffer resistance from the air and from the friction in the bearings of supporting pulleys, which are necessary in long horizontal belts. With these exceptions they are capable of moving at a high rate of speed and transmitting power without appreciable loss.

Following this proposition into modern engineering practice, we find how experience has gradually conformed to what these properties in belts would suggest ; wire and other ropes with a diminished cross section to avoid air friction, and allowed to droop in low curves to avoid supporting pulleys, are now commonly employed for transmitting power through long distances. This system has been very successfully carried out in Germany and America, in some cases for distributing power in large manufacturing establishments.

Belts, among which are included all flexible bands, do not afford the facilities for taking off power at differents points that shafts do, but have advantages in transmitting power to portable machinery, or, in other words, when the power is to be taken off at movable points, as in the case of travelling cranes, hoists, and so on.

An interesting example in the use of belts for communicating power to movable machinery is furnished in the travelling cranes of Mr. Ramsbottom, in the shops of the London and North-Western Railway, at Crewe, and at other works, where powerful travelling cranes receive both the lifting and traversing power by means of a cotton rope not more than 1in. in diameter, which moves at a high velocity, the motion being reduced by means of tangent wheels and gearing to attain the force required in lifting heavy loads. In looking at this mechanism, those who had not their conceptions based on a true knowledge of power and the relations between power and speed, would see, in the effect of this small cotton rope, something marvellous.

Considered as means for transmitting power, the contrast as to advantages and disadvantages lies especially between belts and gearing instead of between belts and shafts. It is true in extreme cases, such as that cited at Crewe, or in conveying water power from inaccessible places through long distances, and so on, the comparison lies between belts and shafts, but for ordinary practice, in three cases out four, the problem as to mechanism for conveying power is between belts and gearing.

If experience in the use of belts was thorough, as it is in the case of gearing, and if the quality of belts did not form an important part in the estimates, there would not be much difficulty in determining where belts should be employed and where gearing would be preferable.

Belts are continually taking the place of gearing, even in cases where they have been until very recently thought inadmissible ; at least one of the largest rolling mills in Pittsburg, Pennsylvania, except a singlr pair of spur wheels as the last movers at each train of rolls, is driven by belts throughout.

Leaving out the matter of a positive relative movement between shafts, which belts as a means of transmitting power cannot insure, there are the following conditions that must be considered in determining whether belts or other means should be employed in transmitting power:

1. The distance to which the power must be carried. 2. The speed at which tha transmitting machinery must move. 3. The course or direction of transmission, whether in straight lines or at angles. 4. Durability and the cost of construction. 5. The loss of power during transmission. 6. Noise, vibration, and jar.

In every case where there can be a question as to whether gearing shafts or belts will be the best means of transmitting power, the several conditions named will furnish a solution if properly investigated. Speed, noise, or angles may become determinative conditions, and are such in a large number of cases ; first cost and loss of power are generally secondary conditions.

Applying these tests to cases where belts, shafts, or wheels may be employed, and carefully considering the special conditions of any case, the apprentice willsoon find himself in possession of knowledge to guide him in his own plans and enable him to judge of the correctness of examples that come under his notice.

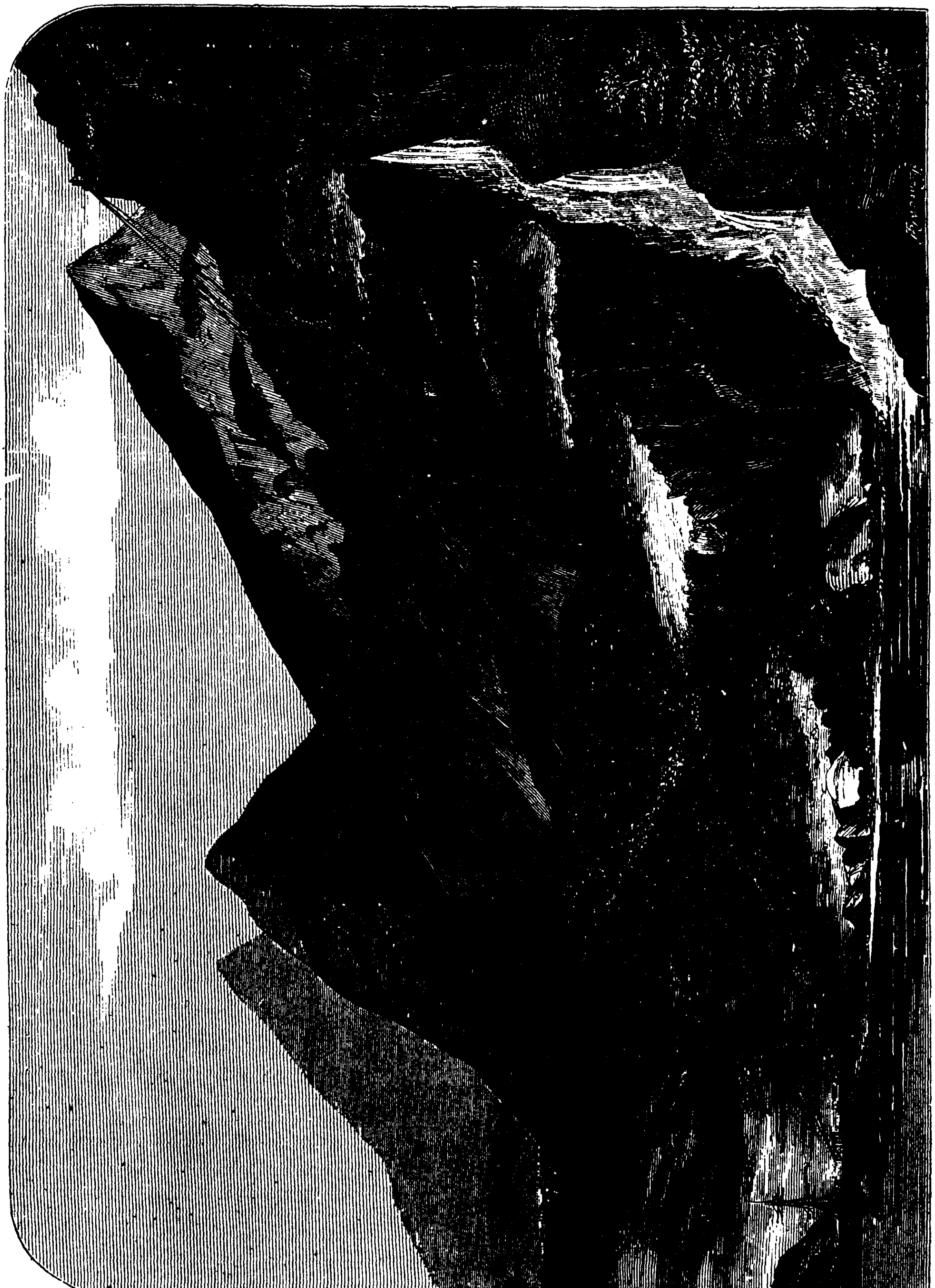
It is never enough to know that any piece of work is generally constructed in some particular manner, or that such a proposition is generally accepted as being correct ; nothing is learned, in the true sense, until the reasons for it are understood, and it is by no means sufficient to know from observation alone that belts are best for high speeds, that gearing is best to form angles in transmitting powor, and that belts produce less jar and noise ; the reasons for these things and the principles that lie at the bottom must be reached before it can be assumed that tne subject is understood.

(To be continued.)

WATCH-MAKING IN SWITZERLAND.

Horological industry has grown to extraordinary dimensions in Switzerland, and the *Journal de Genève* supplies the following statistics:—In the four cantons of Neuchâtel, Berne, Vaud, and Geneva more than 25,200 men and 12,700 women are employed in the various branches of the business, of whom 30,600 belong to Neuchâtel and Berne. The trade has grown of late most rapidly in Berne, where at present half a million of common watches are produced annually, their value being set down at an average of forty francs each, making a total of £800,000. In the canton of Geneva the number made annually does not exceed 150,000, but nearly all of them are in gold cases, and ornamental, so that the total value is about the same as the half million produced in Berne. Vaud makes about the same number as Geneva; the movements are generally well finished, but many of them are exported without cases; the value is considered to average about 55 francs, giving a total of £320,000. The same canton also produces about 80,000 musical boxes of the value of £80,000. One-half of the whole of the watches made in Switzerland are produced in Neuchâtel, and, in value, 35 per cent. of the whole, or £1,400,000 per annum. The total number and value of watches produced is given as follows:—Switzerland, 1,600,000 of the approximative value of £3,520,000 ; France, 300,000, value £660,300 ; England, 200,000 value £640,000; and the United States of America, 100,000 valued at £300,000. It will be observed from the above figures that while the average value of Swiss watches is about 4s. 6d. each those of France reach an average of 44s., those of England 68s., and those of America 60s. The fine balance-spring of a watch is said to furnish the most remarkable example of the increase of the value of a raw material by the application of skill. It would be curious to know the cost of the materials employed to produce the 2,200,000 watches of the four countries quoted, of the approximate value of £4,800,000. Still more curious would be the relative value of a first-rate chronometer, and the materials with which it is produced.

Galignani states that the French Stamp-office has just purchased the secret of the composition of an ink absolutely indelible, and which resists the strength of all known reagents. Owing to that discovery, it will be able to put an end to the numerous frauds which are constantly committed to the prejudice of the Treasury, and which consist in restoring to stamped paper already used its original purity. The annual loss to the revenue on that head is calculated at 600,000f. in the Department of the Seine alone.



WIRE TRAMWAY AT IRON MINES NEAR AALSUND, NORWAY.

