Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- [ ] Coloured covers/ Couverture de couleur
- [ ] Covers damaged/ Couverture endommagée
- [ ] Covers restored and/or laminated/ Couverture restaurée et/ou pelliculée
- [ ] Cover title missing/ Le titre de couverture manque
- [ ] Coloured maps/ Cartes géographiques en couleur
- [ ] Coloured ink (i.e. other than blue or black)/ Encre de couleur (i.e. autre que bleue ou noire)
- [ ] Coloured plates and/or illustrations/ Planches et/ou illustrations en couleur
- [x] Bound with other material/ Relié avec d'autres documents
- [x] Tight binding may cause shadows or distortion along interior margin/ La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure
- [ ] Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/ Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.

- [ ] Coloured pages/ Pages de couleur
- [ ] Pages damaged/ Pages endommagées
- [ ] Pages restored and/or laminated/ Pages restaurées et/ou pelliculées
- [x] Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
- [ ] Pages detached/ Pages détachées
- [x] Showthrough/ Transparence
- [x] Quality of print varies/ Qualité inégale de l'impression
- [x] Continuous pagination/ Pagination continue
- [ ] Includes index(es)/ Comprend un (des) index

Title on header taken from:/
Le titre de l'en-tête provient:

- [ ] Title page of issue/ Page de titre de la livraison
- [ ] Caption of issue/ Titre de départ de la livraison
- [ ] Masthead/ Générique (périodiques) de la livraison

- [ ] Additional comments:/ Commentaires supplémentaires:

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X		14X		18X		22X		26X		30X	
	12X		16X		20X		24X	✓	28X		32X

The Canadian Patent Office Record and Mechanics' Magazine

Vol. II.—No. 4. JULY, 1874. Price in Canada $2.00 per An·
United States - $2.50 "

SIR WILLIAM FAIRBAIRN.—(See page 110.)

PRINCIPLES OF SHOP MANIPULATION FOR ENGINEERING APPRENTICES.*

By John Richards, M.E.

(*Continued from page* 74, vol 2.)

MOTIVE MACHINERY.

Water wheels, next to steam engines, are the most common motive agents. For centuries water wheels remained without much improvement or change, down to the period of turbine water wheels, when it was discovered that instead of being a very simple matter, the application of water power really involved some very intricate conditions, and this gave rise to many problems of scientific interest, that in the end produced the modern turbine wheels.

A modern turbine water wheel, of the best construction, operating under favorable conditions, gives a percentage of the power of the water that (taking into account the friction of the wheel itself) almost reaches the theoretical co-efficient due to gravity, and it may be assumed that there will in the future be but little improvement made in such water wheels except in the way of simplifying and cheapening their construction. In fact, there is no other class of machines that seems to have reached the same state of perfection as water wheels, nor any other class of machinery that is constructed with the same uniformity of design and arrangement in different countries and by different makers.

Every one remembers the classification of water wheels met with in the older school-books on natural philosophy, where we are informed that there are three kinds of wheels—as there were "three kinds of levers"—namely, overshot, undershot, and breast wheels, with a brief notice of Barker's mill, that ran apparently without any good reason for so doing.

Without finding fault with this plan of describing water power, further than to say that a little explanation of the principles by which power is derived from the water would have been more useful, I will venture upon a different classification of water-wheels, that is more in accord with modern practice, and without reference to the special mechanism of the different wheels, except when unavoidable.

Water-wheels can be divided into four general types :

1. Gravity wheels, acting directly from the weight of the water which is loaded upon one side of a wheel revolving in a vertical plane, the weight resting upon the wheel until the water has reached the lowest point where it is discharged.

2 Impact wheels, driven by the force of spouting water that expends its percussive force against the float tangentally to the course of rotation and at a right angle to the face of the floats or vanes.

3. Reaction wheels, that are "enclosed," as it is termed, and filled with water under pressure, this water being allowed to escape through tangental orifices, and the force being derived from the unbalanced pressure within the wheel or from the reaction due to the weight of the water that is thrown off from the periphery.

4. Pressure wheels, acting in every respect upon the principle of a rotary steam engine, except so far as differences arise from operating with a non-elastic instead of an elasting fluid, the pressure of the water resting continually against the floats or abutment, without chance to escape except by the rotation of the wheel

To this classification might be added combination wheels, acting partly by the gravity and partly by the percussive force of the water; or acting partly by impact and partly by reaction, or by impact and pressure, which are common conditions of operation in water wheels.

The water wheel or water power, as a mechanical subject, is apparently quite disconnected with shop manipulation, but serves as a good example for conveying general ideas of force and motion, and, on these grounds, will warrant a more extended notice than the seeming connection with the general subject would otherwise call for.

In the remarks upon steam engines it was explained that power is derived from heat, and that the water and the engine were both to be regarded as agents through which power was applied, and, further, that all power is a product of heat. There is, perhaps, no problem in the whole range of mechanics more interesting than to trace the application of this principle to water wheels : one that is not only interesting, but instructive, and may suggest to the mind of the apprentice a course of investigation that will apply to many other matters connected with power and mechanics.

The power derived from water by means of wheels is due to the gravity of the water in descending from a higher to a lower level; but the question arises, what has heat to do with this? if heat is the source of power, and power a product of heat, there must be a connection somewhere between heat and the descent of the water.

Water in descending from one level to another can give out no more power than was consumed in raising it to the higher level, and this power we will find to be heat.

Water is evaporated by the heat of the sun, expanded until it is lighter than the atmosphere, rises through the air, and by condensation falls in the form of rain over the earth's surface, then drains into the ocean through streams and rivers, to again resume its round by evaporation, giving out power in its descent that we turn to useful accounts by means of water wheels. Evaporation is continually going on; the rainfall is likewise quite constant, so that streams are maintained within a sufficient regularity to be available for operating machinery.

The analogy between steam power and water power is, therefore, quite complete. Water is, in both cases, the medium through which power is obtained; evaporation is also the leading principle in both cases, the main difference being that in the case of steam power there is used a force arising directly from the expansion of water by heat, and in water power a force which is an indirect result of expansion by heat.

Returning to the classification of water wheels, gravity or "overshot" wheels, as they are called, seem to be the most effective and capable of utilizing the whole effect due to the gravity of the water; but in practice this is not the case, and it is only under peculiar conditions that wheels of this class are preferable to turbine wheels, and in no case will they give out a greater per cent of power than turbine wheels of the best class. The reasons for this will be apparent by examining the conditions of their operation.

A gravity wheel must have a diameter equal to the fall of water, or, to use the technical name, the height of the head The speed at the periphery cannot well exceed 16 ft. per second without losing effect due to the descending weight of the water. This produces a very slow axial speed, and a train of multiplying gearing becomes necessary in order to reach the speed required in most operations where power is applied. This train of gearing, besides being liable to wear and accident, and costing usually a large amount as an investment, consumes a considerable share of the power by frictional resistance, especially when the gearing consists of tooth wheels.

Gravity wheels, from their large size and their necessarily exposed situation, are subject to be frozen up in cold climates, and, as the parts are liable to be first wet and then dry, or warm and cold by exposure to the air and the water alternately, the tendency to corrosion of iron, or decay if of wood, is much greater than in submerged wheels. Gravity wheels, to realise the fullest effect from the water, require a diameter so great that they must drag in the water at the lower or delivering side, and are especially affected by back water, to which all wheels are more or less liable, from the reflux of tides or by freshets. These are among the most notable of the disadvantages pertaining to gravity wheels—disadvantages which have with other reasons, such as the inconvenience of manufacturing them, first cost, and so on, driven such wheels out of use by the force of circumstances rather than by actual tests or theoretical deductions.

Impact wheels, or those driven by the percussive force of water, including the class termed turbines, are now generally used for heads of all heights.

The theory of their action may be explained in the following propositions :

The spouting force of water is theoretically equal to its gravity.

The percussive force of water can only be utilised to its full extent if its motion is altogether arrested by the floats of the wheel.

The force of the water is greatest by its striking against planes at right angles to its course.

Any force represented by the water rebounding from the

* This, and the succeeding articles under the same title, were published simultaneously in the *Journal of the Franklin Institute*, Philadelphia and in *Engineering*.

floats parallel to their face, or at any angle reverse to the motion of the wheel, is lost.

This rebounding action becomes less as the columns of water projected upon the wheel are increased in number and diminished in size.

To meet the conditions of rotation in the wheel, and to facilitate the escape of the water without dragging, after it has expended its force upon the vanes, the reversed curves of the turbine arrangement become necessary. Keeping these general principles in view, the apprentice will be able to understand in general the construction of impact wheels.

The modern turbine has been the subject of the most careful investigation by able engineers, and there is no lack of mathematical data to be referred to and studied after the general principles are understood. It is a subject of great complicity, if followed to detail, and, perhaps, less useful to a mechanical engineer, who does not intend to confine his practice to water wheels, than other subjects that may be studied with more advantage. The subject of water wheels may be called an exhausted one, that can promise but little return for labour spent upon it with a view to improvements; the efforts of the ablest hydraulic engineers have not added much to the percentage of useful effect realised by turbine wheels during fifteen years past, and their present performance is quite equal to anything that can be hoped for in future.

This matter is alluded to for the reason that in choosing any particular branch for a special study, an apprentice should select such as are least perfect, and present the best chance for improvement, instead of such things as there is every reason to believe have reached a reasonable state of perfection, and are in future to remain substantially the same. The last statement of course applies only to a few branches in the engineering arts, and perhaps more fully to water wheels than to any other.

Reaction wheels are used only to a limited extent, and will soon, no doubt, become extinct as a class of water wheels. In speaking of them, I will select what is known as Barker's mill for an example, because of the familiarity with which it is known, although its construction is greatly at variance with modern reaction wheels. A query as to the principle of action in a Barker wheel, while it may be very clear in a scientific sense, still remains a puzzle to the minds of many who are well versed in mechanics, some contending that the power is directly from pressure, others that it is from the dynamical effect due to reaction. It is one of the problems so difficult to determine by ordinary standards, that it serves for endless debate between those who hold to different views; and, considering the advantage that is derived from such controversies, perhaps, the most useful manner of disposing of the problem here is to state the two sides as clearly as possible, and leave the reader to determine for himself which he thinks right and which wrong.

Presuming the vertical shaft and the horizontal arms of a Barker wheel to be filled with water under a head of 16 ft., there would be a pressure of about 7 lb. upon each inch of surface within the cross arm exerting an equal force in every direction. By opening an orifice at the sides of these arms equal to 1 in. of area, the pressure would at that point be relieved by the escape of the water, and the internal pressure be unbalanced to that extent. In other words, opposite this orifice, and on the other sides of the arm, there would be a force of 7 lb. that was not balanced, and would act as a propelling force in turning the wheel.

This is one theory of the principle upon which the Barker wheel acts, that has been laid down in "Vodges' Mensuration," and perhaps elsewhere, as an explanation. The opposing theory is that, direct action and reaction being equal, ponderable matter discharged tangentally from the periphery of a wheel must create a reactive force equal to the direct force with which the weight is thrown off. To state it more plainly, the spouting water that issues from the arm of a Barker wheel must react in the opposite course in proportion to its weight.

The two propositions may be consistent with each other and even identical, but there still remains an apparent difference. The latter seems a plausible theory, and perhaps a correct one; but there are two facts in connection with the operation of reaction water wheels that seem to controvert the latter and favour the first theory, namely, that reaction wheels seldom utilise more than 40 per cent. of useful effect from the water, and that their speed may *exceed the initial velocity of the water*. With this the subject is left as one for argument and investigation on the part of those who choose to consider it.

Pressure wheels, like gravity wheels, would, upon theoretical inference, be expected to give a high per cent. of power, the water resting with the whole of its weight against the vanes or abutments, and without chance of escape except by turning the wheel, would seem to meet the true conditions of realising the whole force; and so it would, if such wheels had not to contend with certain mechanical difficulties that render them impracticable in most cases.

A pressure wheel, like a steam engine, must include running contact between water-tight surfaces, and, like a rotary steam engine, running contact between water-tight joints that move at degrees of speed that vary in the same joint, and when it is considered that the most careful workmanship has never produced rotary engines that would surmount these difficulties in working steam, it can hardly be expected they may be overcome in using water, that is liable to be filled with grit and sediment, and lacks the peculiar lubricating property of steam.

A rotary steam engine is in effect the same as a pressure water wheel, and the apprentice in studying the first will fully understand the principles of both by supposing steam to be substituted by water.

(To be continued.)

CIDER AND CIDER-VINEGAR.

To procure either cider or cider vinegar of the best quality, care and skill are required in the manufacture. Some too economical persons, thinking, that nothing should be wasted, are now engaged in gathering all the wormy and defective apples that fall from the trees, and consigning them to the cider-press. As new cider this questionable liquid is sold to the unsuspecting consumer for fifty cents a gallon. It however bears no comparison with cider that is carefully made from sound apples, and can not be made to produce a well-flavoured vinegar. It would be better economy to feed all such apples to the pigs, for the first requisite for good cider or vinegar is sound fruit. All bruised, wormy, or defective apples must be discarded, if perfection is desired in the product. The next consideration is the mill and press, and the method of using them. In districts where timber is plentiful, and the necessary mechanical skill can be had, an improvement upon the old-fashioned mill and press is probably the best machine that can be procured. It is made wholly of wood, and no iron comes into contact with the crushed fruit. The timber should be sugar-maple or birch. These are free from the tannic acid, which renders oak objectionable, and stand wear and tear sufficiently well. The crushers are made of solid blocks, carefully seasoned under cover, so that they are free from cracks. They should be about 18 inches in diameter, and about two feet long. They should be turned perfectly cylindrical in a lathe, and deep, broad grooves cut lengthwise in them, so that the teeth of each, which are left projecting, fit accurately into the grooves of the opposite one. Four inches wide and three deep is a proper size for the grooves. This work should be done by a millwright, or a carpenter used to doing mill-work, as it is a somewhat difficult job. Upon the perfection of the rollers or crushers, the yield of cider greatly depends, as the apples must be reduced to a pulp, before all the juice can be pressed from them. The rollers are furnished with axles, also accurately turned, and are fitted into a frame, which is shown in fig. 1. This frame consits of a strong bottom of plank, four inches thick, preferably of maple, closely jointed and matched together. This is raised about 20 inches from the ground, upon a stout frame, and is pinned fast to heavy posts, set a few inches in the ground, so as to be immoveable. A raised border is placed around the bottom planks. A cross-frame is built across the centre of the bottom, into which the axles of the rollers are fitted, and to which they are secured by short blocks, pinned or bolted to the frame-work. The lower axles of the rollers fit into holes made in the bottom planks. The axle of one roller is lengthened, and attached to a horizontal arm, to which the horse may be hitched. A hopper is built at the rear of the crushers, to receive the apples, and feed them to the crushers. Fig. 1 sufficiently explains all other details. The press is shown in fig. 2. It is an improvement upon the old-fashioned heavy press, which is made from the trunk of a large tree, and frequently requires the trunk of another large tree as a support for it,

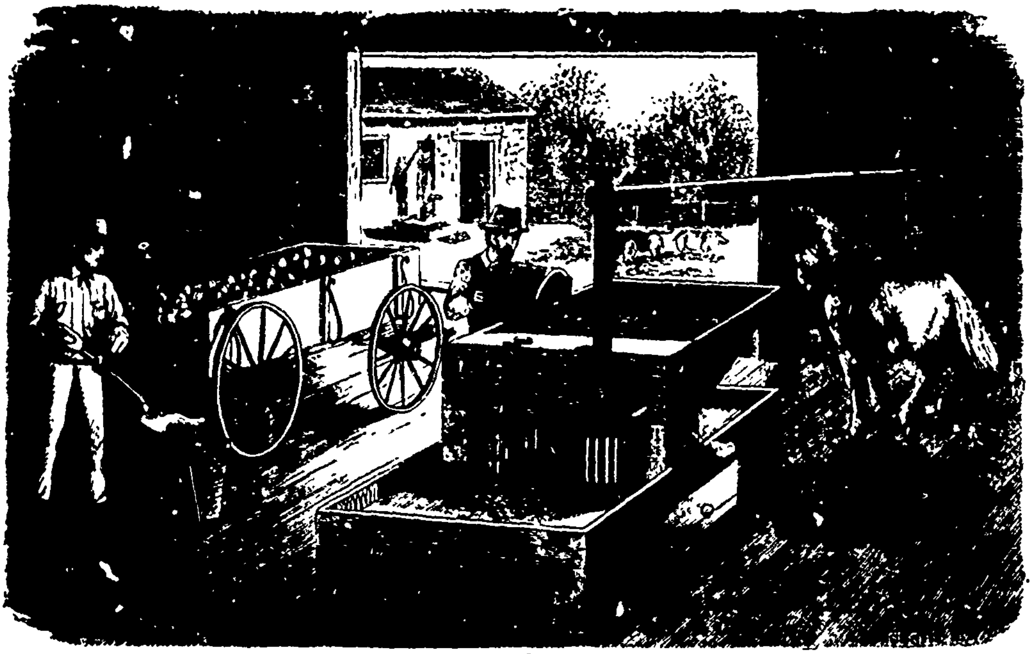


Fig. 1.—Cider Making—Crushing the Apples.