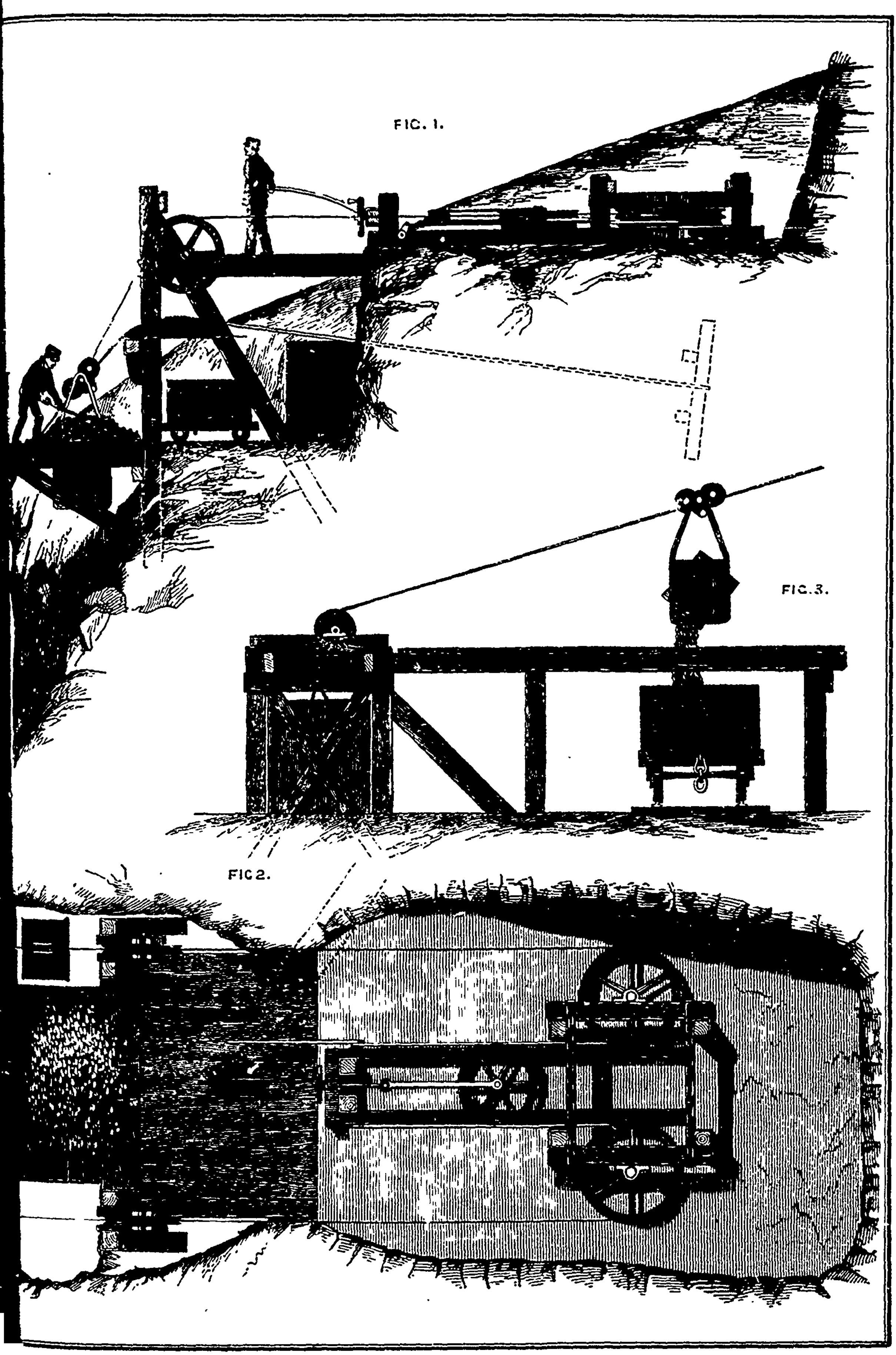


FIG. 1.
FIG. 3.
FIG 2.

WIRE TRAMWAY IN NORWAY.

Many valuable iron mines are at present either worked to a very small extent, or even left unworked, owing to their being placed at such inaccessible spots as to preclude the possibility of economically transporting the ore to a port of shipment. Frequent examples of such mines are to be found on the coast of Norway situated high up amongst the mountains, which tower above the numerous fiords which indent its seaboard. The only approach to these mines consists of a rugged and zig-zag road quite unfit for the carriage of any large quantity of mineral, and owing to the extreme steepness of the mountain side, often leading a circuit of many miles to reach a spot which is less than half a mile distant in a straight line. To accommodate such cases an arrangement of wire rope incline has been designed and successfully worked, as shown in the engravings from *Engineering*, on pages 212, and 213 It consists of two steel ropes of about 40 tons breaking strain fixed at the mines, and stretching direct to the small pier at the foot of the mountain, spanning a distance of 750 yards without support. On it are run two cages with small grooved wheels, in which are placed about 12 cwt. of iron ore, the fixed ropes being kept in tension by means of weight boxes at the bottom. The loaded cage is made to draw up the light one by means of a light steel rope, which passes round suitable brake sheaves at the mine, and by which the speed of the descending load is governed. On arriving at the bottom, the cage is discharged into a large truck ready to receive the ore, which when full is in its turn discharged into the ship to be loaded. The light cage has meantime arrived at the top, and being filled is allowed to descend, and to draw the emptied cage up The incline is an angle of 65 deg., and the speed at which the cages are run is about 15 to 20 miles per hour. By this means about 100 tons per ten hours are transported at a very low cost, the only expense being the men required to work it, namely, about three at the top and two at the bottom The incline illustrated was made by the Wire Tramway Company, (Limited), from the designs and under the superintendence of their engineer, Mr. W. T. H. Carrington, for some iron mines situated near Aalsund, which are the property of Messrs. Adamson & Co., of London. The work was carried out on the spot by Mr. H. Dunn, one of the Company's assistant engineers.

By the application of such inclines, which from their simplicity are of small expense, it appears probable that many valuable mines, at present unworked, could be utilised and their products brought to market. Tramways on the system of the company are now being erected in many parts of the world, one having lately been opened at Llanelly in South Wales for the carriage of coal, and at Leitrim for a similar purpose, the latter working on an incline of 1 in 3

SEWER GAS.

The following letter, bearing the signature "M.D.," has appeared in a prominent position and type in the *London Times*:—

My own personal experience and the letters which have from time to time appeared in the *Times* prove to me that the modes of excluding sewer gas from our houses are still very imperfectly understood by the public, by the majority, I fear, of builders, and by not a few house surveyors and engineers. Sewer gas finds its way into a house by one or more of five distinct kinds of channels :—

1. Sewer gas very frequently enters a house through the pipes which carry off refuse water, for example, housemaids' sinks, butlers' pantry sinks, baths.

As a rule, the pipes from these places are carried directly into the house-drain The pipes are trapped where they enter the drain, and the traps when of good construction, well fixed, and new, completely shut out sewer gases from the house, the dirty water passes into the sewer, but no gas can pass back into the house. But traps are made of metal, and metal wears, and when the metal is worn the trap lets the water flow into the drain, but no longer keeps back the sewer gas. The pipe from the sink or bath, when the trap is out of order, conveys sewer gas into the house, and the defect in the trap is frequently not discovered till serious illness, due to sewer gas poisoning, has called attention to the " state of the drains.

It is easy to prevent the entrance into a house of sewer gas through these pipes. The pipes which carry off refuse water should terminate, not in a drain, but in the open air In London houses they may pour the water directly into the area. I had constant trouble from offensive odours in my own house and was frequently put to much trouble and expense for new traps, the removal of area flagstones to ascertain if traps, already existing, were effective, &c., till I had, at a cost of about 30*s.* only, five pipes, which carried refuse water from the house, cut off from all communication with the drain, and made to terminate in the nearest areas. I thus did way for ever with five channels through which, if by accident or wear a trap was defective, sewer gas could enter my house, and obviated the annoyance and expense which recurred every time a trap was even suspected of being defective.

2. Sewer gas may enter a house through the overflow pipes of the cistern.

Every cistern has a pipe to convey away the water which, if the cock of the cistern were out of order, would flood the house as often as the water came into the cistern.

This overflow pipe of the cistern is frequently made to open into the soil pipe of the nearest water-closet—*i.e.*, into a pipe filled with sewer gas.

The reflux of the sewer gas from the soil pipe into the overflow pipe of the cistern is, the builders say, prevented by a bend in the pipe filled with water. So long as the water in this siphon bend is sufficient in quantity, and frequently renewed, it forms an effective trap, but the water in the bend may evaporate or it may become saturated with sewer gas from the soil pipe, and when so saturated it will give off from the cistern end as much gas as it receives at the soil pipe end, and so sewer gas be disseminated in the house and enter into the water of the cistern—water which is used frequently for drinking purposes, filling water bottles for the toilet, &c.

The overflow pipes of all cisterns should terminate in the open air.

3. In towns the water-closets are at the back of the house and the main sewer runs down the centre of the street in front of the house. The consequence is that a drain has to be made under the house from back to front.

Injury to the walls of this drain, may result from accumulated sewer gas, and the escape of sewer gas from the drain through any aperture (accidental or other) in the drain will be in proportion for the pressure of the sewer gas on the walls of the drain. To prevent this pressure the drain should be ventilated—*i.e.*, a pipe should be carried from the drain up the back of the house to a little below the level of the chimney pots.

4. A common practice is to make one pipe to serve the double purpose of ventilating the sewer and of carrying off the rain water from the roof. The pipe serving this double purpose is frequently a channel for the conveyance of sewer gas into a house. For every cubic foot of water that enters the pipe a cubic foot of sewer gas is forced out, and if, as is commonly the case, the top windows are near to the aperture of this pipe, sewer gas finds a ready entrance into the house.

The pipe which conveys the rain water from the roof should open into the area, and never into the drain.

5. The soil pipe of a water-closet, like the house drain, should always be ventilated—*i.e.*, an open pipe should pass from the soil pipe to a little below the level of the chimneys —to an elevated spot, that is to say, at some distance from all openings leading into the house. If the soil pipe of the water-closet be not ventilated, then whenever the closet is used, should there be the least defect from wear or accident in the trap, a certain amount of sewer gas will be forced upwards into the house from the soil pipe.