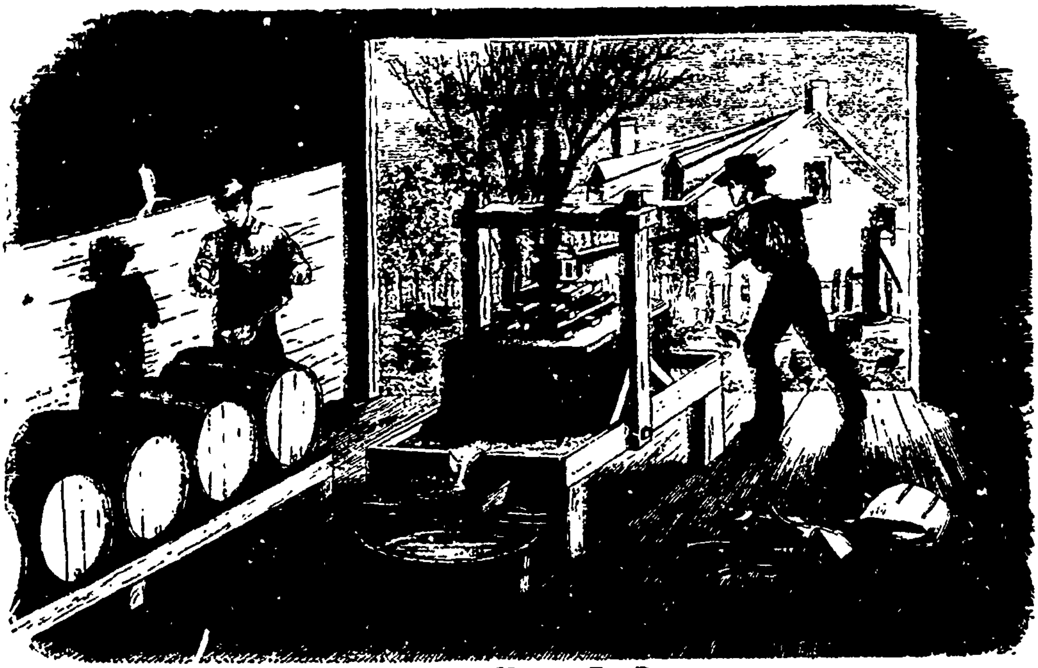


Fig. 2.—Cider Making—The Press.

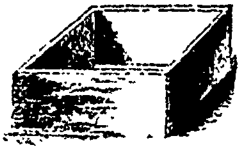


Fig. 3.—Box.

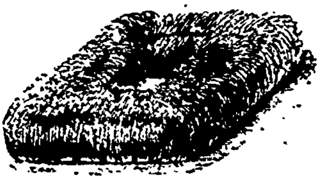
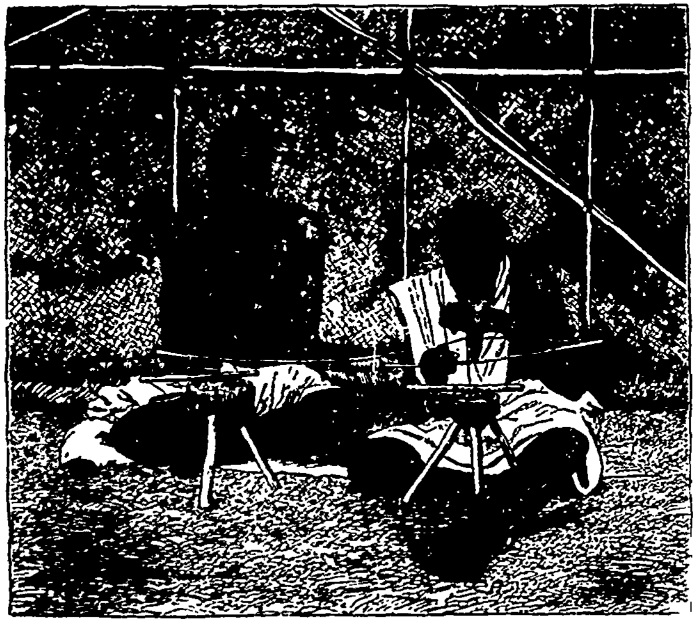


Fig. 4.—The Cheese.

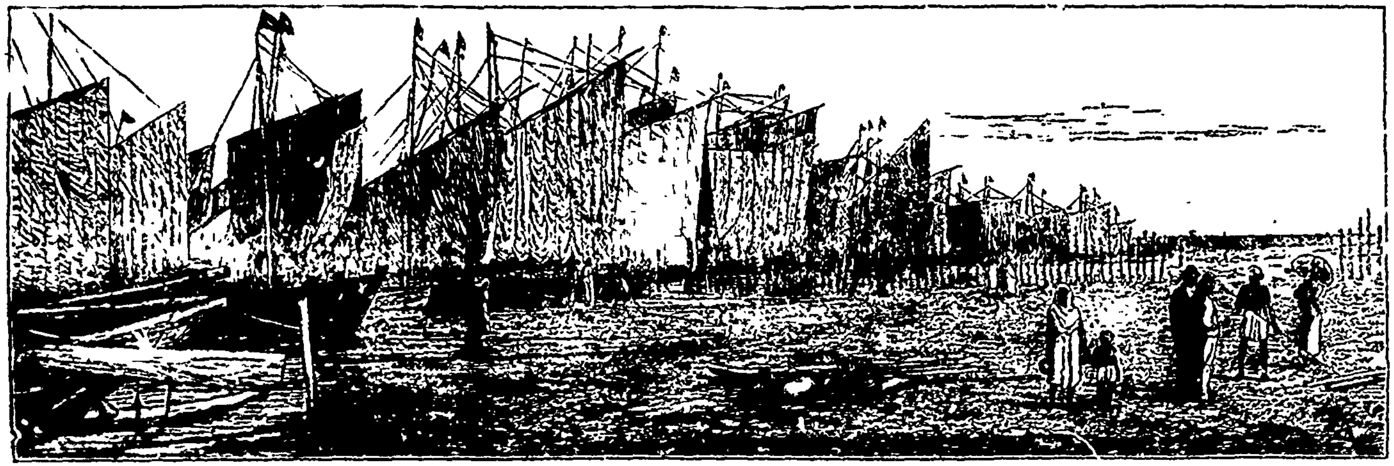
Fig. 5.

THE CEYLON PEARL FISHERY.



Drilling Holes in the Pearls.

The Government Kottoo.



Boats preparing to Start.

and which is weighted at the end with a clumsy screw, a foot in diameter, and a ton of stones in a huge box. If any person supposed all this huge weight saved labor, he was greatly mistaken, because before a pound of pressure could be exerted upon the pomace, the whole weight of beam, screw, and stone, must be raised. In this ancient machine the weight, which causes the pressure, is raised, while in the one here illustrated the pressure is brought to bear directly. The immense weight of the old press is, therefore, not only useless, but a hindrance. It is needless to give any description of what is so clearly shown in the engraving, further than to state that the material of the press is similar to that of the mill, and that the screw may be of wood, preferably of beech, but is better, and in most cases cheaper of iron. The screw should be lubricated with hard tallow, ground up smoothly with black lead. As the apples are ground, the pomace should be put into the press immediately, if light coloured cider or vinegar is desired. If a deeper colour is wished for, it can be procured by exposing the pomace in the mill to the air, while one batch is pressing. A wooden scoop should be used to lift the pomace. No iron should touch the crushed fruit or juice during the process, if excellence is wished for. In building up the "cheese" in the press, it is better to use a small square frame of boards in the centre, by which an interior space is left in the mass of pomace, through which the juice is expressed more readily than if the mass were solid. The use of this small frame will obviate the necessity of a second pressing. The frame, fig. 3., is placed in the centre of the press. From this centre a channel two inches wide, and one inch deep, is made to the front, to carry off the juice as it flows. A piece of board is laid over this channel, and the floor of the press is covered with clean, straight rye-straw, leaving the ends projecting at each side, which have to be turned over the first layer of the pomace. This prevents the pomace from being squeezed out when it is pressed. When the first layer is finished, and the straw is turned upon it, it appears as in fig. 4. This process is repeated, until the press is full, when the pressure is applied gradually, so as not to burst the cheese. The juice runs through a filter of cut straw into a vat, from which it may be dipped or pumped into the barrels. It is well to have a strainer of hair-cloth in the funnel, or across the mouth of the pail, as the barrels are filled. In all these processes the utmost cleanliness should be observed, if a good product is wished for. For those who find it more convenient to use a manufactured mill, that known as Schenck's Apple and Grape Grinder, which is able to grind 200 bushels per hour, may be desirable. There are several excellent cider-mills manufactured by different parties East and West, which are convenient for those who have but few apples, or who have enough to keep one hand-machine going. One of these, known as the Keystone Cider Mill, is an excellent one. We have made cider and vinegar of a very light colour in one of these mills, as the pomace is exposed to the air only for a moment, as it falls from the grinders, and it is passed immediately under the press. No straw is needed in using a press of this kind. When the juice is safely in the barrels, it needs close watching during the fermentation. It is best to keep the bung-hole covered, to exclude insects and the air. For this purpose a perforated bung is useful, in which a glass tube, an inch in diameter, (fig. 5,) may be inserted. The tube 12 inches long, may be kept filled, which will prevent any access of air into the barrel. When the cider is to be kept for a length of time, this course is advisable. After fermentation has stopped, which may be seen by observing that gas no longer bubbles up and escapes through the glass tube, the cider should be carefully drawn off into fresh, sweet casks. The barrels should then be stored away in a place where the temperature is even, and the bung-holes tightly closed. If it is intended for vinegar, empty vinegar-casks may be used. The bung-holes should be left open, and kept covered with a piece of fine wire gauze, so as to admit the air. After a time the vinegar will make, and should be again drawn off in o clean casks, without disturbing the sediment. If the sediment should become disturbed, the vinegar is never perfectly clear afterward. To make vinegar from cider in the most rapid manner, the building must be heated to about 70°, and the liquid frequently exposed to the air, by drawing it from one cask to another.—*American Agriculturist.*

THE United States Government will soon sell by auction seven single turret monitors and five ironclads at Philadelphia.

DRUCE AND STEERS' PATENT SCREW AND SCREW-DRIVER.

In connection with machinery and other composite mechanical, engineering, and architectural structures, of wood or metal, separate or combined, considerable interest and importance attaches to the devices whereby a firm and secure union, attachment, and connection, is or may be obtained and effected between the individual and component parts. As structural elements these devices discharge very indispensable functions; and perhaps the foremost place among them must be assigned to screws and screw-bolts; wherefore these small but essential parts of compound structures have by no means been neglected by inventors and improvers, although the attention and ingenuity devoted to them has almost exclusively been directed to the body, shank, or threaded portion, of the screw or screw-bolt—as witness the Palliser bolt and the Fairbairn screw—the head coming in for a very trifling share, if any, of consideration and improvement. Whereas every practical workman or industrial employer, who has had to do with screws and their congeners—every amateur or professional cabinet-maker, carpenter, joiner, pattern-maker, or millwright, who has lost time, patience, and temper, over the common screw and its accessory the common screw-driver who has been ignominiously beaten, and has damaged costly finished surfaces, in his assaults upon a refractory screw, which he has been driven to apostrophise with injurious epithets—must have been forcibly impressed with the conviction that even the best modern screws and screw-drivers fail—*longo intervallo*—of perfection.

Among recent patented inventions to which our attention has been directed, we are disposed to regard with much favour that of Messrs. Druce and Steers, for a patent screw and screw-driver upon a new and sound principle, now being introduced by Messrs Steers and Co., 4, Queen's Buildings, Queen Victoria Street, London, E.C.; and whereof the annexed engravings give an illustration, which almost speaks for itself. This improvement relates to and concerns the head only, that part which has for so long remained without variation from its primitive form and construction; and its effect is to improve upon, or rather entirely to supersede, the slit or groove in the screw-head, commonly called the nick, which indeed is not susceptible of improvement as a nick, inasmuch as, whether it be made deep or shallow, it presents in either alternative obvious defects, in stripping, splitting, or slipping, either on the part of the screw or of the screw-driver. It seems to us, therefore, that the inventors have turned their attention in the right direction, and, so to say, have "hit the right nail on the head," if such an expression be admissible in respect of screws.

In the engravings, figs. 1, 2, and 3 represent these variously-headed patent screws; figs. 4, 5, 6, side views, and figs. 7, 8, 9, end views of the points or heads of the corresponding screw-drivers; fig. 10 is a sectional view of a screw; and fig. 11, a delineation of a patent screw-driver, showing how one size will fit any size of the corresponding screws, whether large or small.

The essential principle and characteristic feature of the invention is simple and obvious, and consists in the formation, within the head, of a pyramidal recess, tapering down to a point in the body or shank of the screw, and leaving at all points of the periphery, for the requirements of strength, protection, and security, a sufficient margin or interval of metal between the outside and the recess. The turnscrew or screw-driver is made with a head of similar form, to correspond, such head will, therefore, be pyramidal in form, fitting, with exactness and precision into the corresponding recess in the head of the screw; and it is obvious, therefore, that the largest size of turnscrew is available for use with every size of screw, down to the smallest, so as to drive them home, or withdraw them, without in any way touching or injuring the surrounding surface or material. An important practical advantage in favour of this form is, that the head of the turnscrew can readily be inserted in the recess of the screw, and, when pressed firmly home, necessarily assumes a true axial position in relation to the screw; while the rotating force applied is employed to the utmost advantage, the operating edges and surfaces being of considerable extent, so that there is a sure and firm grip, while the accidental displacement of the turnscrew, and consequent injurious effects are entirely obviated.

Of the ordinary forms of this improved screw and screw-driver, that shown in figs. 3, 6, and 9, which is tetraëdral, will, we opine, prove the best adapted for universal use, and preferable in many respects to that shown in figs. 1, 4, and 7, which is triangular. The exceptional form shown in figs. 2, 5, and 8, a conoidal trefoil, together with various others of similar character, may be made and employed in fancy work, and wherever it is found desirable or necessary to enlist them as aids to ornamentation, as in cabinet-work and the like, in which case the recesses may be filled up with coloured material of any suitable kind. It must be obvious that this improved form and its concomitant advantages are by no means limited to the common class of wood screws, but extend to all kinds and classes of screws and screw-bolts.

In comparison with ordinary screws there must be an obvious economy in the weight of metal per gross, as well as in the labour of making the improved screws, when manufactured by suitable special machinery; and the comparison must be still more favourable as against screw-bolts, with square or hexagon heads, as the metal and labour of the heads will be almost entirely economised; resulting in a material reduction in weight and cost of bolts, as well as of the structures whereof they are component parts. Another, and by no means unimportant advantage would be found in the heads being flush with the surfaces of the structure, all projections of boltheads being eliminated. These are points which must specially commend this improved screw to railway engineers, as important improvements in connection with permanent way and plant, as well as to Government, Admiralty, and War departments, for armour-plated and other composite structures, fixed and floating. Hence, a wide range of employment and utility may be confidently anticipated for this simple, ingenious, and effective invention, although it concerns only articles which are small things, *per se*.

CRANE ARRANGEMENT.

To reduce the friction upon the posts of rotating cranes, Mr. George Weichum, engineer on the Austrian States Railway, has introduced with considerable success a detail which we illustrate by the views on page 104. It consists in the application around the crane post of two cast-iron rings A and B, Fig. 1. The former of these is placed vertically and has attached to its inner surface a grooved wrought-iron ring forming a track for a number of steel balls, which press as shown against the top of the post. The lower ring B is placed horizontally; it also has a grooved wrought-iron ring attached to its lower side in which run a second series of balls upon a fixed disc below. This detail, which has some advantages, has been adopted largely in Austria.

FIELD'S SCALE PREVENTER.

We illustrate on page 105 an ingeniously arranged and apparently very efficient apparatus for preventing the accumulation of scale on the internal surfaces of steam boilers and which appears indeed to have the effect of removing scale already formed. It consists, as will be seen from the section, merely of a rod passing through the boiler, and properly supported and insulated by the bracket and insulators C, D, E. The lower end of the rod is turned over to form a loop, and it supports a bell as shown in the sketch, or as preferably employed, a cone in both cases left free to oscillate. The disc or bell is submerged about 4 in. below the level of the water in the boiler. A battery of one or two cells, which may be kept in any convenient position, and quite removed from the boilers, is connected with the apparatus, one pole being placed in communication with the rod by a wire, and the other pole connected to the shell of the boiler.

Carefully conducted experiments establish the existence of a steady current setting towards the shell of the boiler, and the theory upon which the inventor has proceeded, is that by this current the soluble salts in the water are carried forward and deposited upon the surface of the iron, but by reversing the current with the aid of a battery, the tendency to deposit is destroyed, and the salts in solution are precipitated. That this apparatus is reliable in its action, is proved by considerable experience gained upon a number of steam boilers to which it has been applied, and as consequent upon the advantage of keeping the boiler shell clean it effects a marked economy in the consumption of fuel, there is every reason why it should find a wide application among owners of steam boilers.

ROBEY'S VERTICAL BOILER.

We give on page 105 engravings of a new form of vertical boiler which is now being exhibited at the show of the Royal Agricultural Society at Bedford by Messrs. Robey and Co. (Limited), of Lincoln. The leading features of the boiler will be at once seen from our engravings. As shown, the lower part of the firebox is made tapered, while above this tapered portion is an enlargement, produced by flanging the lower firebox plate outwards. From the shoulder thus formed water tubes—slightly inclined inwards—extend upwards to the firebox crown, this crown being made slightly concave, and being protected from the deposition of dirt by a concave tray fixed above it, this tray also probably serving a good purpose by deflecting laterally the currents of water rising through the water tubes just mentioned.

Outside the ring of water tubes there is fixed a ring of flue tubes, extending from the firebox crown to the top of the boiler, and from the position of these tubes it follows that the products of combustion, on their way to them, must pass between the water tubes, thus causing the heating surface exposed by the latter to be very effective. The water, after rising through the water tubes and parting with its steam, returns down the sides of the firebox, and the sudden change of direction which it undergoes, when turning to again rise upwards through the ring of water tubes, greatly facilitates the deposition of any matters in suspension, these matters accumulating in the large space left around the base of the firebox, from which space they can be removed through the mudholes when convenient. We are informed that careful experiments with this boiler have shown it to be capable of evaporating, at atmospheric pressure, 10½ lb. of water per pound of coal, and there appears to be every reason for expecting it to give a good evaporative performance.

THE GIFFARD PISTON.

This new arrangement of pistons has attracted much attention in Europe, and constant working at gas and other works is considered to have established its importance. M. Poillon, of Lille, who is the maker of them, furnishes them in three principal forms, for aspiration, for compression, and double-actioned.

The piston for aspiration is represented in fig. 1. It consists of a solid plate with a groove round the edge, in which is placed an indiarubber ring of one centimetre, or less, in thickness. Apertures, as shown in the drawing, are pierced near the circumference of the piston. The rubber ring is only half the thickness of the circular channel in which it lies, so that when the piston is descending, as shown in the figure, the ring rises and leaves the water or gas ways open. When the piston descends, the ring, on the contrary, closes the apertures hermetically, while the pressure of the fluids causes the ring to expand and pack the piston perfectly.