To sum up, the pipes which convey refuse water from the house and those which convey surplus water from the cisterns should, without exception or excuse, terminate in the open air The main drain of the house and the soil pipes of every water-closet should be ventilated, and the ventilating pipes should be carried up to about 3 or 4 feet below the level of the opening of the chimneys and at some distance from all other openings into the house—*e.g.*, trap doors on the roof, windows, &c. The pipe which conveys rain water from the roof should terminate in the open air, and should never be used for ventilating the sewer.

The above letter has called forth the following correspondence. "Another M.D.," writes .—

It is to be hoped that every householder in the kingdom will read and try to master the five plain facts contained in the letter of "M. D."

There is one point which may, I think, be a little enlarged upon with advantage. This is the insecurity of siphon traps (and all water traps are but modification of the siphon) if their water be not frequently renewed. All who sit up late at night must occasionally have become acquainted with the sickly smell that arises from the sink in the back kitchen or scullery. The main reason for this is that, the cook and scullerymaid having retired to rest, the water in the trap has not been renewed. The sewer gas on the far side of the trap has saturated the water and is being given off into the house. Pouring water down the pipe removes the smell for a time. If the waste-pipes be all cut off from direct communication with the sewer, as "M. D." advises, this nuisance cannot arise

I once took part in an experiment to show the rapidity with which sulphuretted hydrogen gas is absorbed by water and given off again, and we found that this gas would, without pressure, pass through a column of water contained in the bend of a tube (a siphon trap, in fact), in about the time which it takes to write this paragraph.

A third correspondent writes.—

Some few years ago I instructed my builder to let me see the end of every basin, sink, waste, and overflow pipe in the open air, to ventilate the soil-pipe to the roof, and all water-closet traps and containers by half-inch pipe to the outside.

I am not competent to discuss the great sewage question, but I can confidently assert that, so far as the interior of each house is concerned, the adoption of the above plan is an effectual safeguard against the danger of sewer gas

Now that winter is approaching, when fires will be lighted and doors and windows shut, the precaution suggested by "M.D." is more than ever needed.

The essential principle involved is that, by breaking the continuity of each pipe with the drain, atmospheric equilibrium is maintained between the interior of the drain and the connecting pipe during every variation of atmospheric pressure, and, notwithstanding the more or less highly rarefied condition of the air in the interior of the house, fresh air, and that only, can be sucked back through these insidious pipes.

RAZORS.

Razors, after all, form no unimportant subject, and their purpose—shaving—mounts in antiquity to pre-historic time. Far later than that rather indefinite epoch of the archæologists, Persians and Chinese, Egyptian, Jews, and Gentiles, Greeks, Romans, and innumerable barbarous peoples shaved, if not their beards, more or less of their heads. The processes and the instruments employed by divers peoples and times were, no doubt, various, and probably curious in many ways, though but little is known about them. While soap was unknown, or a rare cosmetic, and steel not widely diffused, "Easy shaving" could only have been accomplished by methods very different from our own Almost in our own day might have been witnessed the extremes of the barber's craft in its primitive and its perfect instruments. Captain Cook was shaved in one of the Pacific Islands as an act of homage, by the king's barber, with a sharpened oyster shell, the process of getting over the tough beard of the great navigator occupying about six hours. Cook, no doubt, had his own old-fashioned steel razors in his cabin—quite as good, probably, as "the newest thing out" now in that line, and at the present day Sheffield razors are to be found plentifully amongst the Fiji Islanders, Bosjesmens, Hottentots, and the tribes subject to King Coffee.

The Chinese razor is a curious bit of sheet steel, very much like a penny piece clipped off straight at one side, and sharpened at the opposite one, with a thin projecting tail which connects it with the split handle almost identical with that of modern European razors, which suggests the notion that the rather peculiar handles in which our razors are mounted may have come to us from Asia. In Europe the straight or slightly curved blade of some 4in. in length is universal, but innumerable varieties and vagaries, in form and proportion, weight, &c., are everywhere encountered, the real reason as the base of all being, probably, that there are razors made to sell and some to shave But is an instrument for shaving a thing absolutely beyond the control of rational principle, or the teachings of experience? There must be some one size and form of blade, and some one weight, that should be the best possible for the average human face and beard. Yet as to this no certainty can be arrived at from the doctors of the craft of razor fabrication. One recommends a light razor; another "our own make," with a crooked shank next the handle, probably that no fingers not provided with the suckers of the octopus could hold; a third oracularly advises a heavy razor, with a thick back, and strong enough to cut the throat of Goliah; while Germans tell us our British razors are all wrong, that nothing shaves well but the Hamburgh razor, with its hollow sides and thin pliable edge, which never requires setting. We should like some light and guide through all this labyrinth and contradiction, for we must confess that the resulting impression chiefly left upon our minds by it is, that there are few branches of retail trade in small wares in which there is more humbug than in that branch of the cutlery craft which deals in razors. An excellent razor, well tempered, of good still, and with a black handle, can be purchased for about 1s. We can testify that such a razor can shave well, and for many years. Yet go into some eminent "cutlery establishment" in any of the great London thoroughfares and you will be asked 12s. to 14s. for a pair of instruments with, perhaps, ivory handles, and much glitter from the polishing wheel, but intrinsically not a white better than the soldier's razor at 1s. A curious essay, and of some length, might be written as to the improvements, pretended or real, that have within this century attracted scientific or general attention in razor making. Some of these, like those given account of by Parkes, of Birmingham, in his "Chemical Essays" of some forty years ago, which attempted to fix the temperature at which razors should best be tempered, were laudable attempts to reduce empiricism in art to the science of rule, though little came of it. Nor did any real improvements result from the somewhat elaborate experiments of Faraday and Stodart on improving razor steel, by the alloy of other metals in minute quantities. Rhodium and silver-steel razors have all passed away, though so-called "silver steel razors" can still be purchased near Sheffield which do not contain a trace of silver. First-class cast steel of the most brilliant fracture and closest grain and perfect hardening and tempering are the only real requisites to form a first-class razor. The right quality of steel can be chosen, but in the tempering an element of uncertainty remains, which is no doubt the cause on which the capriciousness experienced in the goodness of any "pair" of razors proving quite alike depends.

A knife or surgical scalpel may cut through animal tissues with perfect smoothness and but little effort, but it may not shave well. The razor edge must not only be sharp, but smooth, i.e., if it be like all edges, that of a saw, it must be that of a saw whose teeth are more than microscopically fine. This was the basis of a mode of sharpening razors proposed about forty-five years ago by Mr. Gill, a patent agent and editor of "Gill's Technical Repository," which drew for a time some attention, namely, to burnish simply the sides of the razors edge with the "currier's steel," which is only a bit of finely hardened and polished steel wire, and this thinning and smoothing of the edge is also the foundation of the Hamburgh construction, in which the edge formed by the osculation of opposite outside surfaces is thin enough to bend under the finger nail and yet return to its position. But though these razors are said to need no setting, they *scrape* rather than shave, and most uncomfortably.

Then the "setting" of the razor becomes a source of ever renewed need and annoyance, it being a rare thing to get it well done, and the expense is no longer beneath consideration, since London cutlers have fallen in with the prevailing habits of extortion and doubled their prices, under the plea of enhanced wages, &c. We have very many readers in all classes and in all sorts of occupations, and amongst them many ingenious and inventive men. We ask them to consider whether it be not possible to construct a machine for automatically setting razors—one that driven by power shall apply its fine grinding power to the razor blade already fixed into a suitable rest or frame, in such a manner as to effect all that now depends upon the dexterity of the "setter's" hand, or the degree of carelessness, or the contrary, with which he does his work. With the polishing machine for telescopic specula and the gem cutter's wheel before us, why should we despair of this? Once accomplished, it would prove, even in London alone, a little gold-field to reward the perseverance of the inventor.—*The Engineer*.

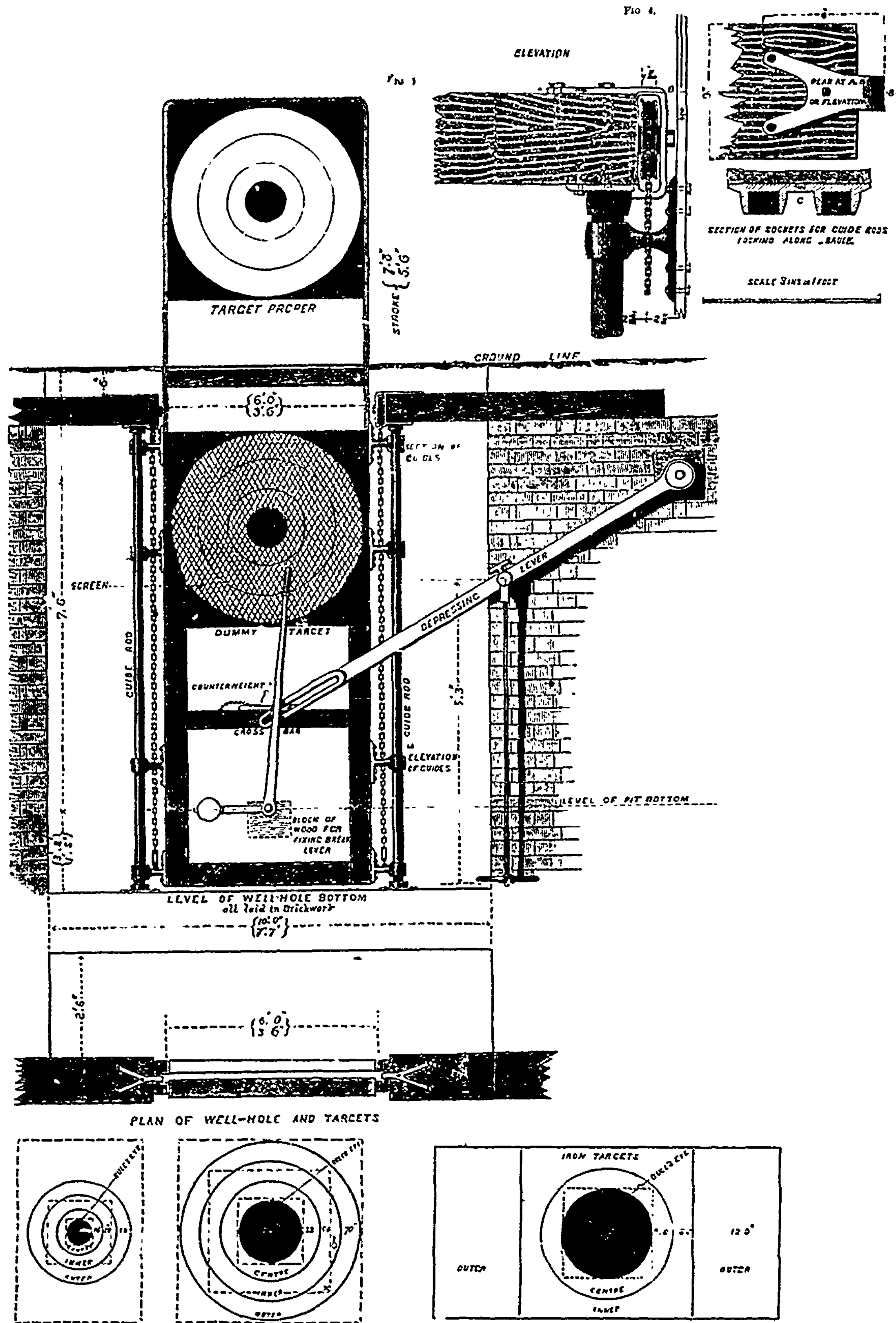
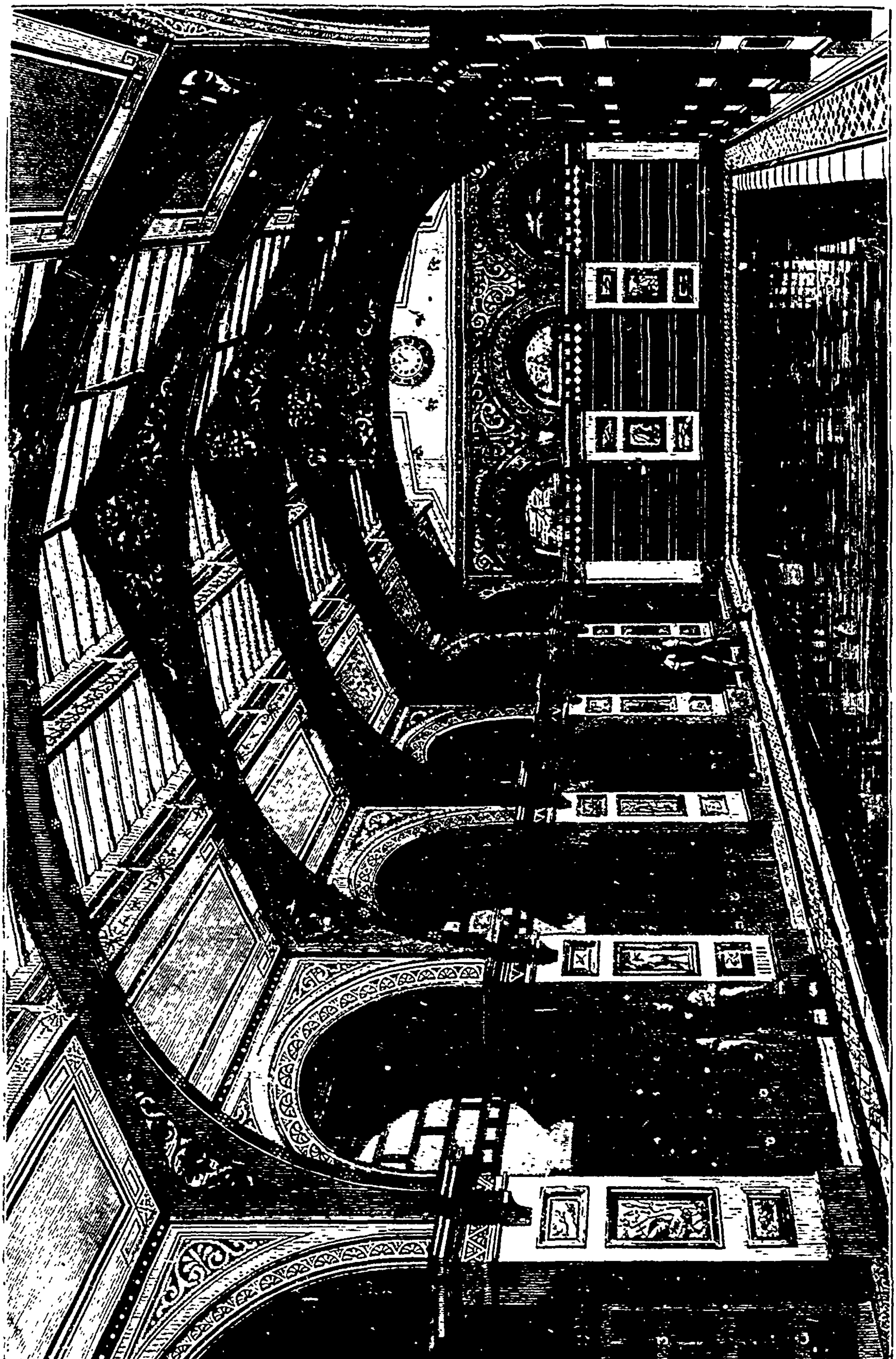


FIG. 2. FIG. 3.

THE NEW WIMBLEDON TARGET.



ST. MARYLEBONE NEW SWIMMING BATH.

THE NEW WIMBLEDON RIFLE TARGET.

The introduction, by the National Rifle Association at Wimbledon, of the new rifle targets, an invention of Captain Costin, the executive officer of the council, has had a material effect upon the shooting during the meeting of 1874, last summer. The object of the change was to inaugurate such a system of marking as should secure the highest possible conditions of fairness to the marksmen, to prevent the occurrence of "ties"—such a fertile source of annoyance heretofore—and to obviate the necessity for the severe labour hitherto exercised by the markers in the covered pits before the old iron targets, as well as to render their occupation a safer one. The following sweeping reform was therefore effected at all the butts, excepting those for the 800, 900, and 1000 yards ranges, those at which the Swiss targets had already been erected, and a few others of minor importance. The iron targets were removed, and a series of movable canvas ones were contrived somewhat similar in construction to the old Swiss ones, the peculiar merits of which had been satisfactorily tested. A novel system of marking was moreover applied to *all* the targets.

The nature of the new targets is of so interesting a character that we shall give a somewhat elaborate description of them. A series of longitudinal pits (see Fig. 1), connected by subterranean tunnels of brickwork, so as to enable the markers in one butt to communicate with those in another, is dug in front of the butts, in some cases to a depth of 9ft. and in others, to a depth of 11ft. These pits are portioned off by piers into recesses for the various targets, the recesses themselves and the piers between being revetted with brickwork. The front side of the pits is lined with boarding. Upon the summits of the piers stout baulks of timber are laid, which are securely bolted to uprights let into the brickwork and to a framing behind. The ends of the baulks project a little from the piers, and are sufficiently far apart to admit of the targets being placed between them. Standards of gas-pipe ascend from the foundations of the pits to the extremities of the baulks, two on either side, which act as guides, for the targets to run up and down on. These consist of two, a striking and a "dummy" target to each recess, the former being for the marksman to shoot at and the latter for the shot to be "marked" on. The target proper consists of an iron frame covered with canvas, which is painted with a large white circle and a back "bull's eye," &c., the corners being left black, the frame constructed of knife-edged iron presenting an angle of about 50 deg. to the front, which is assumed to be the best angle for preventing splashes from the bullets. The "dummy" consists of a wooden frame, covered and painted in a similar manner, except that the bull's eye is *red* instead of *black*, and that a wire screen is attached to the whole of the front surface to hang the marking discs on. The targets are hung to the ends of two chains, one on each side, which pass over pulleys fixed to the ends of the baulks of timber, sliding up and down the guide rods like buckets in a well, by means of the guides which are attached to their bottoms. Thus when the striking target is down the dummy target is up, and *vice versâ*. Now the striking target with its iron frame is of course heavier than the dummy, which has only a wooden one. Hence the normal positions of the targets would be with the dummy elevated. But the dummy has a long iron lever attached to it by an elongated slot passing over a button, the opposite extremity working on a fulcrum fixed in the wall or pier. To the centre of this lever a step is hung upon which a man can stand, and his weight is sufficient to counterbalance the difference between the weights of the wooden and iron frames. Thus we have two motions established. The iron-framed target raises the wooden-framed one, and the latter, with the marker standing on the step of the lever, raises the former. Practically, the iron-framed target is too violent in action, and a brake has consequently been placed upon the cross-bar of the dummy, which controls the action of the lever and at the same time acts as an additional counterweight. It lies loose upon the cross-bar when the dummy is down, but as the rounded end of the lever projects above the cross-bar during the ascent of the dummy, the counterweight, which is broad and hinged, is lifted, and when it is checked by the short break chain shown in the drawing, the further elevation of the dummy is correspondingly arrested. In order to keep the dummy down, when the marker gets off the step of the depressing lever, a break handle with a drop weight is contrived in the front wall of the well-hole into which the targets sink, this is lower than the pit-bottom, a stop on the brake-lever handle catching a button on the dummy target, and preventing its rising again until the handle is drawn back, as shown in the engraving. A small handle is placed upon the depressing lever alluded to before, for the marker to grasp in his descent, in order to prevent his hands being jambed between the lever and the wall.