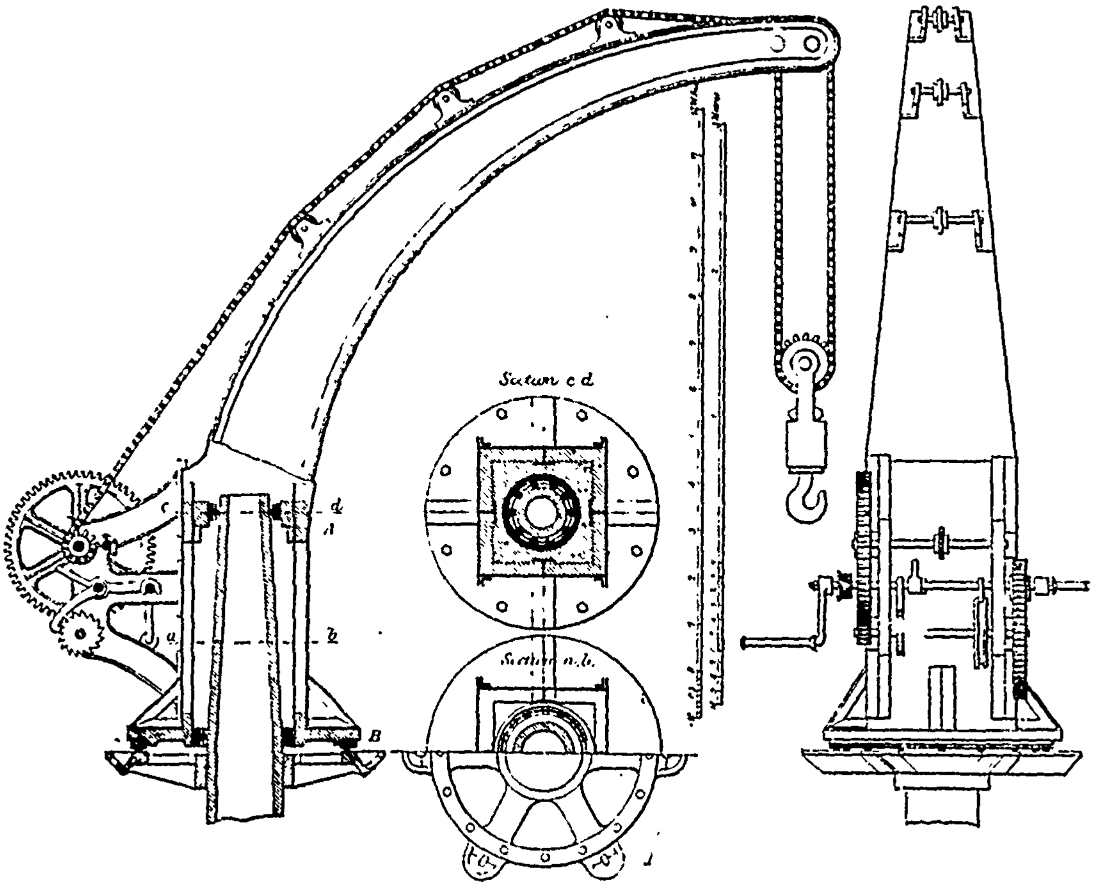
The friction is said to be reduced to such an extent as to produce an economy of about twenty per cent. in fuel, the depth of the ring being only about one-fifteenth of the ordinary packing. And all valves are dispensed with.

The forcing piston, as shown in fig. 2, is simply the reverse of that which precedes it.

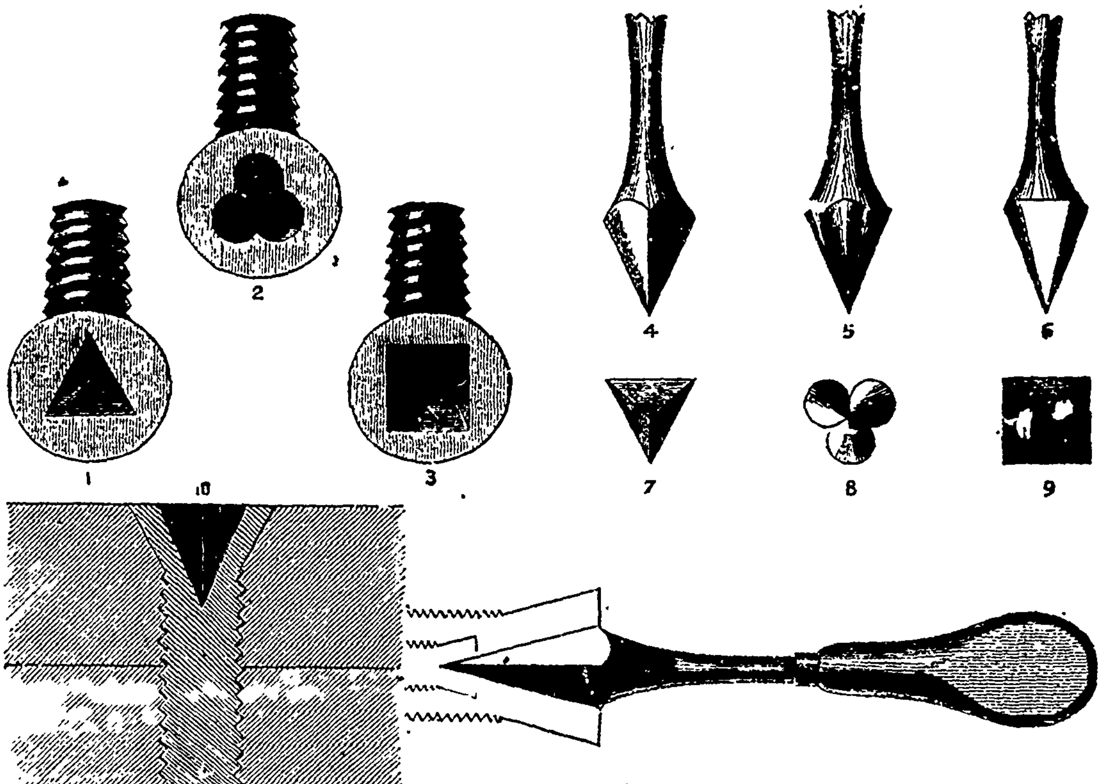
The double-action piston, fig. 3, has no apertures, and the ring has less play, just enough to allow of its submitting to sufficient force to make it spread and pack the piston.

Pistons of this kind have been used at the Paris gasworks for twelve months without the ring undergoing the slightest injury, and other experiments bear out this assertion.

Another advantage of the arrangement is that it reduces the thickness of the piston by about three-fourths, and of course the cylinder in the same proportion. In addition to their application to ordinary pumps, the pistons are specially recommended for air pumps, as producing an almost perfect vacuum for blast furnaces, for surgical syringes which require so much nicety of action, and for moderator-lamps, for which they are said to be cheap and peculiarly effective. It remains to be seen how the rubber will support the action of oil.



WEICHUM'S CRANE JIBS



DRUCE AND SHEER'S PATENT SCREW AND SCREW-DRIVER.

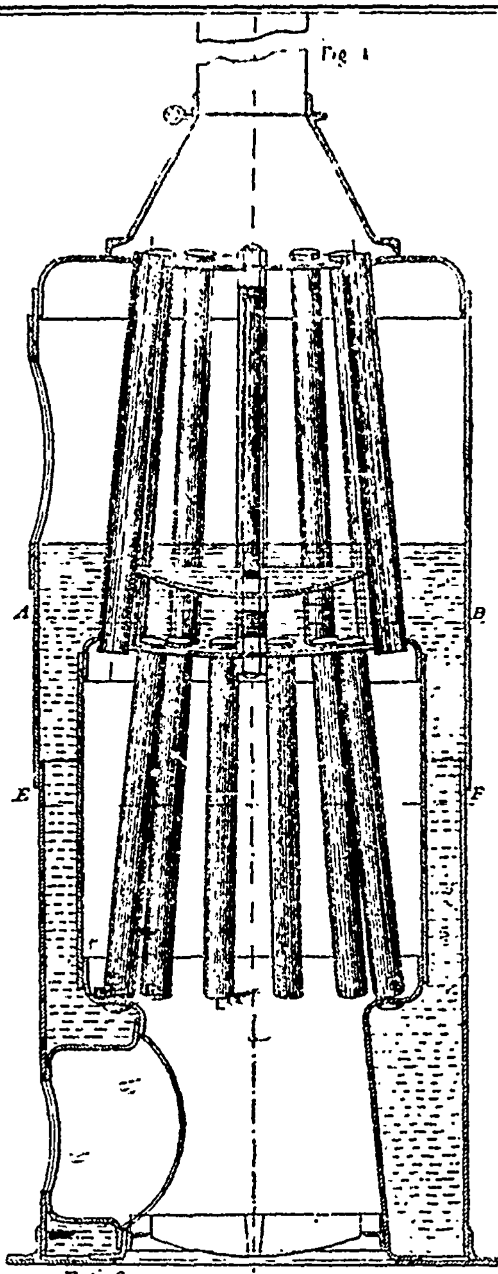
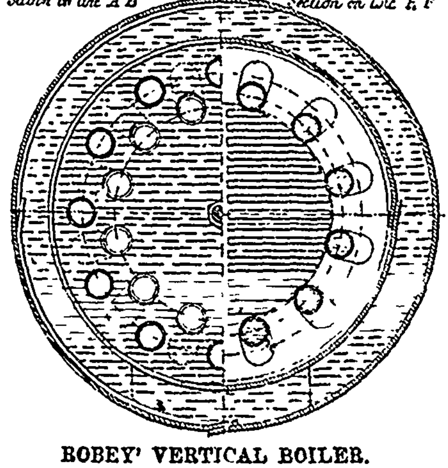
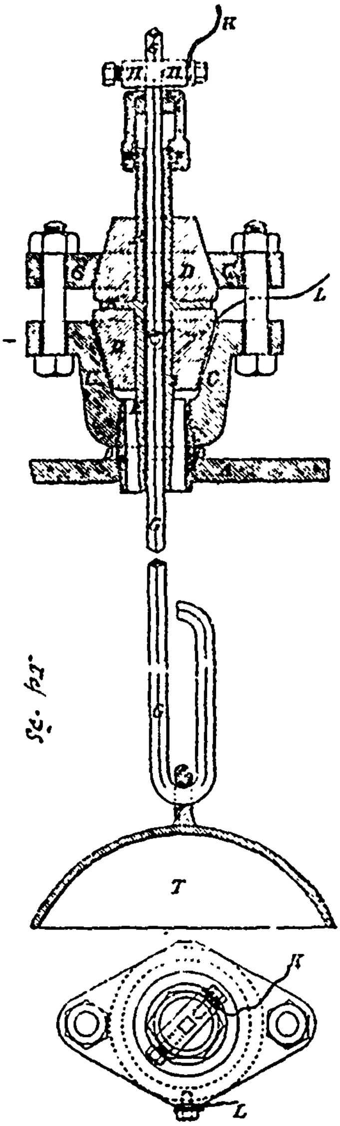


Fig. 2.

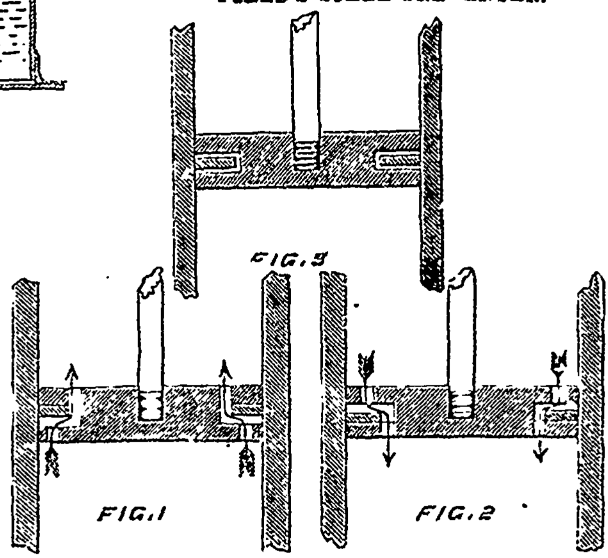
Section on line A B — Section on line E F



ROBEY' VERTICAL BOILER.



FIELD'S SCALE PREVENTER.



THE GIFFARD PISTON.

MUSCULAR STRENGTH OF INSECTS.

It is an interesting study to compare the motive power of birds and insects, and recent experiments prove that they are superior in this respect to quadrupeds, especially when the possibility of aerial navigation is taken into account. In a few minutes the condor will soar many miles in height; the swallow is not weary of describing its rapid and graceful curves for fifteen hours at a time. It has been calculated that the eagle, with its rapid flight, produces an effort sufficient to bear up its own weight equal to twenty-six horse power.

Insect organization is as full of wonders as that of the bird. The energy which lives within these curious little creature may well excite the wonder of an observer. "If you compare their loads with the size of their bodies," says Pliny, in speaking of ants "it must be allowed that no other animal is endowed with such immense strength in proportion.' Sir Walter Scott suggests the same idea.

When a beetle is placed under a candlestick it will move it, in its efforts to escape, which is relatively the same thing as a prisoner in Newgate shaking the building with his back. Linnæus remarks that an elephant, having the force of a horn-beetle, would be able to move a mountain. M. Félix Plateau, a young Belgian naturalist, and a son of the celebrated physician, has lately tried some very delicate experiments to measure the muscular strength of insects, as others have done with man and the horse. The strength of the last two is estimated by the aid of a machine called a dynamometer, where the tension of a spring is counterbalanced by an effort exercised for a very short time. A man, it is found has the power of traction equal to five-sixths his weight; but this is very small in comparison with the strength of insects, many of which can draw forty times that amount.

The way in which Mr Plateau has measured these powers is ingenious. He harnessed the insect by a horizontal thread, which was passed over a light moveable pulley; to this was attached a balance loaded with a few grains of sand. To prevent the insect turning aside, he made it walk between two bars of glass on a rough board covered with muslin, so as to afford a rough surface, exciting it forward, he gradually poured fresh sand into the balance until it refused to advance further; the sand and the insect were then weighed, and the experiment was repeated three times, in order to arrive at a correct conclusion as to the greatest effort that each could make. The tables which give the results of these trials seem clearly to demonstrate that, in the same group of insects, the lightest and smallest possess the greatest strength, or that the relative force is in inverse ratio to the weight. This law applies also to the experiments in flying and pushing as well as to drawing.

This law, assuredly very curious and interesting in the economy of nature, has been confirmed by trying a dozen individuals of various species, in order to obtain results more approaching to the truth These have been fully successful in confirming previous experience—for example, the drone is four times the weight of the bee, yet it can only drag a weight fifteen times greater than its own: whilst the bee easily draws twenty-three or twenty-four times its own bulk. In flying, it can raise a weight very little inferior to its own; whilst the drone can only transport in this manner half its own weight The law in question appears also to apply not only to the species which belong to the same entomological subdivision, but in a certain measure to the entire class of insects. It is true that if the species examined are arranged by the increasing order of their weight, the corresponding relations which express their relative force are not always exactly progressive. There are exceptions, which may be explained by the difference of structure The law holds good if they are divided into three groups, comprising, respectively the lightest insects, those of a middle size, and the heaviest. In this way the relative force is represented for the first group by twenty-six; for the second, by nineteen, for the last, by nine. This relates only to the power of traction; if that in flying be taken into consideration, the lightest can far surpass the heaviest; the first being equal to one and one-third, the last is but one-half. The strongest insects appear to be those so familiar to the naturalist, which live on lilies and roses, such as the Crioceres and Trichies. These little beings can draw a weight about forty times superior to their own, and one, an athlete of the tribe, drew sixty-seven times its own weight. A small beetle of the tribe Anomale has executed the same feat. Another more remarkable fact is related of a horn-beetle, which held between its mandibles, alternately raising and lowering its head and breast, a rod of thirty centimeters long, weighing four hundred grammes; its own weight was but two grammes. At the side of this insect, what are the acrobats who can carry a table between their teeth! Such examples show to what an extent insects are superior to the larger animals in the strength of their muscles Dry and nervous, they can in proportion to themselves, move mountains. In addition to this, they are ingenious; when an obstacle does not yield to them, they know how to turn it aside. One day, in a garden, a small wasp was trying to raise a caterpillar, which it had just killed. The caterpillar was at least five or six times heavier than its conqueror, which could not gain its end. Six times successively, weary of the war, despairing of success, it abandoned its prey, and sadly placed itself at some distance. At last a bright idea saved it from its embarrassment: it returned, placed itself across the caterpillar, as if on horseback; with its two middle feet it embraced the body of its victim, raised it against its breast, and managed to walk on the four feet which were at liberty; thus it soon crossed a walk of 6ft. wide, and laid its prey against a wall.

Investigations have been made regarding the jumping insects of the order Orthoptera—the weight which crickets and grasshoppers can raise when jumping. To prevent them using their wings, M Plateau tied them and the elytra or outer sheaths with a thread. The burden was a ball of wax ballasted with morsels of lead, which was hung to a thread tied round the thorax; as much lead was added to the wax until the insect could only raise itself an inch from the ground. The ball and the insect were afterwards weighed, the latter having been made insensible by the fumes of ether. Crickets of the larger kind raised about one and a half of their own weight; the smaller ones, three or four times their weight. The grasshopper differs from the cricket in having longer and thinner legs, the green variety weighing about two and a-half grammes, can only raise a weight equal to its own, confirming the law, that the muscular force of insects increases as their size diminishes. When allowed to jump freely, crickets describe a curve in the air similar to all projectiles. It is curious that the amplitude of the spring is the same for the large and smaller kinds alike. This result was foreseen by the celebrated naturalist, Strauss-Durckheim In his work on "The Comparative Anatomy of Articulated Animals," he establishes the point, that two animals of similar form, but of different dimensions, will jump the same height above the point where lies their centre of gravity at the moment when they quit the soil. He takes as an example the cat and the tiger, and adds that the same conclusion is applicable to crickets and grasshoppers. The principle which serves as a basis for this theory is, that the motive power of animals increases with the section, and not with the volume of the muscles. It depends only on the number of fibres of which the muscles are composed; from whence it follows that it ought to be in proportion to the surface of the section of these organs, whilst the weight of the animal is proportional to their volume. The weight augments more rapidly than the motive power, and the relation between this weight and this force becomes the more unfavourable as the animal is larger. Other naturalists who agree to this as a whole do not consider it to be an absolute or general law.

Among the insects that dig or burrow in the ground, a different plan was tried to see their power of pushing forwards. They were placed in a cardboard tube, which had been blackened and made rough for the feet; at one end, a transparent plate of glass was fixed to a horizontal lever. Perceiving the light before it through the plate which barred its exit, the insect, when excited, pushes with all its strength; the plates gives way, the lever turns, and raises at its other extremity the balance which is attached by a pulley, and into which the sand is poured as before. In this way the Oryctes, weighing about forty-six grains, pushed three or four times its own weight, whilst the little Onthophagus moved eighty or ninety times that amount.

The experiments in the way of flying lead to the conclusion that insects employ much less muscular force in that way than in drawing or pushing, perhaps it is that, unlike birds, they are not intended to carry large weights through the air. A ball of soft wax of a weight little superior to what the insect might be expected to bear, was fastened round its body, and it was tried as to whether it could support this in the air; if it fell, the size was diminished. Among various insects belonging to the five orders of Coleoptera (beetles), it was found that th could raise from one-sixth to double their own weight; t common fly could manage triple that amount. Yet the flight of insects is so rapid that some can distance the swallows that pursue them, and certain kinds of flies are said to be able to pass a racehorse or a locomotive going at full speed.

If we inquire why the smaller species are the stronger, the answer may be, that their way of life necessitates it. Thus, the hardness of the soil is the same to all the burrowers: the grains of sand which the larger can easily displace are rocks to the smaller ones; and comparing them with animals, the mole and the rabbit require much less strength to force a passage than the ant. The prodigious leaps of the cricket, the locust, and the grasshopper, would in the same proportion make a lion spring over half a mile. Not less surprising is the power of destruction in certain classes: the termites have undermined whole towns, which are now suspended over catacombs; such is the case with Valencia, in New Granada; La Rochelle is menaced by the same fate. The larvæ of the Sirex pierce through balls of lead with their mandibles. During the Crimean War, packets of cartouches were found, the conical balls of which were perforated in various parts. The little African ant can raise mounds of clay five yards high, and the solidity is such that the wild cattle stand on them to explore the horizon. Such edifices are thousands of time largers than their architects, whilst the pyramid of Cheops is but ninety times the height of man.

Another subject which has engaged the attention of naturalists of late is the strict relation which exists between the habits, manners, and mode of life in insects, with the conformation of their organs. Mr. Darwin has acknowledged the organic adaptation of species to the condition of existence; but he thinks that, owing to their want of exercise on one side, and natural selection on the other, these organs may undergo deep and hereditary modifications. Thus he explains the want of wings in many coleopterous insects which inhabit the island of Madeira; they lose the habit of flying, because if they used it the wind would carry them away into the sea, and the race would soon disappear: thus, winged insects made for flight, can transform themselves, in time, into walkers or swimmers.

If we consider the locomotive organs of insects, it is easy to see that broad members, which can be converted into oars, belong to swimmers; when they are short and indented, they are to be used like shovels and pickaxes by the burrowing tribes. Though the mouths of insects are formed with the same number of appliances, yet they are adapted to the condition of each species. By examining one or two parts of the mouth of a larva, a naturalist can discover the food it lives upon, and the way in which it partakes of it. Thus, if two caterpillars of different kinds live on the same plant, one may attack the leaves from the edge, the other will, perhaps, eat the flower-bud; these habits are recognized by indubitable signs, when the lips and mandibles are examined. By similar means, the inspections of the foot will decide whether the insect walks on leaves, or climbs up the stem of the shrub it has chosen for its home. There are some insects which lead an idle life, whilst others have one of work and fighting; they are each armed with the necessary appliances for their particular destiny, some having at their extremities nippers, pincers, a saw, an auger, or even a poisoned sword. Looking at the class of Spiders, what an arsenal of work and war they possess! The mandibles are scissors, grindstones, lancets; the jaws are trunks and suckers, the lower lip is often a spinning-plate. Their locomotive organs adapt themselves to a number of uses —spades, picks, oars, sometime tending in rakes, forks, spindles, brushes, and baskets; and all these instruments are of far more delicate conformation than the clumsy tools of man's making. Those kinds that spin, weave an infinite variety of webs; some are closely spun like stuffs, others are nets or simple threads thrown by chance. Here the claws play a principal part; they resemble combs or cards among those which produce the close tissue, and forks in those which weave with a wider mesh.

The eyes of insects, often of enormous dimensions, are of strange optical structure, and marvellously fulfil their varied uses. Those which hunt for their prey have them raised on such an eminence that they can look all around them, and see their booty from afar. The one which is always in a hiding-place has its eyes widely disseminated; if its lair be in a tube, they are arranged in front, and the number is diminished; the eyes at the back have disappeared. In others, the position and conformation of the respiratory organs reveal the way of life to which they are accustomed. Fifty years ago Cuvier said: "Give me a bone, and I will reconstruct the animal in its entirety" Such science may also be applied to insects.

These complex and perfect arrangements astonish us the more because they are in bodies of the smallest dimensions; we naturally think that the organisation must be very simple, the intelligence of the lowest type The dimensions of the whale, or the immense reptiles of the early geological periods, excite our interest; but the attention is not so powerfully attracted by the admirable structure of the fly, and yet the humblest beings furnish precious teachings to the philosopher. It can scarcely be denied that in relation to their intelligence, some of them are superior to the larger animals. They show a highly developed sense of perception, instincts of wonderful finesse, extraordinary aptitude for all kinds of work, but there is even something more undeniable, marks of higher faculties. These are visible when, in the course of their work, an accident occurs, or an unforeseen obstacle arises: they overcome them, and guard against the danger that might arise. At other times, an idle bird profits by the chance which places an old nest in its way, making it habitable by a few easy repairs. So the smaller insects, not acting as simple machines, make choice between a bad and good situation, conceive the idea of sparing their work when they can arrive at the required end without it, and become idle, when they were created for labour. Can we call this instinct only?

AN OPTICAL DELUSION.

The following is an optical delusion which is none the less interesting for being very easily explained.

Let a person, standing before a looking glass, look attentively at the reflection of the pupil of one of his eyes, and then at that of the other—let him look at different parts of the eye, and from one eye to the other, first at one and then at the other. Knowing that thus, in changing the direction of his gaze, his eyes must move about in their sockets, he will expect to see that they do so in the glass. As a fact, they will appear perfectly still.

If he looks at the eyes of another person trying the experiment, the peculiar fixedness of his own will be still more striking, when he looks at them again.

I will not spoil the riddle by giving the answer at the end. —*Nature.*

THE MALLEABLE IRON WORKS.

We can safely say that we have the best Malleable Iron Manufactory in Canada—in fact, that we have the only good one—and that the quality of its productions are not excelled in the world. This is pretty strong talk, but it is conceded that American malleable iron is better than English, and Mr. Glen, the President of the Joseph Hall Manufacturing Company, who has used malleable castings for several years from eight of the leading malleable iron manufactories in the United States, says he has never had any castings superior to those made here. There is no class of machinery which tests the quality of malleable castings more severely than reapers and mowers, and when we say the Oshawa Malleable Iron Company make as good reaper malleables as are made in the world we cannot say more. We can add that its reputation is fully established, and its success assured. There have been so many failures in this business in Canada that it was difficult to gain the confidence of the trade. Manufacturers who had reapers and mowers returned on their hands through poor malleables did not feel like giving their orders to an untried concern, but this period has been successfully passed, and Oshawa can claim the first and only successful malleable iron works in Canada. As the risk is very great in proportion to the profit, even with men of experience, it may be some time before we have another successful establishment in Canada. The President of a leading malleable iron company in the States told us only a short time since that in getting their experience, even with practical managers, they destroyed $25,000 worth of castings. We understand our company's works are to be enlarged at once. We hope and expect to see them extended frequently in the future to meet the demands upon them.—*Oshawa Reformer.*

LOCUSTS DESTROYING A GRAIN FIELD

IRRIGATION IN COLORADO.

MECHANICS' MAGAZINE.

MONTREAL, JULY, 1874.

ILLUSTRATIONS:

CONTENTS:

SIR WILLIAM FAIRBAIRN.

This celebrated engineer and eminent man of science, whose death on the 18th of August, we have to record, was born at Kelso on the 19th February 1789. His parents were people in humble circumstances and his education was consequently, most of it, self-acquired. From an early period of his life he showed a taste for mechanical pursuits, the first symptoms of which appeared in the construction of a small carriage in which he used to draw about his younger brother—afterwards Sir Peter Fairbairn. From the age of fourteen Fairbairn engaged in active work suited to his genius. At the age of sixteen he was apprenticed to a colliery company where he underwent a regular course of professional training. During this time he laid down for himself a regular plan of self-education, devoting each evening to separate studies, the chief being arithmetic, algebra, mensuration, mathematics and mechanical construction. His early life was one of struggling energy and it was by slow degrees that he gradually rose to a situation of eminence and independence as a maker of machinery. His special branch was that of mill-work, in which he originated many improvements, among others the substitution of iron for wood in the construction of mill machinery and ships.

In 1831 he built a small vessel at his works in Manchester, which was conveyed through the streets to the Irwell, and thence proceeded to sea. This was one of the earliest examples of iron ship-building, and was so successful in its results as to induce Sir William to establish, in 1835, the well-known works at Millwall — subsequently occupied by Mr. Scott Russell — where, during the fourteen years he occupied them, he built about 120 iron ships, some being over 2,000 tons burthen.

Subsequently he was associated with Robert Stephenson in the construction of iron tubular bridges. the experience gained in which operations was of much service afterwards to him in the improvement of the construction of iron ships. Besides pamphlets, papers, &c, Sir William Fairbairn contributed several valuable additions to scientific literature. Among these are "Mills and Mill-Works," "Iron Shipbuilding," "The Application of Iron to Building Purposes," &c. During his busy life he found time to carry on exhaustive experiments for ascertaining the strength of iron, and not only in this but in numerous other directions of commercial and mechanical importance did his active mind contribute important improvements and discoveries to a greater extent, perhaps, than in the case of any other contemporary scientific man.

NEW COLONIAL OFFICES, LONDON.

These new offices, which we illustrate on page 112 are from the design of Sir Gilbert Scott, and are now approaching completion. The general design is said to be of a stately character but not to be of a character to excite enthusiasm. This however is made up for in the detailed ornament which is said to be good in every way both in design and in execution. The broad band of flowing acanthus foliage divides the ground and first floors This has been carefully designed and is a very rich and refined piece of work. Among the ornaments the figures on the right wing, by Mr. Armstead, represent the *five* quarters of the globe; Europe, a figure launching a ship to sail over the globe (which is represented in a somewhat too material and matter-of-fact manner), Asia, a heavy half-made figure, seated in a kind of indolent stateliness, and backed by an elephant; Africa, a Hottentot figure further helped out by a hippopotamus; America, indicated by a Choctaw Indian and a bison; and Australia, by a very lively young woman, who looks as if she were about to emulate the leaping powers of the kangaroo which keeps her company. Asia and Africa strike us as the most successful of these; the former is a figure of considerable character and power. How long these and the delicate carved work will remain intelligible to the eye of the passer-by, is one of those questions which architects and sculptors who have to work in London smoke can only try to put out of mind as much as possible.

THE CEYLON PEARL FISHERY.

Our illustrations on page 101 represent the first pearl fishery that has taken place in Ceylon during a period of ten years, the oysters having mysteriously disappeared for that length of time. Great efforts were made to discover the reason of their disappearance but without effect. The fishery is described as follows in the *London Graphic*. "The present fishery has yielded rather more than a million oysters, netting to Government a lac of rupees (£10,000.) An ordinary Tamil Coolie is said to have picked up an oyster in which he found a pearl worth £150, but generally the oysters have been too young to yield good pearls. The pearl fishing-ground is about twelve miles distant from Silawatorre, and about 200 boats, divided into two fleets, distinguished by red and blue flags, were engaged during the twelve days for which the fishery was fixed. At midnight a signal gun is fired from the shore, whereupon the boats start for the Banks as represented in one of our engravings. On arrival another gun is fired, and operations are forthwith begun. To each boat there is a crew of twenty-three persons, to whom one-fourth of each take belongs, the other three-fourths accruing to the Government. The divers are let down by stones fastened to ropes. They stay from fifty to seventy-five seconds under water, during which time they fill their baskets with oysters. The diving on this grand scale—from a couple of hundred boats—was a very interesting sight. Moreover, there was an English diver in regular diving dress, who stayed an hour under water, walked a mile, and pointed out to the natives where the beds of oysters lay, thus saving much time. Another engraving represents the Government Kottoo, a long thatched verandah, with several heaps of oysters placed at intervals in it, Coolies with sacks of oysters on their heads, and clerks and overseers watching the counting. The third engraving shows a couple of Tamils sitting crosslegged, and intently engaged in drilling holes in the pearls, the pearls being apparently fixed in a curiously constructed three-legged stool.

THE "INDEPENDENZIA."

This vessel, which is said to be the heaviest ever attempted to be launched is a turret ship being built on the Thames for the Brazilian Government. She measures 300 ft. long and 63 ft. beam and is to have a draught of water nearly 25 ft. Her measurement is a little over 5,000 tons with a displacement of about 9,000 tons. The first attempt to launch her was unsuccessful as all the pressure that could be brought to bear failed to move her. An other attempt with additional hydraulic power was subsequently made. This time the vessel made a start and slid down the "ways" for about her own length, and until her stern became well immersed—sufficiently so, it is stated, to be lifted perceptibly by the buoyancy of the water Here, however, the resistance of the water, added to the friction of the ways, seem to have become greater than the weight of the vessel resolved along the ways, and sufficient to destroy the momentum acquired by the vessel, and she was brought to rest.

It is said that in about three hours after the vessel stopped the bottom began to give way. The whole of the bottom amidships was entirely crushed up from the bilge inwards, keels, keelsons, pillars, beams, decks, and bulkheads in the engine and boiler rooms were bent, broken, or doubled up, and formed a pitiable sight, and the vessel dropped aft until the stern became sunk for a depth of some 8 ft. in the mud and gravelly bottom of the river. The bow remained on the ways and was lifted as the stern went down. There now she lies, the object of much interest and much speculation.

When it was reported at Lloyd's that the bottom had gone up and the vessel was breaking, intense excitement followed, and men who had insured for one-eighth per cent. were glad to re-insure their risks at 50 and even at 60 per cent.

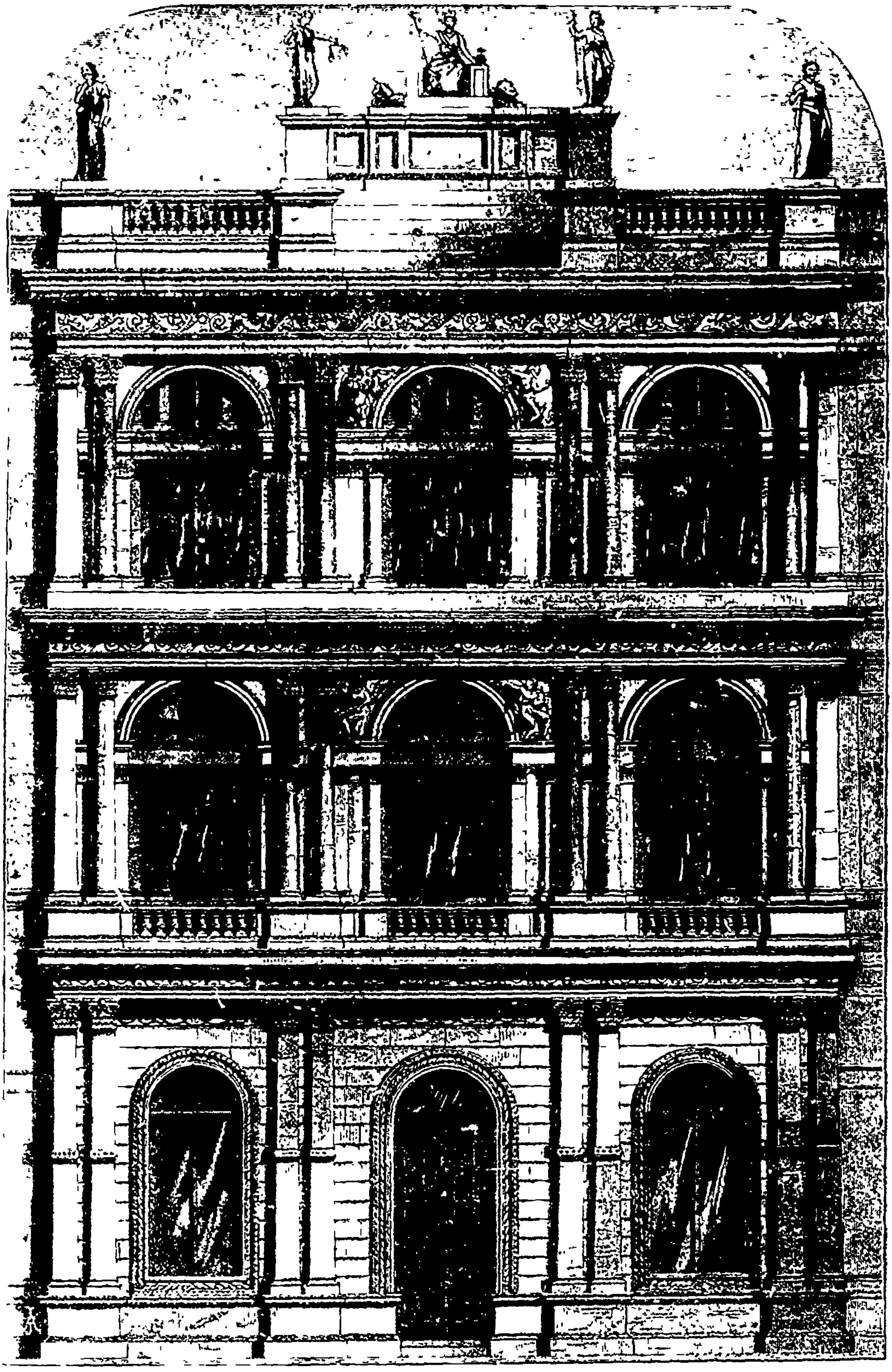
The popular belief is, that she has broken her back, and is a hopeless wreck, while professional men are for the most part sanguine that the vessel can be got off and repaired at a fraction of her total cost.

IRRIGATION IN COLORADO.