Such is the arrangement of Captain Costin's new targets. Their mechanical working is capital; it is, however, anticipated that several modifications will be made in ensuing years, a better disposition of the woodwork framing behind the piers and of the baulks being contemplated. The dimensions of the targets, spaces, divisions, &c., may be seen by a reference to drawings Figs. 1 and 2. The smaller ones are not as yet completed, but will replace those marked "A" in Fig. 2 next year, they not having been fitted as originally intended.

The "marking" at all distances is with large discs hung upon the screen over the face of the dummy target, as nearly as possible over the corresponding spot to that which has been pierced by the bullet in the striking target. The arrangement is as follows:—

Bull's eye	signalled with	white disc	and scoring	5 marks.
Centre		red disc		4 marks.
Inner		white and black		3 marks.
Outer		black		2 marks.

A ricochet is signalled with the letter R on a disc. A shot striking outside the outer circle is not signalled. But in order more fully to satisfy the marksman in the identification of his shot, a small piece of zinc, with a hook upon it, called a "Bland's patch," is hooked into the actual aperture made in the striking target, where it remains until a consequent shot is fired, and can easily be seen with a binocular glass from the firing point.

The advantages resulting from the introduction of the new targets and the new system of marking are very apparent. The increase in the number of divisions on the face of the targets, from three to four, must necessarily diminish the chances of "ties." The occurrence of these often destroyed a good match at its termination. The alteration in the shape of the divisions from square to round is also an improvement. Observe the dotted lines in Fig. 2 for 500 and 600 yard targets which show the old marking. The shot marked *b* is actually nearer the centre of the bull's eye than that marked *x*, and yet it would have scored less under the old system of marking! We would, moreover, quote an incident to demonstrate the safety of working the new targets. A single important accident from bullet splashes occured during the Wimbledon meeting of 1874. This was at the *old* targets. The accuracy of the new system of marking a shot appears to have given general satisfaction to the volunteers and others engaged in prize shooting. As to the reduction or otherwise in the amount of labour required to be exercised by the marker's we can say nothing. Opinions differ on this point very widely.—*The Engineer.*

THE AUTOMATIC GAS SAVER.

It has been calculated that the average consumer of illuminating gas, in large cities, is subject to a waste which costs him from one quarter to one third more for gas than is really necessary to produce the requisite light. The reason is obvious from the fact that the pressure, as transmitted from the works, must always be sufficient to insure a full supply, not merely to the highest places, whither the gas rushes at greatest velocity, but to the lowest localities. The normal pressure, therefore, never falls to a point at which no waste at the burner can take place. Nor is it, indeed, possible for the manufacturer to supply each customer with the proper pressure to insure the greatest luminosity, for he is prevented, both by difference of situation of points of delivery and by the constant variation in the quantities drawn from the works by individual consumers. Cutting off at the service cock or using check burners simply reduces the light without affecting the proportional degree of waste; so that the only valid means of avoiding the latter lies in an apparatus which will automatically control the pressure, keeping the same uniformly at the most advantageous point, as the gas leaves the meter.

A new machine for this purpose has lately been patented (May 19, 1874), and engravings of the same are presented on page 220. The noticeable feature is the absence of the straight diaphragm, heretofore commonly employed, forming a flat dish, with the valve rod secured to its center, and governing the valve through its being forced upward as the pressure is augmented. The difficulty, due to the hardening of this appliance and consequent loss of its vibratory power, is, it is claimed, obviated in the present apparatus, by making the device of leather, covered with graphite, and in telescopic form, so as to have from one and a half to six inches vibratory motion, according to the size of the machine.

The operation will be understood from the sectional view, Fig. 1.

An increase of pressure, whether it occurs in the mains or service pipe, by putting out lights, is instantly communicated to membrane, A, the tension of which is thereby increased. As the membrane expands it is forced upwards, carrying with it the rod, C. which works the valve, E, and contracts the aperture through which the gas enters chamber, G; the quantity now admitted in a given time being exactly equal to that which passed when the pressure was less and the opening greater. When the pressure again diminishes, the tension of the membrane is of course relaxed, and being forced downwards by the weight in the cup, B, again carries with it the rod, C, and the aperture to the chamber, G, is enlarged. Thus it will be seen that the saver is a self-acting valve, the operation of which depends on the equalization of antagonistic forces, namely, the pressure of the gas within the chamber, G, impelling the membrane outwards, and the weight without impelling it inwards. By the combined action of these very dissimilar agents, the area of this aparture, by which the gas enters chamber, G, is exactly adjusted to the velocity with which it moves. From the chamber, G, the gas escapes by the outlet pipe.

The comparative size of the apparatus and its mode of adjustment to the meter are shown in Fig. 2. The effect upon the flame will also be noticed. The construction is substantial and durable, the best quality of sheet copper, without seam, being used to confine the gas. The valves are ground and fitted so as to control a single burner, and may be readily cleaned of impurities.

The manufacturers add that whoever pays six or eight dollars, or even less, a quarter for gas, will save at the rate of from twenty to forty per cent on his gas bills by using this machine.

BOLT AND STUD-END CUTTER.

We illustrate, from *Engineering*, on page 220, a very handy little tool for finishing the ends of bolts and studs. It consists, as will be seen from Fig. 1, of a tubular body which is screwed upon the stud or bolt, of which the end is to be cut, a ring or washer being slipped over the stud so that the body of the tool is screwed up against an abutment. Within the body there is a short spindle, the lower end of which forms a tool-holder, as shown in Figs. 1, and 3, while the upper end carries a handle by which it can be rotated. The upper part of the body of the tool is counterbored, and has a screw thread cut within it, there being fitted to this portion a nut, the head of which has teeth cut around it, as shown in Fig. 5. This nut does not directly fit the spindle carrying the tool, there being interposed between the two a thin brass bush having a collar formed at its lower end. From this collar project two lugs which fit into grooves or keyways cut in the screwed portion of the body, as shown in Fig. 1, and 2. These lugs prevent the bush from moving round with the spindle, and thus prevent any motion from being communicated to the nut by friction as the spindle revolves.

The nut of which we have just been speaking gives the downward feed of the tool, the nut receiving an intermittent motion by the neat and simple arrangement of self-acting gear shown by Figs. 1, and 5. From these views it will be seen that the handle carries on its underside a small casing containing a detent or pawl, which is forced towards the feed nut by a spiral spring. This detent has a face deeper than the nut and the lower part of this face bears against a collar which almost surrounds the upper end of the body of the tool, this collar being, however, cut away at one point so as to form a notch shown in the plan Fig. 5. For the main part of each revolution the feed pawl bears against this collar, and is prevented by the latter from engaging the teeth of the feed nut; on the notch being reached, however, it enters it, and at the same time engages with the feed nut, the latter being then carried round until the pawl is lifted out of gear again by sliding up the inclined side of the notch.

The form of cutting tool used is clearly shown by the engravings, and it is, as will be seen, of a simple shape and easily fixed. Being fixed on the stud or bolt to be operated upon, the tool makes a perfectly steady cut, and turns out excellent work, the finish being fully as good as could be obtained in a lathe. Mr. Nelson informs us that by the aid of this tool twelve ⅞ in. stud ends can be finished in twelve minutes, while there is the advantage that the work is done without incurring the risk of breaking or loosening the stud or bolt. Altogether the tool is a very useful one, and we expect to see it largely used.

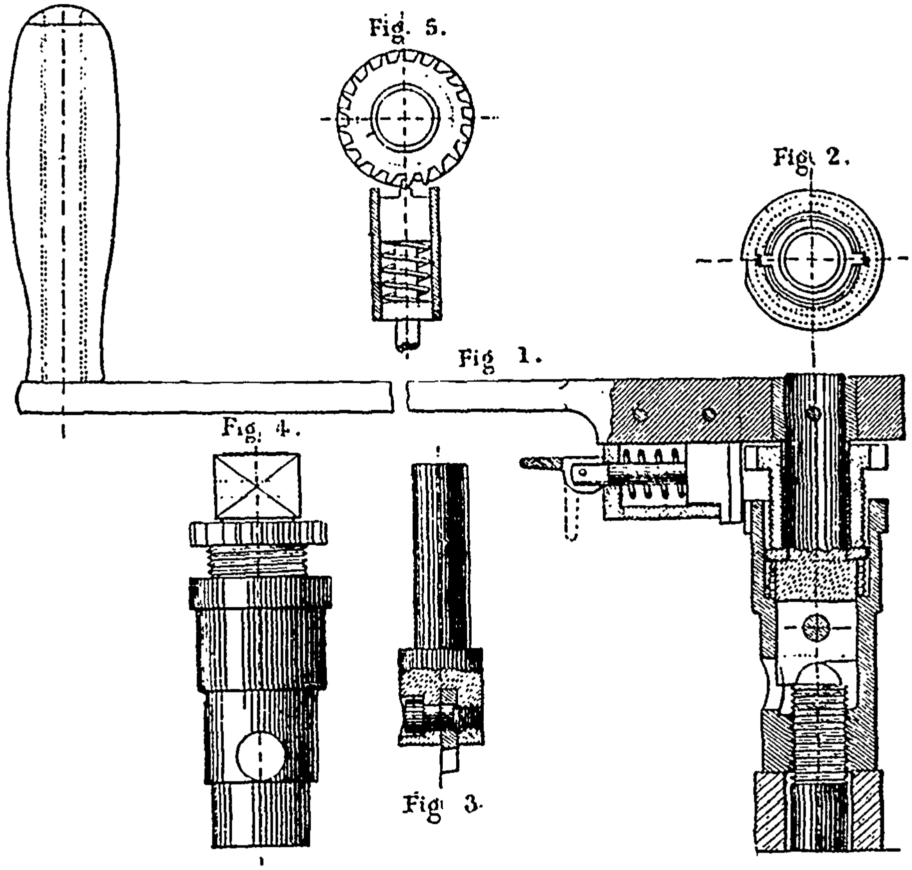
MISCELLANEOUS.