There is, on this continent, as in Asia, a vast extent of land which, to become capable of sustaining population, must be cultivated by a system entirely different to that followed in the parts at present most extensively peopled. In Colorado, for instance, the character of the soil is said to have been greatly changed for the better by the system of irrigation now extensibly pursued there, a sketch of which we give on page 109. From the large rivers and streams such as the Arksansas, the Platte and the Bear rivers, canals are dug which branch off in diminishing streams over the surface of the land to be cultivated. Without irrigation the chances of a harvest are extremely problematical, but with its aid deserts become cultivated land and fruitful gardens, the land trebles its accustomed yield and the very climate becomes more healthful and invigorating. The ancients regarded the practice with such admiration and adoption as to place Aquarius among the constellations. The real practical effect, however, may be estimated by considering the enormous populations sustained and the prosperous condition of such countries as ancient Egypt, China, India under native rule and Spain under Moorish rule, in all of which a fully developed system of irrigation was the main producing cause of prosperity.

THE CHANGE OF GAUGE ON THE GRAND TRUNK RAILWAY.

It has been a matter of much pleasure to us to chronicle from time to time the projection of new railroads in Canada and to record the progress of their construction. We have always considered that the condition of the roads of a country was a fair index of its civilization and prosperity. It is with much satisfaction, therefore, that we record the accomplishment of the unification of gauge on what may be called the arterial road of Canada At the time when the question of the best gauge for Canadian railways was decided, the prevalent opinion was in favour of the broad or 5 ft. 6 in. gauge, and consequently enormous lengths of road were constructed on this gauge. But as time went on and traffic from the West sought to pass over the shortest road it was found that the broad gauge was a mistake, constructed as it was after the previous existence on the same continent of so many roads on the 4ft. 8½ in. gauge. Still, in spite of the hindrance, it was found remunerative to take freight from the narrow roads and by various devices carry it over the broad gauge Sometimes cars were employed with axles capable of rapid shortening and lenghtening to suit the two gauges. Sometimes a third rail was laid but oftener the freight was bodily unloaded and loaded again at great expense of time and labour. Of course this condition of affairs could not be suffered to continue for ever and it was at length decided to change the gauge of the whole road in large sections at a time. Accordingly in 1872 the line between Sarnia and Fort Erie was changed. This was the beginning and we have now to announce the completion of this vast undertaking. As to the manner of its accomplishment we refer our readers to an account on another page. Some idea of the difficulty of the undertaking may be gained from that — but a personal inspection is needed to realize the real magnitude of the work. At two points on the line there is collected rolling stock which, if coupled on the line, would extend without break for a distance of at least fifteen miles. All this must be changed from 5ft. 6 to the 4ft. 8½ in. pattern. It is stated that the Company had to order about sixty new engines and to change the gauge of at least fifteen hundred carriages. The result of all this is that the road is in itself now a unit and is also uniform with the other roads of the continent. The advantage of this is too evident to need any more words. Freight may now pass over the road in its course from Chicago to Portland without any hindrance, and passenger traffic between Montreal and the seaboard shares in the gain. The present improvement is but the rectification of a mistake and it shows how careful we should be in such vast undertakings not to give way too easily to the prevailing current of opinion. The alteration with other improvements along the line, additions to the rolling stock and the building of the Niagara bridge have entailed an expenditure of about twelve millions of dollars. The money has certainly been well expended and it now only remains to congratulate the officers of the road on their success and to trust that the justly expected increase of traffic and reduction of working expenses may benefit the shareholders as much as the improvement in the road benefits the country.



NEW COLONIAL OFFICES, LONDON, ENGLAND.

THE LAUNCH OF THE INDEPENDENZA.

GRAND TRUNK RAILWAY.

To-day the Grand Trunk Railway is, or rather will be by this evening, throughout its entire length, of the uniform continental gauge of four feet eight and a half inches. The determination to complete the change of gauge on the eastern section was arrived at only in June last, and since that time the energies of the different departments have been devoted to carrying out the work. The grounds at Point St. Charles have for some time back been an object of interest owing to the acres of railway trucks which were spread out upon them, the chief indication to the general public of the important work for which preparation was being made. These have been distributed when required for the use of the rolling stock to be changed and the process of loading was one of the interesting features of the work. Twenty-five platform cars were attached together, and an inclined plane placed at the end of them, up which the trucks, banded together, were pushed along a temporary wooden track laid upon the platforms. By this process some ninety-three trucks could be loaded in two hours ready for the road. Large numbers of these trucks are used for changing the rolling stock at the Point, and the process of changing was certainly an interesting one. A shed, open at each end, with a track with a third rail for broad or narrow gauge running through it, and an engine at the side in a covered lean-to, made the place where the work was carried on. On each side of the track were two powerful screws, worked by the engine, and the broad gauge car being drawn in on one side by a horse, is stopped in the centre of the shed. Heavy iron rails are placed under the box, leaning upon stretchers placed upon the screws, and then the engine working these last, the car box is raised off the broad gauge trucks, which are drawn from under it. The men speedily change the plates on each side, and then the narrow gauge trucks were drawn under them, the box let down, and the work of changing is completed. The men employed at this work are divided into gangs of six, working eight hours each, but receiving, by way of encouragement, twelve hours' pay. The gang which had just completed its eight hours, before we had the pleasure of examining the process, had changed no less than fifty-four cars in that time. By dint of working night and day, the process of changing makes rapid progress. There are about two thousand two hundred passenger and other cars to change, leaving four thousand four hundred broad gauge trucks. Of these, some sixteen hundred can be reduced so as to answer for the new gauge, and for these new bodies will be made, thus increasing the aggregate rolling stock by that number. On Friday there were no less than one hundred and twenty locomotives off the line.

This briefly is the operation which has been going on at Point St. Charles, and which is now going on with some five hundred cars, accumulated on the Arthabaska branch, and for which the narrow gauge trucks, loaded on platform cars, as we have described, have been already sent to that point. As to the work of changing the gauge itself, the rapidity with which the work has been carried out is the best indication of the completeness of the preparations made for it. In the first place, in order to avoid any unnecessary accumulation of freight for the eastern section of the road, circulars were sent to the station agents west of Montreal, on the 11th Sept., stating that for the next ten days the "through traffic" for points east of Montreal on the Grand Trunk line should not be unnecessarily pressed, but as much as possible should be done in obtaining traffic to points reached by the Central Vermont by way of St. Johns; the object being to utilize the narrow gauge stock as fully as it could be made use of, and not to crowd traffic down to Montreal which could not be moved eastward expeditiously on the broad gauge line. The whole line between Montreal and Portland was divided into twenty districts, averaging about fifteen miles in length each, under the charge of an experienced overseer and three section foremen. From Richmond to Quebec was similarly divided into seven districts and that from Quebec to Rivière du Loup into eight districts. Section foremen were required to go carefully over their sections one week before the change of gauge to see that all culverts and cattle-guards were in perfect order for being narrowed, either with a third stringer in place, or, where the stringer had to be narrowed, to see that the bed was properly prepared, cleaned off and level, and that the necessary rods and blocks were on hand to make secure after being narrowed. They were also required one week in advance of the change of gauge to see that all switch gearing was on hand, such as sliding bars, connecting rods, socket rods, cotters, and all other parts necessary, such new iron work to be laid along side each switch ready for use. Mr. Hannaford himself passed over the entire line from Montreal to Portland, and Richmond to Point Levi and River du Loup, by hand-car, and explained to each foreman the working of his section, examined the gauge of the spikes driven, and the bridges and cattle-guards. He also arranged each gang in position, and explained that the work must be carried out according to the instruction thus given. In the working of the men, it was arranged that each section (the average length of which was five miles) should have two gangs of about eight men in each gang, and, one of these gangs being placed at each end of the section, should work toward the centre of the section until they met, both of the gangs should then narrow the station yard if any on the section. The regular section foreman of the section was required to place a competent and trustworthy man in charge of one of his gangs, he having charge of the other gang, and taking the narrow gauge hand-car with him, he was required, when both gangs met, to run his hand-car over that part of the section narrowed by the other gang to see that the gauge was right, and that all was ready for the passing of the regular trains.

These arrangements were well calculated to accomplish what they in fact have accomplished, viz: the smallest possible inconvenience to the traffic of the country, and the greatest possible safety and expedition in the important work of changing the gauge. And in order to give them effect, late last week all the men that could be conveniently spared from the western part of the line were brought down ready to be distributed over the Eastern Section. On Thursday night some six or eight hundred were lodged and fed in the freight sheds at Point St. Charles, which had been temporarily fitted up for that purpose, and on Friday morning early they were sent over the line, and distributed at points where their work was required. Altogether there were some two thousand men engaged on the work. The last through broad gauge train to Portland left Montreal at nine o'clock on Friday morning and the last broad gauge train left Portland the same day at twenty minutes after one o'clock, coming, however, no further than Island Pond. These trains were expected to meet at Groveton, and after passing each other they were required to display a signal agreed upon, showing that they were respectively the last trains. The moment the trains bearing this signal passed, the trackmen commenced their work of narrowing between Island Pond and Portland, the first part of the road that was narrowed. The last broad gauge trains between Montreal and Island Pond left the former place at four in the afternoon on Friday, and the latter at a quarter past two. These trains were to cross at Richmond, and then to display the "last train" signal, upon sight of which the trackmen proceeded with their work. In the same way the work of narrowing was proceeded with on the other sections; and with such promptitude was the work performed, that at eight o'clock on Saturday morning, the work of changing the gauge was practically accomplished, at ten o'clock narrow gauge trains were started eastward, and during the day some twenty-five trains in all were sent off. During Saturday and yesterday the men withdrawn from other parts of the work to assist in this important change were on their way back to their several locations, and the whole work, which for some weeks past has been a source of anxiety and labour to the officers of the Company, may be said to-day to be successfully completed. We congratulate Mr. Hickson, and the several heads of departments upon the admirable manner in which this important work has been carried out, and we anticipate from it valuable results not only for the trade of Canada, but for the proprietors of the Railway as well.—*Montreal Gazette*

WATER SUPPLY OF CHICAGO.—Chicago is supplied with pure water for drinking and culinary purposes by means of a tunnel two miles long carried out to the middle of Lake Michigan. The capacity of this tunnel is stated to be 57,000,000 gallons per day, and yet Chicago, fearing that her growth would be so rapid as to use up this supply, commenced in 1872 building another tunnel (nearly twice as large as the first) which it is expected will be ready for use at the commencement of 1875. Chicago will thus next year have water supply arrangements adapted for a population of somewhere about 5,000,000!

INSECTIVOROUS PLANTS.

Under this heading Prof. Asa Gray contributes to the *New Y.k Tribune* some interesting information on a subject which Dr. Burdon Sanderson recently brought before the Royal Society. The facts are chiefly derived from the communications of a correspondent, as will be seen from the following:—

Dr. Mellichamp, the writer of the letters from which the following extracts are made, is a physician, resident at Bluffton, South Carolina, in the same district were Dr. McBride made his observations over half a century ago upon the same species, i e., *Sarracenia variolaris*, the only species of the region, and the most efficient of the fly-catchers. In rendering assistance to the principal botanists of the country, Dr. M. has before shown himself to be a most capable and reliable investigator. These notes are only the first fruits of his observations, which will doubtless be repeated, extended, and, perhaps, in some particulars, corrected. But it is best to publish them as they are, in all their freshness. If the two capital new points which he appears to have made out should be fully confirmed, this *Sarracenia variolaris* will rank with Dionœa itself as a vegetable wonder. Indeed where Dionœa captures ten or a dozen insects this captures a thousand, and that by a process wholly different, yet not less amazing. Dr. Mellichamp's letters were addressed to Mr. Canby and myself, the first under date of April 26:—

The first point to decide seemed to be whether the watery fluid found in the leaves was a true secretion of the plant or only rain water. As I have two or three patches of *S. variolaris* conveniently near in a neighbouring pine-barren it was no difficult matter to make the necessary examinations. On the 22nd, therefore, the sandy pine-land being very dry and thirsty—no rain having fallen for some days—I visited the plants, which were blooming freely. Many leaves were carefully examined with the throat still closed and impervious to water, and inflated as they usually are with air. Upon slight pressure the air would escape, thus opening the throat for inspection The leaf being tilted, there was almost invariably an escape of fluid—from three to five drops generally—occasionally as many as ten drops, and rarely fifteen drops. It is, therefore, a true secretion, as no rain could possibly have been admitted to the completely closed and sealed leaf. The taste of this secretion was bland and somewhat mucilaginous, yet eventually leaving in the mouth a peculiar astringency, recalling very accurately the taste of the root, with which I am quite familiar. So much for the examination of the not yet matured and unopened leaves, in which I may as well remark that I could find no trace of insects either by puncture, or eggs, or larvæ, nor indeed any débris of any kind. I next examined a great many perfect leaves with the throat open. In almost every leaf the secretion was to be found, containing generally from ten to fifteen drops, very rarely a half drachm. Even in these opened leaves the admission of rain water is next to impossible, so completely does the upper lid overhang the mouth or throat, like the projecting eaves of a house. Unless in severe rainstorms—and perhaps not even then—would this be possible With very rare exceptions, dead and decaying, or more properly, macerated insects were to be found packed at the base of the tube—most frequently a large red ant—also beetles, bugs, flies, &c., and invariably within the decaying mass one or more small white worms, perhaps the larvæ of insects hatched within the putrefying mass.

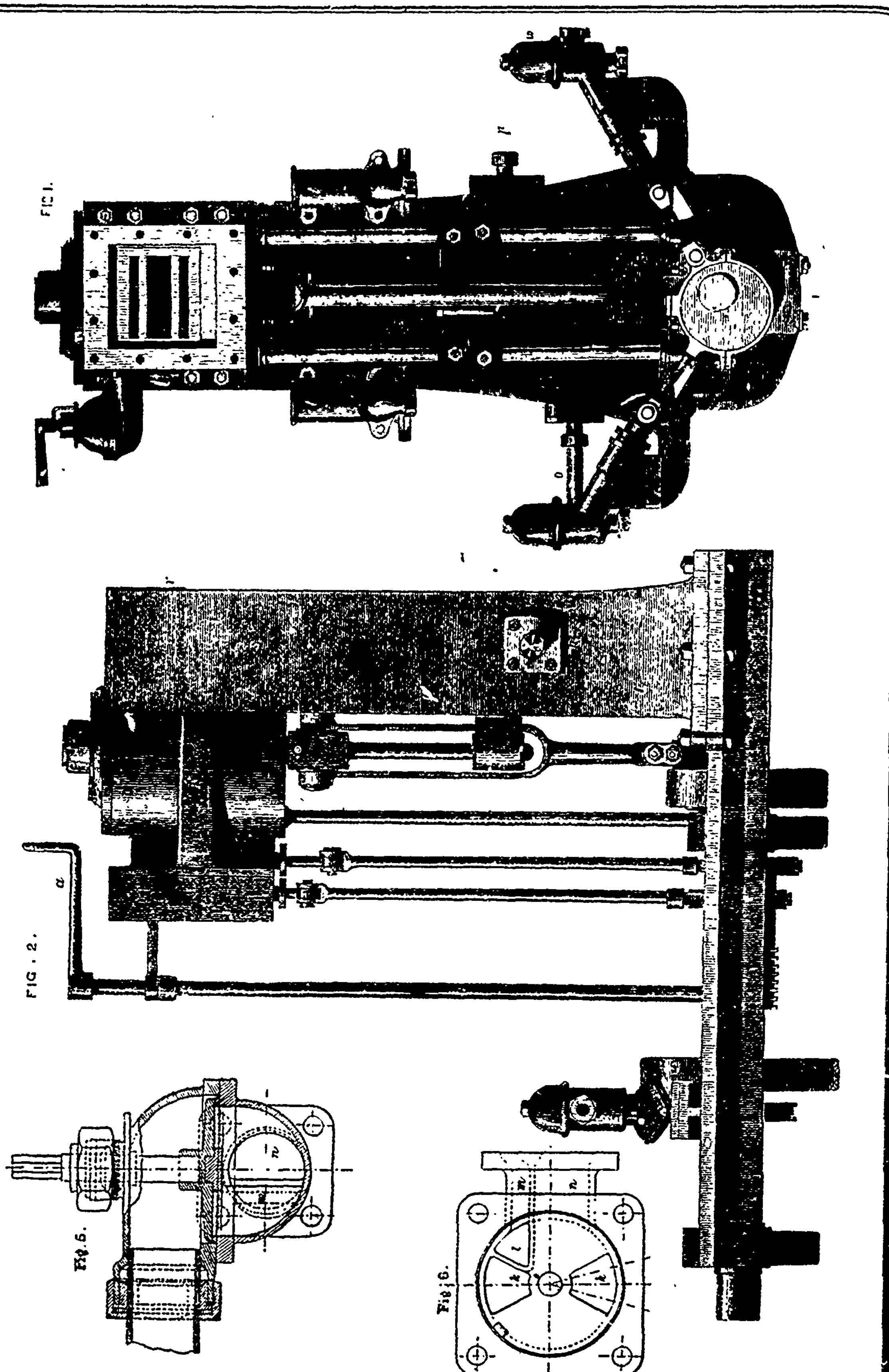
At this period, having examined only young leaves of the season and older ones of the previous year, Dr. Mellichamp had not detected the sweet exudation at the rim of the pitcher. Directing his attention to the watery liquid which collects within, he made the unexpected discovery that this has inebriating or narcotic properties. By draining every leaf plucked of its few drops of juice, I collected about half an ounce of the secretion in a vial, with which I made careful experiments in testing its intoxicating effect upon insects. My "subjects" were chiefly house-flies. About half a drachm to a drachm of the secretion was placed in a small receptaple, and the flies thrown in from time to time—the liquor not being deep enough to immerse them completely, but enabling them to walk about in it without swimming and the risk of being drowned. Some 20 flies were experimented with. At first the fly makes an effort to escape, though apparently he never uses his wings in doing so—the fluid, though seemingly not very tenacious, seems quickly to saturate them, and so clings to them and clogs them as to render flight impossible. A fly when thrown in water is very apt to escape, as the fluid seems to "run" from its wings, but none of these escaped from the bath of the Sarracenia secretion. In their efforts to escape they soon get unsteady in their movements and tumble sometimes on their backs; recovering, they make more active and frantic efforts, but very quickly stupor seems to overtake them, and they then turn upon their sides either dead (as I at first supposed) or in profound anæsthesia.

I had no doubt, from the complete cessation of all motion, and from their soaked or saturated condition, that they were dead, and, like dead men, they were "laid out" from time to time as they succumbed to the powerful liquor; but to my great surprise, after a longer or shorter interval—from a half hour to an hour or more—they indicated signs of returning life by slight motions of the legs and wings or body. Their recovery was very gradual, and eventually, when they crawled away, they seemed badly crippled and worsted by their truly Circean bath After contact with the secretion, the flies which were first thrown in became still, seemingly dead, in about half a minute, but whether from exposure to the air or exhausted by action on these insects, the liquor did not seem to be so intoxicating with those last exposed to its influence. Anæsthesia or intoxication certainly did not occur so quickly; it took from three to five minutes generally, and in one rebellious 'subject' it took at least ten minutes for him to receive his *coup de grâce.* A cockroach thrown in succumbed almost immediately, as did also a small moth, and much more slowly a common house-spider. On the recovery of the latter, it was almost painful to witness his unsteady motions and seeing him dragging his slow length along.

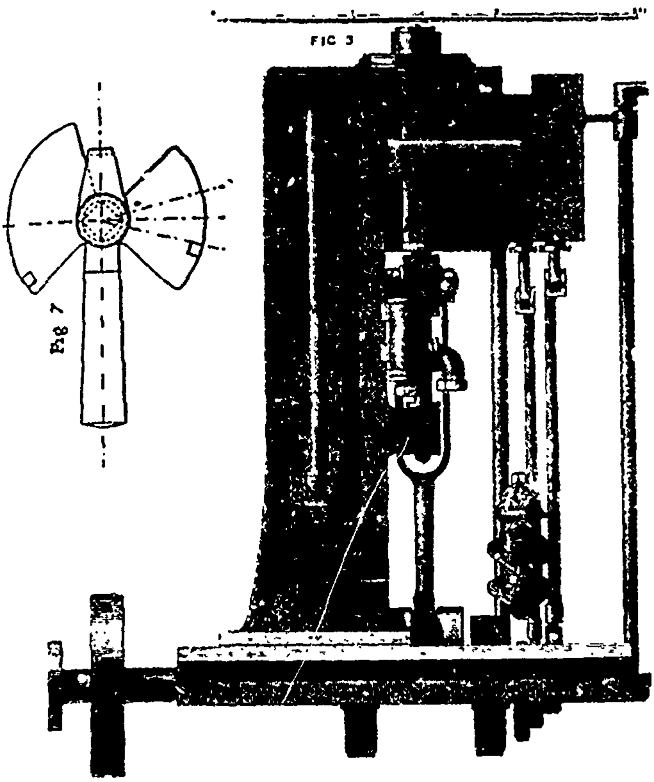
Without doubt, therefore the secretion found in the tubes of *Sarracenia variolaris* is intoxicating—or anæsthetic, or narcotic, or by whatever word you may prefer to indicate that condition to which these small insects succumb. I forgot to mention that while experimenting as above I also threw several flies in water—a few escaped, one remained for some hours, still "paddling" and undrowned. A large "blue fly" was also repeatedly immersed in a weak solution of gum arabic (in imitation of the fluid of Sarracenia), but he remained unhurt all night, when I liberated him in the morning.

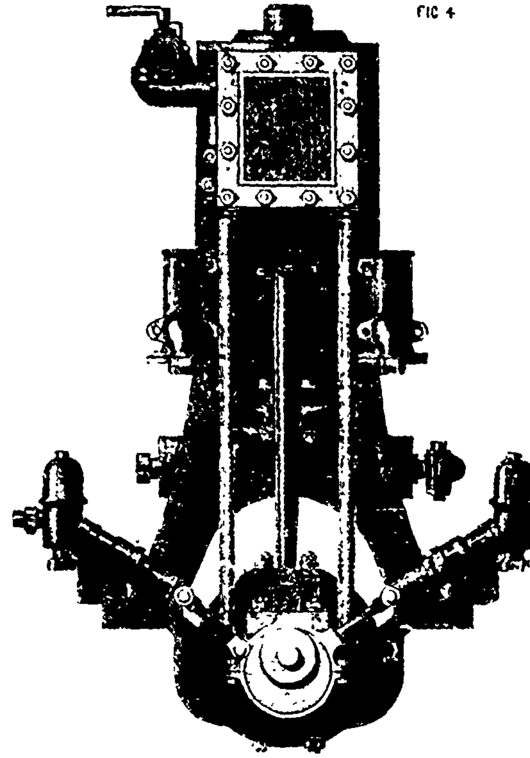
The idea that the macerated or decomposed insects, accumulated in the lower part of the tube, served to nourish the plant naturally raised the question whether the liquid, which deprived them of life, had also any digestive power. Dr. Mellichamp made the experiment of immersing bits of fresh venison in this liquid and also in a corresponding amount of pure water. Examining the two after 15 hours, he found the venison more changed, softened, and broken up in the former than in the latter. But as it was also "more offensive to the nostrils," and as the leaves, when stuffed with insects, become "most disgusting in odour," the only inference to draw is that the liquid may hasten decomposition. For it seems to me that decomposition, not digestion, is what it comes to. In his next letter, written on the 4th of May, after he had received my article upon the Sarracenias, and on examining leaves a week or two older, Dr. Mellichamp announces that he had verified the existence of the sugary secretion within the rim which acts as a lure; and also that he had discovered a trail of it leading down the outside of the pitcher nearly to the ground! This remarkable statement should be read in his own words, as follows:

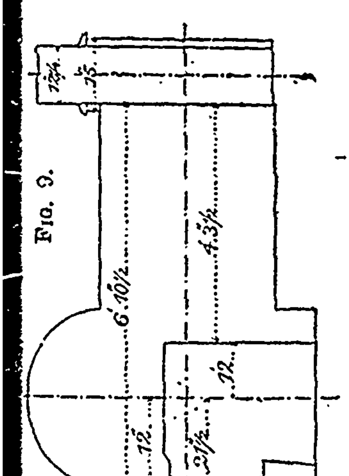
"Having discovered, therefore, in an unburned pineland many plants of *Sarracenia variolaris* which were far more advanced than the more tender and succulent ones first examined, the leaves being more rigid and harsher to the touch and more deeply coloured, I had no difficulty in detecting in almost every leaf the sugary secretion or honey-like exudation noticed by Dr. McBride as being found at the mouth of the tube. I find it precisely in the place described by him, save that it extended downward more than '}in.,' generally ½in., or even ¾in.; I also found it more sparingly under the arched lid or upper lip of the leaf, in and among thick and coarse hairs found there, and which I believe, are thicker and coarser than those in the lowermost portion of the tube. Dr. McBride, however, failed to trace the continuance of the sugary exudation which I frequently found glistening and somewhat viscid —along the whole red or purple-coloured border, or edging of the broad 'wing'—extending from the cleft in the lower lip even to the ground. There is therefore a painted or honey-baited pathway, leading directly from the petiole (or the ground itself) up to the mouth, where it extends on each side as far as

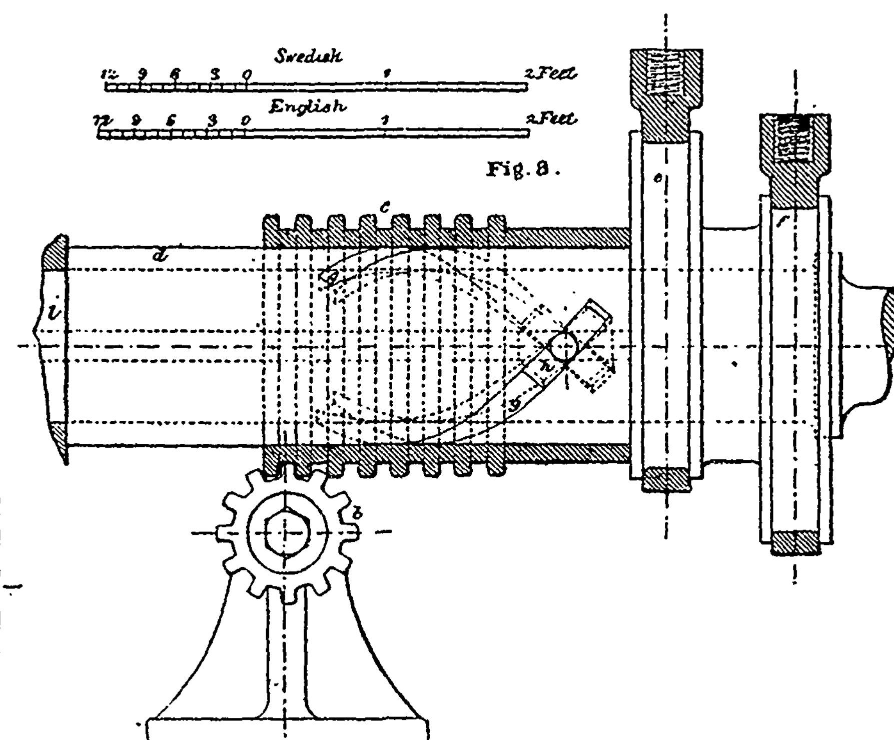


SWEDISH MARINE ENGINES.—(See page 119.)









SWEDISH MARINE ENGINES.—(See page 119.)

the commissures of the lips, from which it runs within and downward, as before stated, for at least ½in.

"One now can readily understand why ants should so frequently be found among the earliest macerated insects at the base of the tube. Their fondness for saccharine juice is well known, and while reconnoitering at the base of the leaf and bent on plunder, they are doubtless soon attracted by the sweets of this honeyed path lying right before them, along which they may eat as they march, until the mouth is reached, where certain destruction awaits them.

"Having determined this still in the woods, I collected a large number of the maturest and most perfect and most sugared leaves. When I reached home I placed them in two goblets of fresh water, and that morning fortunately having perfect leisure, I sat down before them for the purpose of carefully watching the entrapment and determining, if possible, whether the flies were intoxicated after sipping the honey. I remained in my position, for, I suppose, at least two hours, and in other ways continued my observation more or less the greater part of the day. Flies were soon attracted to the leaves, but by no means so greedily as stated by Dr. McBride (there were, however, not many in the house at this season) and many were entrapped, the buzzing of the unfortunate prisoners being incessant. But I soon found that this was no way to test the matter, for although the flies would disappear—none escaping—it was no easy matter to see the process. I therefore turned backward the greater part of the overhanging lid, and thus flooded the prisons with daylight, so that the whole region of the 'sugar countries' could be seen and examined while the flies were busy at their food. Dr. McBride evidently (as you remark) did not suspect any inebriating quality in the exudation, but you yourself 'incline to take Mr. Grady's view of the case.' I cannot but think that the last-named observer is wrong, and that the nectar found at the orifice and border of the wing is simply a lure. Let it be remembered, however, that my examinations were made only on the 2nd day of May, and that it is barely possible the nectar, although attractive to flies is not yet concentrated enough to intoxicate or kill, and that Mr. Grady may be correct. But what did I witness? After turning back the lids of most of the leaves the flies would enter as before, a few alighting on the honeyed border of the wing and walking upward—sipping as they went—to the mouth and entering at the cleft of the lower lip; others would light on the top of the lid and then walk under the roof, feeding there, but most, it seemed to me, preferred to alight just at the 'commissures' of the lips and either enter the tube immediately there, feeding downward upon the honey pastures, or would linger at the brink, sipping along the whole edge of the lower lip and eventually enter near the cleft. After entering (which they generally do with great caution and circumspection, apparently) they begin again to feed, but their foothold for some reason or other seems insecure, and they occasionally slip, as it appears to me upon this exquisitely soft and velvety 'declining pubescence.' (The nectar is not exuded or smeared over the whole of this surface, but, as before remarked, seems disposed in separate little drops.) I have seen them regain their foothold after slipping, and continue to sip, but always moving slowly and with apparent caution, as if aware that they are treading on dangerous ground. After sipping their fill they frequently remain motionless, as if satiated with delights, and in the usual self-congratulatory manner of flies proceed to rub their legs (or hands) together, but in reality, I suppose, to cleanse them. It is then they betake themselves to flight, strike themselves against the opposite sides of the prison-house—either upward or downward, generally the former. Obtaining no perch or foothold they rebound off them from this velvety 'microscopic chevaux de frise' which lines the inner surface still lower, until by a series of zigzag, but generally downward falling flights, they finally reach the coarser and more bristly pubescence of the lower chamber, where, entangled somewhat, they struggle frantically (but by no means drunk or stupefied), and eventually slide into the pool of death, where, once becoming slimed and saturated with these Lethean waters, they cease from their labours. And even here, although they may cease to struggle, and seem dead like 'drowned flies,' yet are they only asphyxiated, not by the nectar, but by this 'cool and animating fluid, limpid as the morning dew,' as saith Bartram. After continued asphyxia they die, and after maceration they add to the vigour and sustenance of the plant. And this seems to be the true use of the 'limpid fluid,' for it does not seem to be at all necessary to the killing of the insects (although it does possess that power), the conformation of the funnel of the fly-trap is sufficient to destroy them They only die the sooner, and the sooner become 'liquid manure.'

"But let me return from this digression to the entrapment of the flies. As before stated, I could never see any indications of unsteadiness or tottering in the sipping flies—nothing save an occasional slip from the uncertain hold which the peculiar pubescence would give—save once or twice while watching intently I saw a fly disappear so quickly downward that I could not with certainty say whether it was flight or a tumble from stupor or insensibility But on so many other occasions have I satisfied myself to the contrary, by seeing them fly upward as well as downward, with full vigour of an unhurt, unintoxicated insect, that I altogether reject the idea of stupor I may state that while watching I observed not a single escape when the lid was down, but after I had turned it back on most of the leaves under examination a few, but only a few, escaped. And those which escaped after sipping to repletion seemed in no wise inebriated.

"Indeed, I have still better proof as to the innocuousness of the nectar. Yesterday (3rd) about sunset I strolled into the pine-land, and brought home with me the laminæ of perhaps a hundred leaves—all maturing and sweet with the exudation. Some of them were placed on a table after candlelight, and attracted a few hungry flies. They remained many minutes sipping, and would return to sip, seeming to enjoy the evening meal thus afforded them. Of course there could be no entrapment here, as only the honey-bearing portions which I had torn off were exposed; the flies I can only say eat and eat, but no unsteadiness, or tottering, or falling, was in a single instance to be seen, and my guests, after having satisfied their appetites with my repast, retired for the night. This morning also the same viands have been temptingly placed before them, and although they have been visiting the board off and on through the day, I have yet to be informed of a single case of intoxication.

"I have only now a word or two more to say as to the cause of the entrapment from the peculiar conformation of *S. variolaris*. The nectar being found below the lower, lip for a half inch or more, when the fly is satiated and makes for flight, he must do so immediately upward for a very short distance, and then somewhat at right angles to get through the outlet—a somewhat difficult flight, which perhaps of all insects only a fly might be capable of, but which even he probably is not. This, too, upon the supposition that his head is upward, whereas his head is, I believe, generally downward, or at least parallel with the lip. If in the first position he attempts flight, he is very apt to strike the arch overhead, and if he escapes that, it is next to an impossibility for him to turn and strike that small space between the projecting (and downward projecting) lid and the lower lip. If, with head downward, he is very apt in flight to strike the opposite wall at a still lower angle, and then from rebound to rebound get lower and lower until he touches the pool. In almost every instance, therefore, a fly once entering is caught."

Dr. Mellichamp finally alludes to the light spots, which give to the species its name of *variolaris*, from a fancied smallpox. These cover the upper and posterior part of the pitcher, and are translucent. Dr. M. suggests, as probably a wild fancy, that this translucent portion may play a part in detaining the flies by suggesting a direction of escape the very opposite of the only practicable one. As to that, one should not hastily reject a view which goes to show that even this arrangement, which is especially conspicuous in the species, may be of useful account to the plant; that is, if the capture and destruction of flies is useful to it, as I cannot doubt. As to Dr. Mellichamp's capital discovery of the honeyed pathway leading from the ground up to the larger feeding-ground to which ants are thus enticed, it may well be compared with the trail of corn with which hunters are wont to entice wild turkeys into their trap. One cannot imagine anything more curious.

HERE is a Japanese receipt for keeping meat fresh in hot weather: Place it in a clean porcelain bowl and pour very hot water over it so as to cover it. Then pour oil on the water. The air is thus quite excluded and the meat is preserved.

SWEDISH MARINE ENGINES.

Visitors to Stockholm are all familiar with the small passenger steamers which the position of that city enables to be used with so much convenience to the public, and the demand for these boats has led to considerable attention being paid to the design of simple engines for driving them. At the late Vienna Exhibition the well-known Motala Works, of Sweden, exhibited one of these boats—the Motala—which was an excellent specimen of her class, and we give on pages 116 and 117 engravings, from *Engineering*, showing the engines with which she was fitted.

The principal dimensions of the Motala are: Length over all, 56 ft. 6 in.; beam, 11 ft 8 in.; draught of water with 106 passengers on board, and coal bunkers filled, 4 ft. 2¾ in. The engines by which the boat is driven is non-condensing, and is rated at 8 horse power, and is shown by Figs. 1 and 2 of our two-page engraving. It has, as will be seen, a single cylinder, and is fitted with an expansion slide working in a separate valve chest to the ordinary slide.

The supply of steam to the engine is controlled by the butterfly valve, of which we give a detailed view in Figs. 5, 6, and 7, this valve and its casing being formed so that steam can be admitted through the openings *k k* to the expansion valve chest only, or to both the expansion valve chest, and the chest containing the ordinary slide, the opening *l* communicating with the latter. This is a handy arrangement, and enables steam to be admitted for nearly the whole stroke at starting, &c., while by covering the port *l*, the expansion valve is at once brought into action.