The Tempering of Steel.—The Government of the United States has acquired, for the sum of 10,000 dols. the following process, invented by MM Garnant and Seighfield, for tempering steel:—"The steel, heated to a cherry red, is sprinkled with sea salt and worked in this state until it has assumed nearly the form required, the chloride of sodium being renewed from time to time. For the latter is afterwards substituted a mixture of equal parts of chloride of sodium, sulphate of copper, sal-ammoniac, carbonate of soda, and a half pint of saltpetre. The steel is again heated, and the hammering is continued until the steel becomes refined throughout its whole substance and assumes the desired shape. It is then again brought slowly to a cherry-red heat, and plunged into a bath of 3 7 litres (3¼ quarts) of rain water, 42 4 grammes (1·484 oz.) of alum the same quantity of carbonate of soda and sulphate of copper, 28 3 grammes (1 oz) of saltpetre, and 169 8 grammes (5 843 oz.) of chloride of sodium.

Latent Heat of Steam.—During the change of water into steam, a remarkable phenomenon has been discovered, being nothing less than the apparent disappearance of large amounts of heat, which appear to be consumed in order to overcome the cohesion of the water particles, and change it into a repulsion, which is the cause of the expansive elasticity of the steam, and results in the useful application of its pressure. The heat which thus disappears is called the latent heat of steam, and it reappears again as soon as the gaseous steam returns to the condition of liquid water. The amount of this heat is about 1000 units; that means, in order to convert 1 lb. of water of 212 deg. into steam of the same temperature, 1000 units of heat will disappear, or as much heat as would suffice to heat 1000 lb. of water 1 deg., 100 lb. 10 deg., or 10 lb. 100 deg., consequently, as 1 lb. of anthracite coal gives 14,220 units of heat, it will convert 14 2 lb. of water, and bituminous coal 13 5 lb. of water into steam. The amount of expansion which the water undergoes during this change is an increase in bulk of about 1700 times; and as 1 cubic foot contains 1728 cubic inches, the usual statement that every cubic inch of water becomes a cubic foot of steam is nearly correct for practial purposes.

A patent has recently been taken out in France for the preparation of leather from tripe, intestines, and other animal membrances. These are soaked in milk of lime while still fresh, then washed in water, and finally immersed in a paste made of starch and white of eggs. The substance thus formed is to be used for glove making, etc., and may also be tanned or curried.

Well worn files are first carefully cleaned with hot water and soda; they are then placed in connection with the positive pole of a battery, in a bath composed of 40 parts of sulphuric acid and 1000 parts of water. The negative is formed of a copper spiral surrounding the files but not touching them; the coil terminates in a wire which rises toward the surface. This arrangement is the result of practical experience. When the files have been in the bath ten minutes they are taken out, washed and dried, when the whole of the hollows will be found to have been attacked in a very sensible manner, but should the effect not be sufficient, they are replaced in the bath for the same period as before. The files, thus treated, are to all appearance like new ones, and are said to be good for 60 hours' work. M. Werdermann employs twelve medium Bunsen elements for his batteries.



BOLT AND STUD-END CUTTER.

Fig. 1.

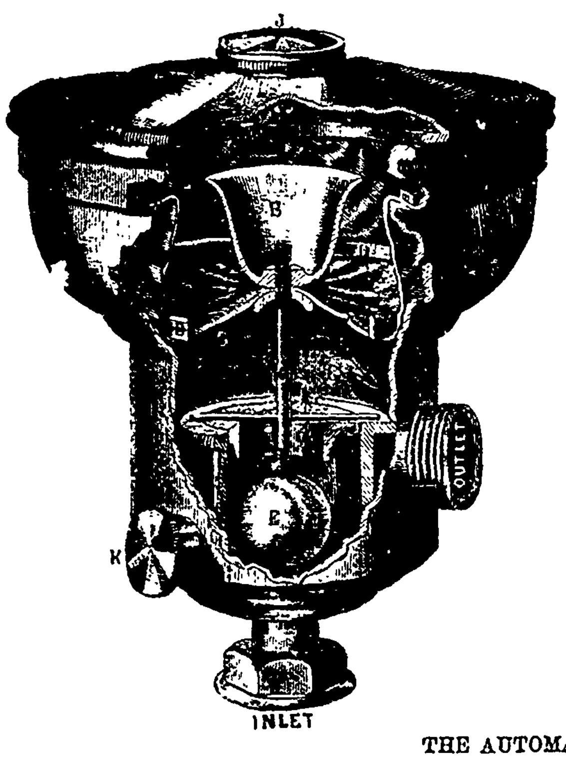
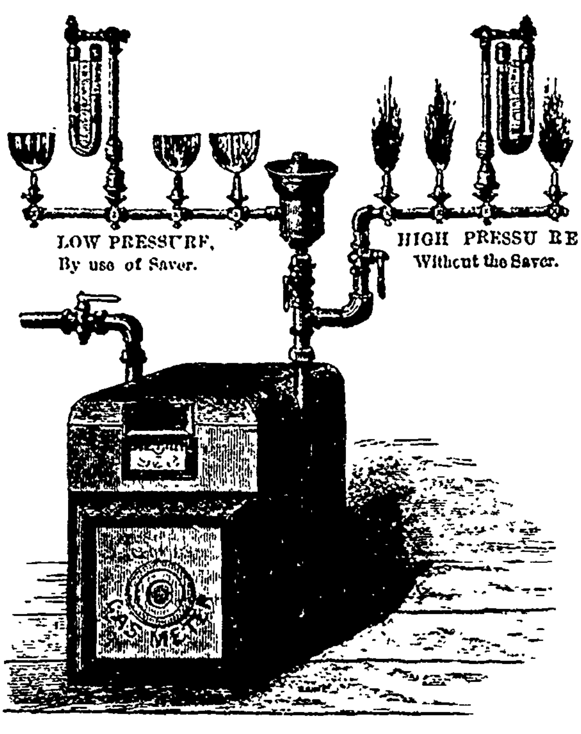
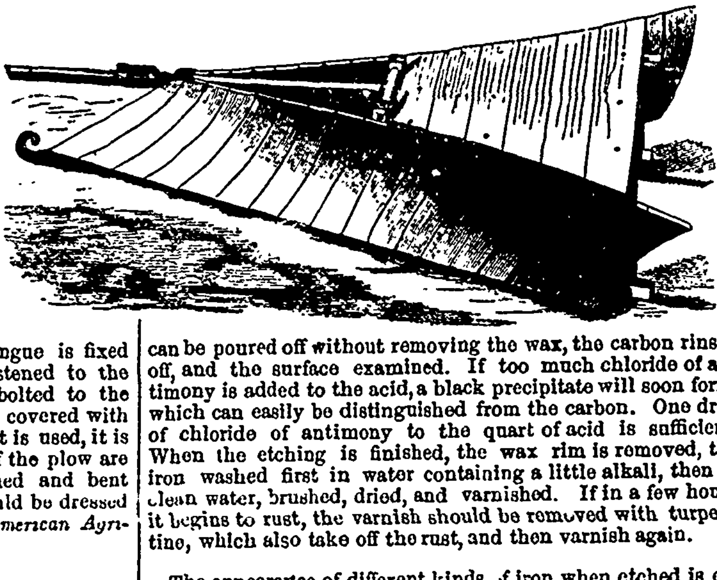


Fig. 2.



THE AUTOMATIC GAS SAVER.

ELEPHANT ATTILLERY SERVICE.



HOW TO BUILD A SNOW-PLOW.

The snow-plow illustrated on this page is built so as to be fixed upon the forward part of a double sled. The frame is made of 4 × 4 oak scantling, and is similar in form to a double mold-board plow. One runner is fixed to the forward part, at such a distance below the edge of the plow as to raise it to clear obstacles such as stones or frozen mud which may be in its way. Four inches would probably in general be a safe distance. The hinder part of the plow rests upon the sled as shown in the engraving, and is bolted to it. A long tongue is fixed into the place of the ordinary one, and is fastened to the front of the plow by an iron strap, which is bolted to the frame. The hinder portion of the plow may be covered with boards, and a seat fixed firmly upon it. When it is used, it is best to load it as much as possible. The sides of the plow are made of half-inch oak or basswood strips, steamed and bent into shape. The outer surface of these strips should be dressed smoothly, which will make the draft easier.—*American Agriculturist.*

ETCHING IRON.

Much time and attention has been devoted by Prof. Kick, of Prague, to the subject of etching iron with acids. His method is not a new one for arriving at a knowledge of the quality of iron or steel, having been used with some success for a long time, but the care with which the professor has conducted his experiments makes them exceedingly valuable.

Some kinds of iron exhibit what is known as the passive state, and are unacted upon by acids until this state has been destroyed by heating. The surfaces thus prepared were inclined to rust very soon. After a series of experiments with nitric, sulphuric, and hydrochloric acids, and etching solutions of copper salts, Prof. Kick found that a mixture of equal parts of hydrochloric acid and water, to which was added a trace of chloride of antimony, was the best etching solution. The chloride of antimony seems to render the iron less inclined to rust, so that, after washing thoroughly in warm water, and applying a coat of Damar varnish, the etched surface may be preserved quite clean.

The smooth surface that is to be etched is surmounted with a ridge of wax an inch high, as is done in etching copper plates, and the acid is poured into the disc thus formed. At a temperature of 55 to 65 deg. Fah. the action soon begins, as shown by the gas evolved; in winter the etching is poor. The time required is from one to two hours, but the etching should go on until the texture is visible. Every half hour the acid can be poured off without removing the wax, the carbon rinsed off, and the surface examined. If too much chloride of antimony is added to the acid, a black precipitate will soon form, which can easily be distinguished from the carbon. One drop of chloride of antimony to the quart of acid is sufficient. When the etching is finished, the wax rim is removed, the iron washed first in water containing a little alkali, then in clean water, brushed, dried, and varnished. If in a few hours it begins to rust, the varnish should be removed with turpentine, which also take off the rust, and then varnish again.