. reversing is effected by means of the arrangements shown in detail by Fig. 8. From this it will be seen that the two eccentrics *e f*, are not fixed directly on the crank-shaft, but are formed on the sleeve *d*, this sleeve being held between two collars on the shaft, so that it cannot shift longitudinally. Encircling the sleeve *d* is another sleeve *c*, which has a series of collars turned upon it, these collars engaging with the pinion *b*. By turning the handle *a*, Fig. 2, the pinion *b*, Fig 8, is made to shift the sleeve *c* longitudinally upon the sleeve *d*. Through the sleeve *d* are cut two spiral slots, shown in Fig. 8, and fitting these slots are blocks *h*, these blocks being carried by the outer sleeve *c*, and their inner ends working in straight grooves cut in the crankshaft. It follows from this arrangement that when the sleeve *c* is shifted longitudinally on *d*, the latter is by the action of the blocks *h* in the spiral slots turned upon the crank-shaft, and the eccentrics are thus shifted from the position for going ahead to that for going astern, or *vice versâ*. The arrangement is not a novel one, but the details are very neatly worked out.

The engine is placed abaft the boiler, and close to it, and the exhaust steam after traversing the belt *q*, enters the feed-water heater *s*, and passes thence through a pipe attached at *r* into the chimney. The feed-water leaves the feed pump by the pipe *o*, traverses a bent pipe inside the heater, and leaves the latter at *p*, whence it is led off to the boiler. The bilge pump is at *u*, and *t t* are hand pumps.

The engine drives a screw 3 ft. 2 in. in diameter, with 6 ft. 9⅜in pitch, and it is supplied with steam at 60 lb. pressure by a boiler of the locomotive type, as shown by the diagram Fig. 9 The dimensions in the letter are in Swedish feet and inches. The principal dimensions in English measures are as follow:

		ft.	in.
Diameter of barrel		3	1
" tubes		0	1.95
Length of tubes between tube plates ...		4	2⅛
Number of tubes	46		
Length of firebox casing		2	11
Total heating surface	120½ sq. ft.		
Firegrate surface ...	3.8 "		

Figs. 3 and 4, on our two-page engraving, show a somewhat differently arranged engine to that above described, this engine, which is also one made at the Motala Works, being intended to be placed aft the boiler, and to give a sufficient distance between the engine and boiler for firing the latter. Both the designs we illustrate are neat and simple, and well adapted for their purpose.

RAILWAY MATTERS.

It is stated that the largest locomotive in the world is the "Pennsylvania," on the Philadelphia and Reading Railroad. The diameter of the cylinder is 20 inches, the stroke 26 inches, the number of the driving wheels twelve, the diameters of the drivers 4 feet, the weight of the engine alone sixty tons.

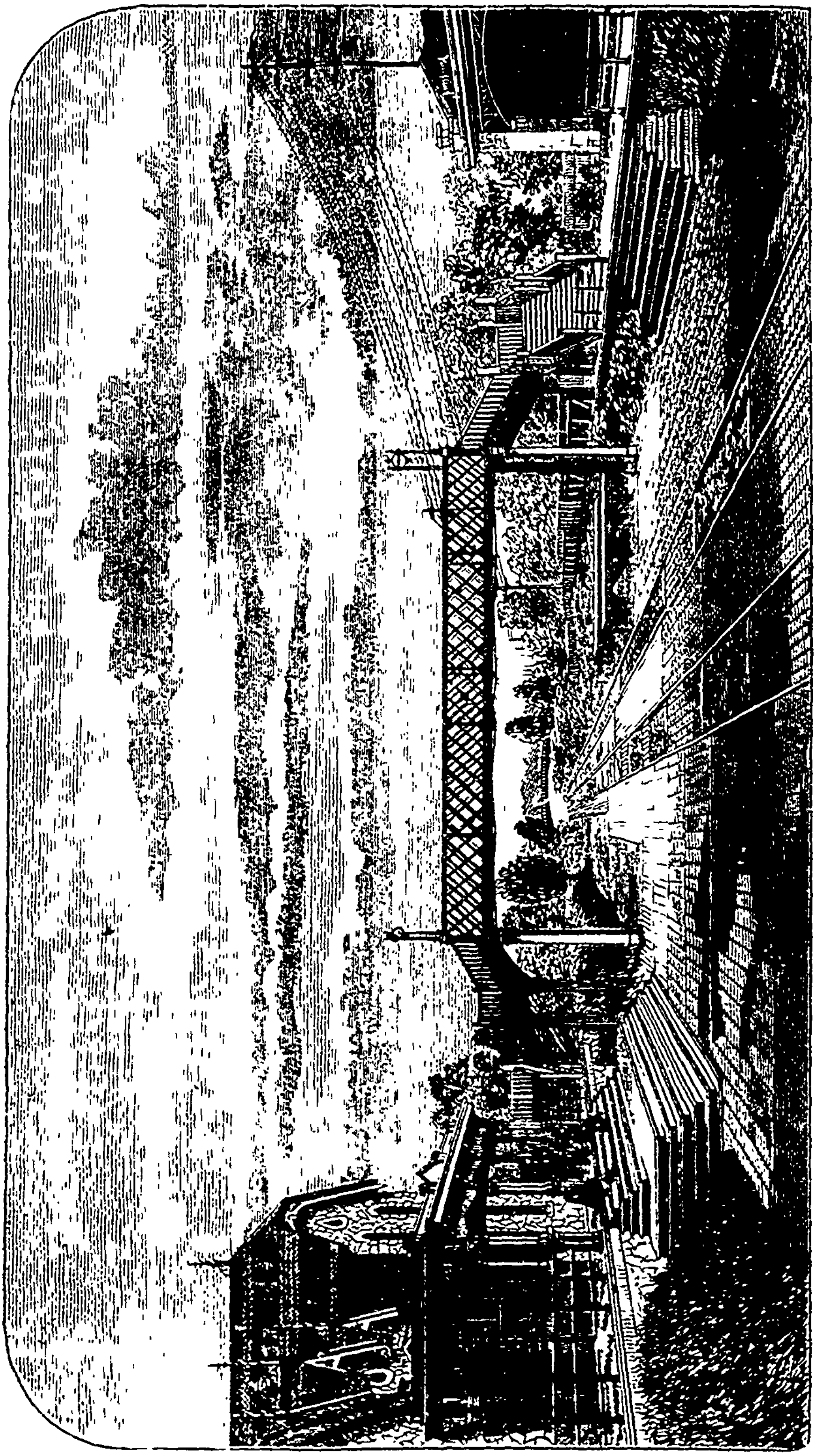
The St. Gothard Tunnel.—It appears from a report made to the Swiss Federal Council, that at the close of June the contractors had completed nearly one-seventh of the whole distance of nine miles, 2213 ft. The progress made during July was about evenly balanced, but the advance on the Goeschenen side was rather more rapid than that effected on the Airolo side.

The tea trade between New York and China and Japan *via* the Pacific Railroad continues to be carried on actively. In one day seventeen car loads of teas arrived at New York by this route, in sixteen days and seventeen hours from Yokohama to San Francisco, and less than fourteen days from the latter city by rail, altogether, including delays, less than thirty-four days, being the quickest time yet made between Japan and New York. It can, however, be done in less time if better coal be used in the Pacific steamers.

The Port Jervis (N. Y.) *Gazette* of recent date says:—"At the Erie car shop in this place a record is kept of the wheels removed from cars To-day four wheels were removed from a freight car which were made, respectively, in the following years: December 24th, 1853; two November 30th, 1853, May 31st, 1854. These wheels have been running over twenty years, have doubtless worn out several cars, and are fit still apparently for as much more wear. Allowing twenty days in each year for standing still, and ten miles an hour while running, they have run 1,697,400 miles."

The Railroad Commissioners of Massachusetts have been hearing a complaint made by the corporation of Boston, that the citizens are annoyed by the sharp railroad whistle, which in one crossing is sounded more than 300 times a day. The commissioners find that it is questionable whether, in its effect on invalids and horses, such frequent annoying whistling does not occasion a greater loss of life than would ensue from its total suppression. They regard it as "a singular relic of the crude expedients employed in the past," that the companies should disturb whole communities in order to attract the attention of their own servants; and it is suggested that electric signals, and a bell, with flagmen at level-crossings, would answer every purpose, except in the management of freight trains, and as a signal of danger. For this last purpose the value of the whistle, it is remarked, would be greatly increased by abolishing that frequent use of it which leads people to pay little attention to it. The commissioners recommend the change of practice thus indicated.

The length of the Panama line from the Atlantic to the Pacific Ocean is nearly 48 miles; the summit ridge is 287 ft. above the mean tide of the Atlantic. The distance from New York to Hong Kong *via* Cape Horn is more than 17,000 miles, but by this railroad across the Isthmus it is less than 12,000, a saving of 5500 miles. Starting from Aspinwall (otherwise called Colon), on the Atlantic side, for Panama, on the Pacific, the traveller is soon in the midst of a scene of tropical beauty hardly to be surpassed in the world. Cocoa, palms, and bread-fruit trees wave their branches on either side, and from the fastnesses of murky swamps richly-coloured aquatic plants rise in luxuriant wildness. The cries of gorgeously plumaged birds are heard on all sides, and now and then the discordant notes of monkeys, parrots, and other natives of the wood. On the low, muddy banks of streams yellower than the Tiber can be seen the huge unwieldy forms of alligators sunning themselves and awaiting some unlucky object of prey. Almost all the towering trees are clasped in the vice-like embrace of plants of parasitic growth, and many tottering trunks attest the effect of such close companionship. Along the sides of the road and upon the woody banks of the streams passed over are to be seen the thatched habitations of the mongrel specimens of humanity that live on the Isthmus. The rainy season commences in May and lasts until October, and it rains "hot water," according to the statement of residents. The wires of the Isthmus Telegraph Company run alongside the tracks. The dampness of the earth is guarded against by setting the telegraph-poles in concrete. The railroad-ties are made of lignum-vitæ, laid on a stone ballast. The railroad and rolling stock have probably cost 12,000,000 dollars.



AMERICAN RAILROAD STATIONS.

It is well known that since the civil war, progress in the United States has been rapid and vigorous in all directions, but in no department has this progress been more marked than in railroads. The main lines or arteries throughout the country are becoming every day more substantial and their permanent way, stations, warehouses, shops, &c., are rapidly assuming the solid appearance that we see on English and Continental roads No road stands higher in this respect than the Pennsylvania Railroad, in fact, it has always maintained a pre-eminent reputation in matters of this kind, with its iron bridges, its solid ballasted track, steel rails, and fine shops.

We publish on this page and the next engravings from *Engineering* of a passenger station erected recently on this line at Bryn Mawr, eight miles from Philadelphia, a portion of the country thronged with summer residences and country seats of wealthy Philadelphians. It is only a sample of a number of others on the road, and shows what this road is doing, and promise to continue doing, for the comfort of its patrons.

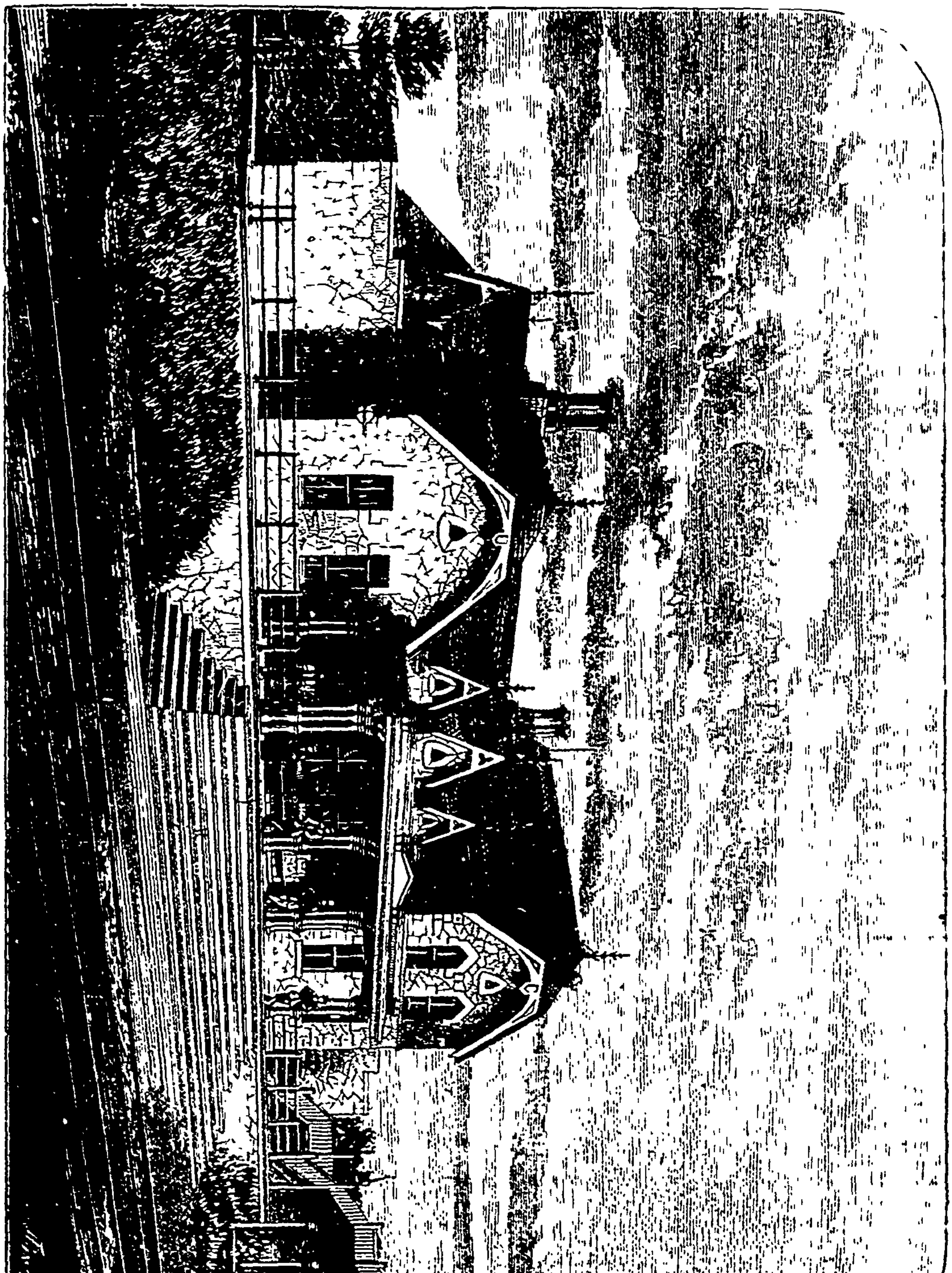
This station consists of a main passenger building and agent's dwelling combined, on the south side of the road, and a passenger shelter on the north side, an iron footbridge connecting both sides to prevent the necessity of passengers crossing on the tracks. The buildings are constructed of a handsome native gneiss rock, with dark pointing, and Connecticut brown-stone dressings. The interior is finished up with hard woods, black walnut and ash, throughout, and presents a very handsome appearance The main waiting-room covers an area of 24 ft. by 37 ft., and has an open timbered roof. The building is lighted by gas made on the premiess

---

The London, Huron and Bruce Railroad is to be put under construction immediately

---

One of a party camped on an island in Muskoka Lake, not six miles from the mouth of Muskoka River, discovered a large quantity of magnetic iron ore, or magnetic pyrites



STATION OF THE PENNSYLVANIA RAILROAD

LIGHTNING AND LIGHTNING CONDUCTORS.

By J. T. Sprague—"Sigma."

(In the *English Mechanic.*)

The common conception of lightning may almost be described as a belief that there is a something packed away in the clouds, which at some uncertain moment falls from them as a "thunder bolt," or rushes out upon the earth as a discharge of "electric fluid," with destructive effects, resembling in some degree those of the bursting of a reservoir of water. The conductor is regarded as having some attraction for the "bolt," and also as a pipe to receive and carry off the fluid. These ideas are not only erroneous scientifically, but they are the source of many practical mistakes in the setting up of conductors which sometimes lead to fatal results.

Those who know something of electricity are of course aware that lightning is strictly analogous to the artificial electric discharge; but the common erroneous views of this latter, based on the fluid theories of electricity, lead to notions not unlike those just described.

The discharge does not merely issue from the clouds and rush to the earth, but the latter fulfils a function just as important as that of the clouds, the latter are indeed "prime conductors" of Nature's great electrical machine, but the force is distributed over a vast "inductive circuit," of which the air and the earth form as much a part as the clouds themselves, and the discharge is a redistribution of force all over this inductive circuit, not across the air simply.

The thunder cloud is in fact to all intents a condenser plate upon which terminates the polarised chain of a circuit, and there are two varieties of thunder-storm, which depend upon the nature of the opposite condensing plate. This may be another cloud above, or at a distance from the first; then the discharges occur only between the clouds themselves, and the only effect on the earth is of an inductive nature, and is usually slight; this is the case with what is called *sheet* lightning, in which the clouds are vividly illuminated, but there is no line of light visible. In the other class the surface of the earth forms the second condenser-plate, the air and all bodies between the clouds and the earth are "polarised," and assume a condition analogous to that produced in the neighbourhood of an electric machine at work. Discharge at last occurs in one or more lines in which the resistance happens to be least, when the tension has risen to a degree greater when the resistance of the circuit can sustain. Very slight circumstances determine the direction of this discharge: an animal standing on the ground, a tree, the presence of extra moisture, or a metallic vein, or a range of piping in the ground may suffice. This is very evident in the case of ships at sea: they will not only draw a flash of lightning, but will frequently cause a change in the direction of the wind itself, by the electrical attraction they set up.

I have frequently seen this occur. On one occasion a very heavy squall-cloud rose on the weather bow of a ship I was in, within the Tropics, when I was in charge of the vessel, it crossed our course and went away to leeward, we running up nearer and nearer to its path: the cloud then stopped, rapidly returned toward us, against the wind we had, and as it reached above us, a violent change of wind occurred, the cloud threw out its charge, struck our fore and main top-gallant masts and killed two men.

To this same order belong a variety of natural phenomena, such as what sailors call St. Elmo's Fire, when the points of masts and yards are tipped with lambent flames, which resemble the common brush discharge of our machines. A third variety, called Ball Lightning, is very uncommon, and its electrical nature is not at present explainable; if, indeed, it is directly electric in its nature at all. In this a large ball of fire is seen to roll along the earth, doing great mischief on its path, and apparently having some connection with or relation to the revolving winds called tornadoes or whirlwinds, models of which may frequently be observed in our streets when the dust is not properly laid by watering, and of which the waterspout is another variety.