The appearance of different kinds of iron when etched is essentially as follows:—Soft or sinewy wrought iron of excellent quality is attacked so equally by the acid, and so little carbon is separated, even after several hours' action, that the surface remains bright and smooth. Fine grained iron acts the same; the surface is still smoother, but a little darker. Coarse grained and cold-short iron is attacked much more violently by acid than the above. In ten minutes, especially with the latter, the surface is black. After thirty minutes a black slime can be washed off, and the surface will remain black in spite of repeated washings, and exhibits numerous little holes. Certain parts of the iron are usually eaten deeper, while others, although black and porous, offer more resistance. By allowing the acid to act for an hour or so, then washing, drying, and polishing with a file, a distinct picture is obtained. Malleable cast iron, we know, rusts more easily than wrought iron, and it is interresting to know that the action of acids is also violent, the surface being attacked very violently. Grey pig-iron acts like steel, the etched surfaces have quite a uniform grey colour. In puddled steel the colour, after etching and washing, is grey, with quite a uniform shade, and the lines are scarcely visible. Cement steel has a very similar appearance, the lines being very weak. In Bessemer and cast steel the etched surfaces are of a perfectly uniform grey colour, with few, if any, uneven places. The softer the steel the lighter the colour.

On etching, the finest hair-like fractures are rendered prominent. A piece of steel, which looked perfect before etching, afterwards exhibited a hair-like fracture throughout its whole length. When different kinds of iron are mixed the acid attacks that for which it has the greater affinity, while the other is less acted upon than if it were alone. Etching is exceedingly valuable to all who deal largely in iron, as as it enables them to determine with comparative accuracy the method of preparing the iron, as in the case of rails, &c., as well as the kinds employed.

CANADA.

The Fort Pelly telegraph line now shows itself on Main street, Winnipeg.

Work on the Victoria Railway is advancing rapidly. The grading in the vicinity of Fenelon Falls is being pushed on vigorously. The bridge over the Fenelon River is well advanced.

A Chinaman while gold digging near Quesnelle, British Columbia, found a piece of gold weighing 25 oz., said by good judges to be the prettiest, best and one of the largest specimens ever found in that province.

The C. P. R. survey party under Mr. John Trutch were, about the 1st. inst., camped on the north side of the Fraser, a little below St. Mary's Mission. It was proposed to cross at One Tree Island, and keep down the north side to New Westminster and Burrard Inlet.

A new car for the use of Mr. Thomas Reynolds, Managing Director of the St. Lawrence and Ottawa Railway Company, arrived at Prescott last week. It is something after the style of the "Pullman," and is, like it, divided into different apartments. It was built at Taunton, Massachusetts, Car Works, and is handsomely and richly fitted up.

A paper mill has been established at Ponobsequis, N.B. A local paper manufactory was a want long felt in the Province, and particularly in St. John, where the daily consumption is very large, and where the publishers of the daily papers have often been put to great inconvenience and loss through delay in the arrival of their orders from Canadian or other houses.

The New Brunswick Railway, through the prompt action of the Minister of Public Works in furnishing old rails at market prices, will be able to make good its promised extension to Andover this season. This will be an immense boon to the lumber trade and to the business of the country generally. Supplies will now be got through to all points during the winter. The Company may have to pay a pretty smart price for the rails, but the obligations of the country to the Government for acting so promptly are none the less.

A wood boat has sailed from St. John, N. B., for Havana, Cuba, with a general cargo. It is considered a foolhardy enterprise.

Mr. Baillargé, Corporation engineer of the North Shore Railway, has prepared a report of his first tour of inspection, which will be presented to the City Council to-night. Mr. Baillargé expresses himself agreeably surprised at the quantity and quality of the work done on the road.

Philipsburgh, Farnham and Yamaska Railroad.—Mr. Gauvreau, the chief Government engineer of Quebec, examined the first section of the line just graded, south of this place, to-day, in company with Mr. Leggee, the engineer-in-chief of the road, and Mr. Foster, the contractor. Mr. Gauvreau expresses himself well satisfied with the progress made and with the character of the work. The completion of the first section will ensure the Government grant next season. It is expected that the road will soon be completed to Philipsburg and open for traffic, a distance of forty-six miles, through a thickly-settled section of the country, to which it will prove of the most inestimable value. This line will extend from opposite Three Rivers to Philipsburg, on Lake Champlain, a total distant of about one hundred miles, and is the most direct and cheapest route for the transport of lumber and minerals from the great St. Maurice district, north of Three Rivers, to the American markets, at the same time affording immense facilities for the transport of hay, grain, and other agricultural products of the fine country through which it passes to the best American and Canadian markets.

A large deposit of fire brick clay—the only one, it is said, in Canada—has lately been discovered at the head of Moore's Lake and Gull River, on lot No. 24, in the 6th concession of Lutterworth. Mr. Thomas Leary, the owner of the property, is negotiating with a party in Toronto to establish a fire-brick manufactory on the spot, and the negotiations are likely soon to be completed. Its superior quality over other clay is that it contains neither lime, magnesia nor iron, which renders it more refractory than any other clay. This is one of the most important discoveries ever made in the backwoods, and the supply of the material is believed to be practically inexhaustible.

The new locomotives for the Intercolonial Railroad, are to be ready by the 15th of June. Of these twenty are being built by the Baldwin Works, Philadelphia, 10 by the Kingston Locomotive Works and 10 in Halifax. The last mentioned lot have been in hand for nearly three years, if we remember rightly, and are about half completed. The Baldwin locomotives are to be delivered free of all charges, at $9,000 a piece, United States funds. The Kingston contract was only secured for a Canadian establishment by giving them the benefit of the duty on the foreign article, by which arrangement their price is so much more than that of the Baldwin Works. We believe the same thing was done in the case of Messrs. Harris & Co., and we consider it perfectly right. The rule of Council, admitting foreign works free of duty, has been suspended and will probably never again be in force. This is a movement in favor of Canadian industry, and it is of the most beneficial character.—*St. John Telegraph.*

The following particulars respecting the first discovery of gold in Nova Scotia are given by Mr. Heatherington in his report on the mining industries of that territory.—The existence of gold in the Province appears to have been known to its earliest settlers, judging from the ancient names of "Cap d'or," "Brass d'or," Jeddore (evidently a corruption of "jeu d'or," or jet d'or," and *Gold* River, in all of which localities the metal has since been found. In Dr. How's *Mineralogy of Nova Scotia* it is stated that gold was found one hundred years ago, and gold washing was practised in the river Avon, at Windsor, about the beginning of the present century. The same authority also writes that the late Canon Gray, D.D., Rector of Trinity Church, St. John's, New Brunswick, who died in 1868, aged 70, told him that as a boy he had taken gold out of rocks on his father's property, near Halifax, and had it smelted by a jeweller in that town, and that Mr. B. G. Gray barrister-at-law, and son of the deceased clergyman, possesses old documents which show that particular importance was attached to certain parts of the family estate, presumably from the known existence of gold. Its occurrence also in Sherbrooke, Isaac's Harbour, and Lawrencetown is stated to have been familiar to the oldest residents. The first recorded instance of scientific discernment aiding discovery, and suggesting the existence of gold-bearing quartz of economic importance, is that of a captain of the Royal Welsh Fusiliers, who, in the spring of 1840, pointed out the auriferous character of the rocks at Gold River, near Chester, but, being on the eve of departure with his regiment, was unable to prosecute a search in person; and it was only after a lapse of twenty-one years that explorations were made and the correctness of his observations proved. The probable occurrence of gold is also mentioned in Sir Charles Lyell's *Notes on the Geology of North America* (1842;) and in the first edition of Dr. J. W. Dawson's *Acadian Geology* (1855), but really practical results were first derived from the following discoveries.—MM. John Campbell and R. G. Fraser washed gold from the beach near Halifax in 1857; and in August, 1858, Mr. E. A. Mitchell, of Halifax, obtained a specimen of auriferous quartz, which was seen by Mr. W. D. Sutherland, solicitor, and subsequently sent to Dr. How, at King's College, Windsor. In 1858 Captain Champagne L'Estrange found gold at Mooseland, Tangier; and in May, 1860, Mr. John Gerrish Pulsiver made the discovery which actually laid the foundation of the gold-mining industry of the Province. With the exception of Mr. Campbell, who was temporarily employed by the Government, these discoverers have received no reward.

REPORT OF WALTER SHANLY, ESQ, C.E., ON THE CAUGHNAWAGA SHIP CANAL.

North Adams, (Mass.)
24th August, 1874.

Hon. John Young,
President Caughnawaga Ship Canal Co.

Dear Sir,—In compliance with your request, that I would examine into, and give my views of, the cost of constructing the "Caughnawaga Canal," so called, and state my opinion, generally, as to the desirability of the work and its probable effect on the trade of the country, I now beg to say :—

First—As respects cost—I have made an estimate based on the dimensions of this canal proposed by the late J. B. Mills, Civil Engineer, in 1848, and which are identical with those of the existing St. Lawrence canals—lock 200 x 45 feet, with 9 feet of water on the sills.

I, of course, accept as correct Mr. Mills' quantities of the several kinds of work embraced in the construction of the canal on the plan referred to, and do so with the utmost confidence in their reliability; a confidence inspired by my knowledge of the care and accuracy with which such calculations ever came from the hands of my deceased friend, and at one time, professional chief.

His estimate of cost amounted in the aggregate to $1,814,-408, which under the prices ruling for such kind of work five and twenty years ago would have been ample at the time, but in view of the great advance in the value of labour, materials, lands, and all things else entering into the cost of undertakings of the sort, I cannot bring the amount that would now be required to complete "Mr. Mills' Canal" in a proper and substantial manner below $3,763,000; in which, however, permanent stone structures are provided for where, in some cases, aqueducts for instance, the original estimate contemplated using wood.

Having now entered upon (at least we have been told so: the external manifestations of the fact are not wholly convincing yet) a second era of Canal enlargement in Canada, the "Caughnawaga" scheme will, of course. have to be reconsidered and remodeled in some of its originally proposed details to make it fit in with the other parts of the system — whatever that is to be. The dimensions adopted for the new, or improved, Welland canal, are—locks 270 x 45 feet, with 12 feet water on the mitre sills.

Not having access to Mr. Mills' detailed plans and notes of survey, I am without the requisite data for making more than an approximate estimate of the cost of constructing the Caughnawaga canal on the scale of the "enlarged Welland," but, approximately, I would not venture to state the additional outlay at much less than 50 per cent. advance on the cost of the lesser work. In other words, the Caughnawaga canal on the dimensions above assigned to the Welland would involve an outlay of some $5,500,000. But I do not think that such large capacity, in respect of depth at all events, is needful to ensure to a canal connecting the St. Lawrence with Lake Champlain its fullest measure of usefulness and success. The difference in cost in a canal adapted to vessels of 12 feet draught and one of two feet less depth would, in this instance, be not far short, probably, of a million and a quarter of dollars. Ten feet draft is as much as is required, and on that basis the Caughnawaga canal may be constructed for about $4,250,000.

So much for my views on the cost question; and now, with your permission I will touch upon the general proposition of the improvement and perfecting of our canal system, as bearing on the Lake Champlain connection.

It is undoubtedly desirable and important that our river improvements—St. Lawrence and Ottawa alike — should be of uniform design; parts of one system; but I hold that the Welland canal ought to be conceived and carried out on a widely different scale, as having a different mission to fulfil. The object of the Welland canal is, or should be, to do away with, so to speak, the barrier dividing Lake Ontario from the Lakes above by making the canal of such ample proportions as will pass, with the least perceptible interruption possible, the largest vessels employed in the carrying of flour and grain. Chicago harbour, formerly adapted to vessels of ten feet draft only, has been improved to 14 feet of depth, and with any less water on its locks-sills the Welland canal will not properly accomplish the object indicated above. The largest propellers loading in Chicago or other upper lake ports should at least, be allowed the option of proceeding without break of bulk to the extremest easterly point of lake navigation in Canadian waters—Kingston or Prescott. Let the bulk, or even a fair proportion of the bulk, of western freight once get down into Lake Ontario, and we of the River can battle for it with every certainty of being able to carry off the victor's share.

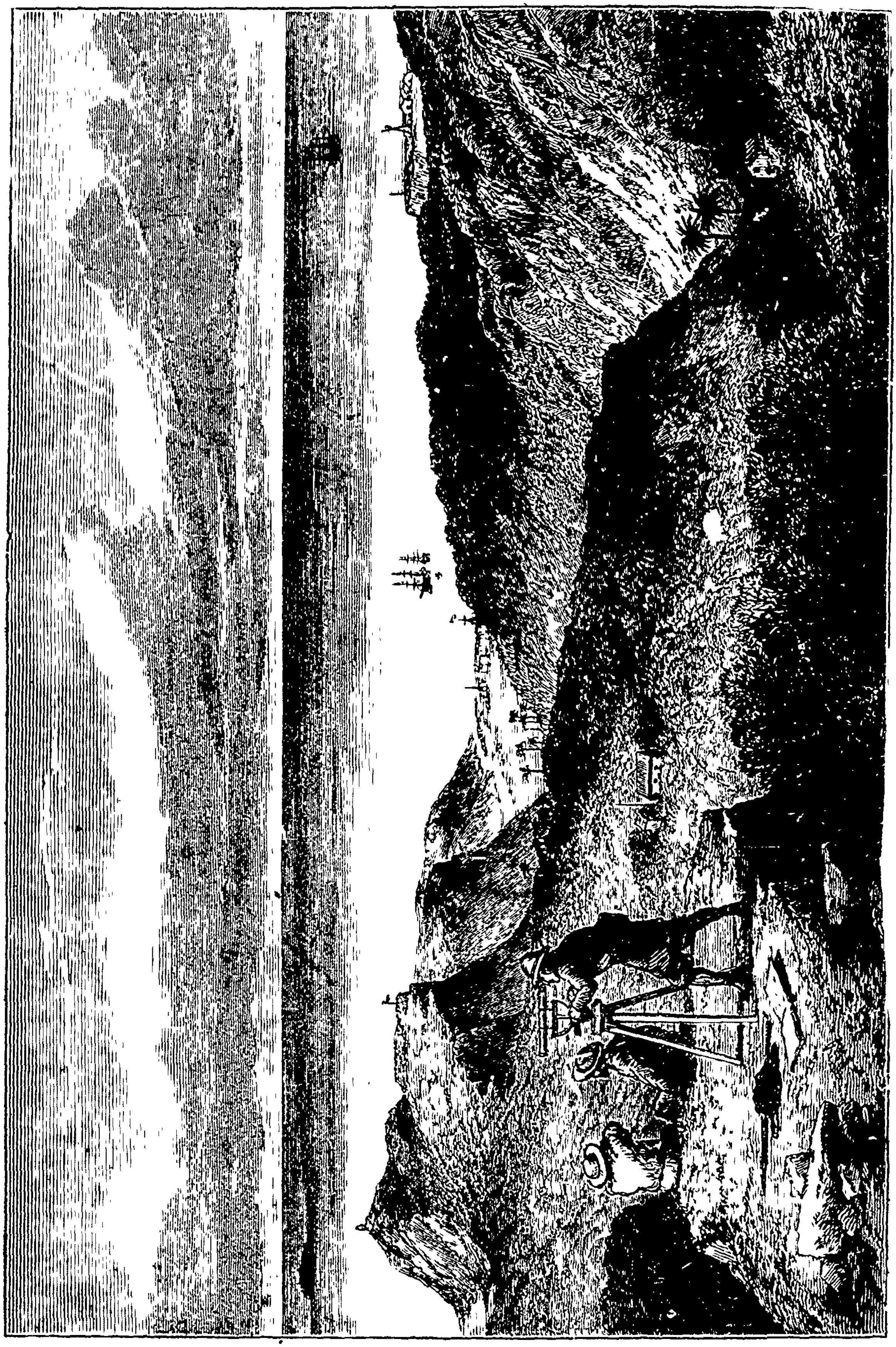
Transhipment from lake vessels to river and canal craft will be the rule in our St. Lawrence carrying trade. Occasionally, in the future as now, a ship will clear from lake ports for a trans-oceanic voyage, and then, as now, let us "improve" our river navigation to the utmost possible capacity that money can effect, will find herself taking low rank among and consequently unfitted to compete on equal terms with, purely sea-going vessels. Direct freighting from the Lakes to Europe will, therefore, for ever be exceptional. Transhipment will be the rule, because it will pay best all round, and the first transfer of cargo will for the most part take place at the point beyond which, because of the shallowing of the water, the largest lake vessels cannot descend. The river navigation never can be improved to the capacity of the lakes, and sailing masters will not throw away the advantage of the two, three, or four feet greater draught that lake navigation will allow of, as compared with the river, merely that they may pass "clear through" to Montreal or Quebec, or, mayhap, odd times to Liverpool.

If, then, lake-navigation is always to imply a totally different class of vessels from that best suited to the river, the next point to be considered is—what is the most fitting craft for the latter service, and what the extreme depth of water really needed for such craft, and that can be obtained within reasonable limits of expenditure.

The bulk of the grain trade from Kingston to Montreal has for the last ten years or thereabouts, been done by means of barges of the extreme size that the St. Lawrence canal-locks are capable of passing, and the capacity of the largest of which (the barges) may, I suppose, be taken at about 22,500 bushels. If then, as is, I think, easily susceptible of proof, no cheaper, safer, or speedier mode of transporting flour and grain over the river portion of the route between Chicago and the ocean (or ocean vessel) can be devised, the barge undoubtedly will continue to be employed to the exclusion of almost every other kind of craft, and the use of propellers for the carrying of those commodities through river and canal, each propeller with engine-power enough for the movement of half a dozen barges, each carrying a propeller's cargo, will, year by year, bear diminishing proportions to the barge fleet.

The St. Lawrence canals, as already noted, have locks of 200 x 45 feet, and were meant to have 9 feet of available depth, but, as a matter of fact, not above 8½ feet can be depended on; not, at all events, in such low-water periods as we have been having experience of in recent years. Had those works been designed in the first instance for ten feet draught, and the sills of the locks put down to where that depth would have always been certain, we should probably never have heard much about future enlargement — not as to depth at any rate. To improve those canals to ten feet draft now will be a work of very large expense, only to be achieved at serious temporary inconvenience to the trade of the river, and it may be worth weighing whether prudence would not counsel to abandon the attempt to deepen them, and, instead, to give the forwarders compensation in increased length of lock—a simple and inexpensive mode, as compared with the delay and cost of deepening, and where expediency has to be practiced, of gaining increased capacity. The St. Lawrence canals, as they are, even, are capable of doing a large business in our season of 200 days or thereabouts. They have never yet been taxed to anything near their full powers of accommodation. I am quite sure that seventy-five milion bushels in the season, and that means a very large business, would not over-tax them. Still, increased capacity will be demanded, and in one form or another must be conceded; but whatever the plan adopted, I hold to ten feet as the greatest depth of which river navigation, without incurring needlessly large outlay, is susceptible, and that for that depth all future improvements, on both rivers, should be planned, and to that depth limited.

(To be continued.)



TRANSIT OF VENUS.—TRIANGULAR OF ISLAND OF RODRIGUEZ.