In the true thunderstorm the cloud consists of a series of layers or zones opposite by electrified with a similarly arranged but opposite series on the earth beneath, the air between completing an electric circuit. Such a circuit is often extended over many miles, so that when a discharge occurs at one extremity a corresponding one in the reverse direction (sometimes called the back stroke) occurs at the other extremity, perhaps twenty miles away. The clouds themselves may be only 100ft. away, or two or thr e miles. Flashes of such length have indeed been measured by the angle occupied by the line of light and the period between the flash and the sound of the thunder, which together furnish the means of calculating the length of the visible flash. Several attempts have also been made to measure the time occupied by a discharge. Moving objects, when photographed by its light, appear as distinct as if stationary, but by means of revolving mirrors it has been ascertained that the actual duration of a flash is something less than 1-500th of a second, its apparent duration is an effect of our own eyes, due to what is called persistence of vision, owing to which we cannot lose an impression once produced in much less than a sixth of a second, on which principle are based so many optical toys.

It is frequently stated that the bodies of those killed by lightning are marked with impressions of neighbouring objects. It is hard to say what amount of truth there is in this, and how much natural exaggeration; credit is most often given to a neighbouring tree as the image copied, and it would seem not unlikely that such marks are caused by an action like that of the brush discharge, causing a series of struggling lines, which the imagination of excited observers converts into a tree. It is of more moment to those who are alarmed at the flashes of lightning to understand that when a flash is seen all danger from it is passed, a person struck never sees the flash, and it would appear that this death is the most instantaneous and painless which can be conceived.

The foregoing considerations as to the nature of the discharge will enable us to see what are the true principles of conductors to avoid its effects. They are not intended to attract or convey a *discharge from* the clouds. Their object is to supersede the condition of polarisation and tension in the *space to be protected*. They do this in a twofold manner:—1. They practically raise the earth's surface to such a curved height as corresponds to the electric relations of the conductor and the air; not in an exact invariable form, as some suppose the protected area to assume; but still, roughly in a cone from the apex of the conductor, and of a radius perhaps equal to the height of the point, but this applies only to the rod itself, when buildings are in the included cone no law can be given, as the conductivity is affected by their materials and contents Whatever the space protected may be, within it the conductor lowers or nullifies the condition of tension, transferring it to the space outside the cone, &c. They react also upon the exterior space in the direction of a reversed cone, by the discharging properties of points when forming part of a polarised area On points, the lines of polarisation converge, and so affect the circuit that it will not rise to its extreme tension; the action is precisely that of a point connected to the rubber of a machine, and held (even much beyond the sparking distance), towards the prime conductor; in these conditions no charge can be given; a brush discharge is kept up and a current passes instead. The lightning conductor performs the same duties: soon as the charged cloud approaches, and would begin to set up an "inductive circuit" under tension in the air to the earth beneath it, a current begins to flow quietly in the conductor, the tension above it is rapidly lowered, and may not be able to accumulate sufficiently for a violent discharge, *i.e.*, a lightning flash, at all; but if it does, the discharge will occur through the space between the cloud and the outer area of the conductor's cone; and the conductor takes it up in the form of a momentary increase of current. In considering these principles it must be remembered that lightning is not a mere thread of flame, or confined to the visible line; a large space all round the line takes part in the discharge, and gives up the force previously accumulated in it as tension.

These principles settle for us all questions as to conductors. They should connect to earth every portion of a building, and as that is possible only with metal buildings, they should connect every salient point and as much of the surface as possible, so as to extend around the building the area of low tension, or artificial "earth" surface opposed to the cloud. Chimneys require especial attention, because they are tubes lined with conducting material, containing warmer air, and if with fires, then extending a comparatively good conducting column of warm air towards the cloud and so inviting a discharge; hence it is that lightning almost always enters a house by the chimneys. All doors and windows causing currents of air should be closed during a thunderstorm.

The prime essential is a good connection to earth; water and gas mains provide the best if the conductor is well secured to them; next to them is the metal shaft of a good pump, in a well constantly supplied by springs; then ponds or ditches. What is required is a large metal surface terminating the conductor, and in contact with a stratum of moist earth, so that a hole sunk into wet gravel, into which the conductor is led, and surrounded with a quantity of coke to increase its surfaces of contact, will answer, but dry clay, or rock is not safe. This connection should, if possible, surround the building by means of rods from its various corners, either led to different earths or else continued by a rod round the house to one earth connection Every piece of metalwork about the building should be utilised such as ridge caps, guttering, and water pipes. They cannot be trusted as conductors because of the joints in them, which offer great resistance, and therefore prevent reduction of tension, but they will help to form a protecting network around the building, especially if strips of copper are soldered across each joint Gas and water pipes within the building, and any tall metal work are sources of danger, the former also because they are in contact with the earth, it is better to connect them at their highest points with the conductors by wires through the walls, but care must be taken that they do not give a better path than the conductor itself, as if they do, the leaden parts might be melted; this will depend greatly upon the "earth" made by the conductor. If this is itself of sufficient size, and connected to the mains, it will be perfectly safe. Several accidents have occurred by gas-pipes, bell-wires, &c., having either received a direct charge through the walls, or having a violent current induced in them. The terminals should be attached to all high or salient points, most particularly chimney-stacks; if these are wide, and contain several chimneys, it is safer to have two points, though usually one is sufficient, but the kitchen chimney, or any one commonly used, should be specially attended to. The points may be made of rods of 1in iron drawn out to a point, rising 2ft. or 3ft. above the building, they are better also for galvanising. There is no advantage in any of the fancy points, patented or otherwise. The conductor depends upon the building. A factory chimney or church steeple should have a copper conductor of at least ½in. section, either as a rod or as a wire rope, well protected against injury. For smaller buildings iron rod will answer, and in most cases galvanised iron wire, about ¼inch, such as it used for telegraphic lines, will answer perfectly, if brought from several salient points and carried down the different sides of a house as connected as above described; but for a simple conductor at least ½ in. should be used. Solid rod is best as it exposes least surface to rust, for it is the mass or weight of metal which conducts, not its surface as some suppose, but every joint must be carefully made and soldered to secure perfect continuity and low resistance.

It will be seen that the conductor should in no account be insulated from the building. In some electrical experiments we surround an electrometer or other apparatus with a cage of wire connected to "earth" or to the negative pole of the source, in order that it may not be influenced by any external electric actions. That is exactly what we want to do with our buildings, to so connect their exterior surface with the earth, the point of zero tension, as to prevent their contents from being affected by external electric disturbance. An iron house well connected to earth and iron roofed, would not only be perfectly safe, but its inmates would scarcely feel any of the effects usually produced on the nervous system by "thundering weather," except so far as these are due to heat The object aimed at in our lightning conductors should be to approach that condition as much as possible; to obtain an enclosed area within a conducting envelope provided with points and connected with earth.

A FIRM of Connecticut brass and copper wire manufacturers recently drew a copper coin into 2700 ft.—more than half a mile—of wire.

A RIFLE which the Evans Rifle Co., at Mechanics Falls, Me., are manufacturing, is said to be capable of discharging thirty-four shots in nineteen seconds.

DOMINION.

THE Levis and Kennebec Railway now have the rails laid as far as St. Mary's, and will open the line for traffic in a few days.

THE first sod of the Pembina Railway was turned on Saturday last at the present northern terminus, eight miles from Winnipeg Men and teams are prepared, and the work is to be commenced this week.

MR. F. C. S. Ridgeway, formerly Editor of the *Citizen*, is at present having a furnace erected at the Baldwin Iron Mine in Hull, which will be in operation in a few months

Intelligence from the Canada Silver Mining Co's. Agent at Thunder Bay are encouraging. At a meeting of Directors last night it was decided to make a contract with the miners to drive a level 100 feet during the winter months.

The manufacturing of sal soda has been begun in Hamilton by C. B. Leickie, late of Scotland. This is the first, it is believed, ever produced in Canada. The ingredients are obtained from their native locality, within twenty miles of this city, and the industry forms an important addition to the list of manufactures of Hamilton.

A LOCK is to be built on the Muskoka River between Mary and Fairy Lakes, by which a fall of over four feet will be overcome. The lock is to be a wooden one, resembling that at Rosedale, and will give a very important stretch of navigation, and another lock or two would add a hundred miles more to the navigable waters.

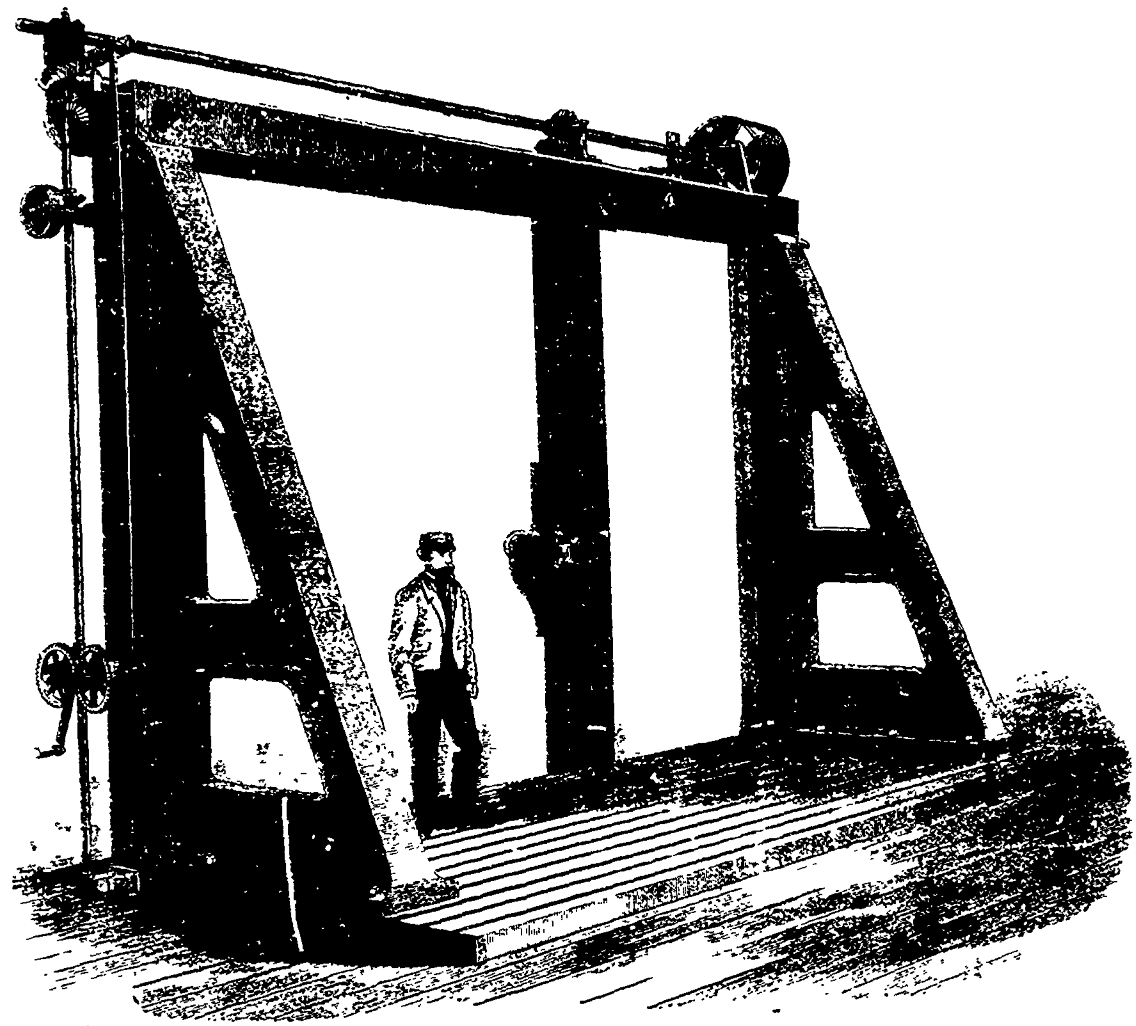
THE Sherbrooke *Gazette* says the construction of the S. E. T. and Kennebec road is being pushed on with vigour, as ten extra miles are to be graded immediately. Mr. Bowen, who is now in London superintending the purchase of rails, advises his partner that he has purchased 700 tons 400 of which are to be shipped on the 10th inst., and the remaining 300 tons soon afterwards, without delay.

THE managers of the Canada Southern Road have projected another international bridge which will cross the western international branch of the Niagara River, to which a short line will be built from Stevensville, then run along Grand Island a distance of about 7 miles, and cross the eastern American branch to the main land, near Tonawanda. The bridge, it is announced, will be finished in August, 1875, and will take the road around Buffalo instead of through it.

THE Nova Scotia Western Counties Railway through Yarmouth county is in an excellent state of progress. The *Herald* reports that the road is nearly all completed to Brazil Lake, a distance of fourteen miles; and between that point and the county line—a distance of about five miles—a large part of the work is also finished. The Company purpose to commence laying the rails about the first of September, and by the end of the month the locomotive and flat cars will commence operations in ballasting the road.

A syndicate is forming for the purpose of purchasing a half interest in the Templeton Iron Mines, owned by Mr. Haycock, who has consented to the terms proposed. It is intended that the Company to be formed by the syndicate and Mr. Haycook shall erect bloomaries to be in operation next January, using charcoal as fuel. It is anticipated that the metal produced will be of a very superior quality. On the Company being in a position to place their own manufactured metal before the public and thus show what they have to operate on, they will extend their capital, and put into operation extensive works.

THE Newcastle *Advocate* says:—Track laying is proceeding rapidly on Section 10 L. C. R. From the deep water terminus to the N. W. Bridge and the station buildings, thence along section 10, some ten miles are already laid, and the work is going ahead at the rate of half a mile every day. The two locomotives landed some time ago are kept busily at work hauling the sleepers, rails, &c., to their destination. Two new locomotives are now being fitted up, having been landed from the brigantine Pierre Polasque, a few days ago, one being ready for work. We understand two more locomotives are expected this fall. It is satisfactory to see such progress being made toward completion, and we hope no unnecessary delay will be allowed to interfere with the work of track laying.



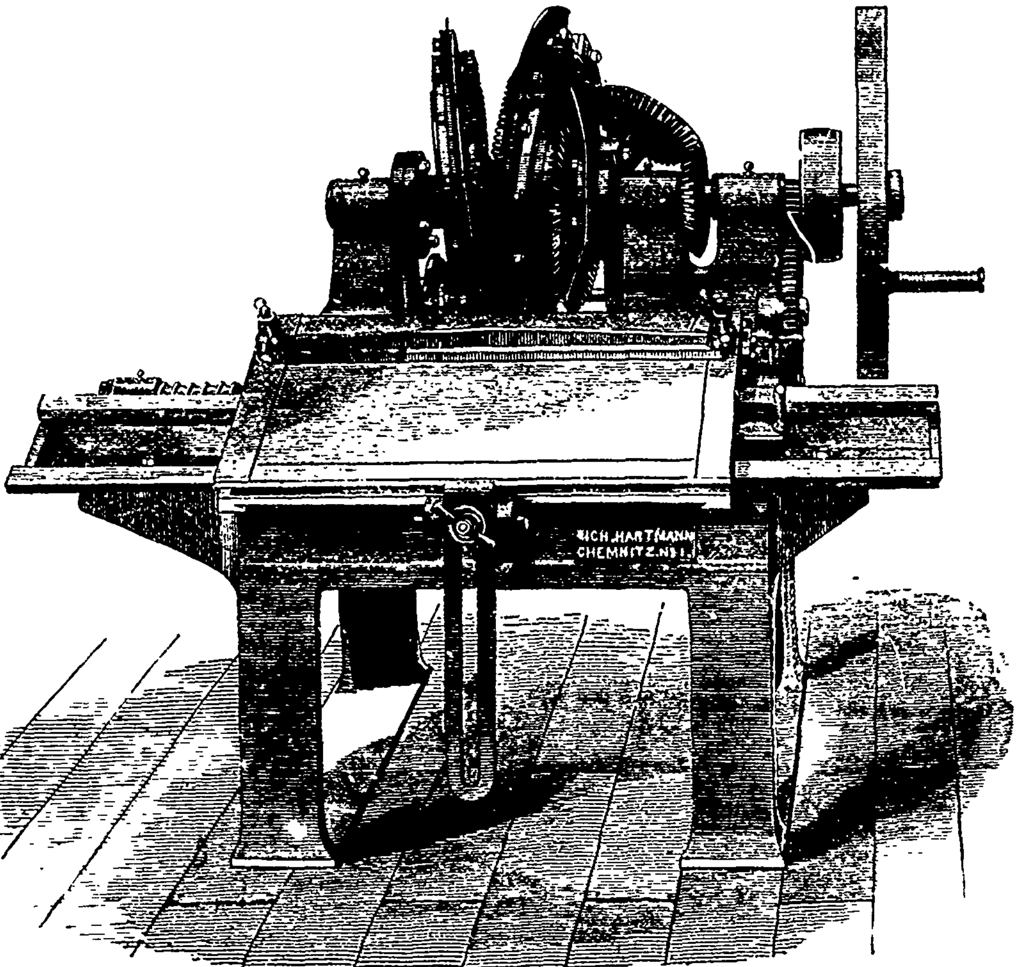
VERTICAL PLANING MACHINE.

Vertical planing machines are now becoming pretty general in engineering workshops of the first class. The Chinese Government have lately established arsenals and dockyards on the European system at several of their principal ports, and among the tools sent out from this country by Messrs. John Bourne and Co to furnish these establishments, there is a type of vertical planing machine which offers several features of advantage. Of this machine we give an illustration.

Upon a planed base plate of cast iron formed with grooves fitted with a T-headed bolts for the attachment of the object to be operated upon, two strong standards are erected which carry planed cross pieces at the top and bottom, along which are drawn by means of screws a great upright bar which carries the cutting tool. The toolholder with the tool, or if desired three tools, is made to travel up and down upon the vertical bar by means of a screw—shown in the engraving—and after each cut the vertical bar is drawn sideways by the top and bottom screws through a suitable distance, whereby an action resembling that of an ordinary planing machine is maintained, except that the cut is vertical. The foundations in many parts of China being precarious, the tool is so constructed as to be independent of walls or buildings. The vertical travel is 12 ft., and the horizontal is 16ft. The cutting tool travels up at twice the speed that it travels down, and as will be seen by a reference to the engraving, the design is one which combines strength with simplicity. The base plate is formed in two parts bolted together laterally for facility of shipment. Only about one-third of its depth is shown above the floor. At the back of the machine there is a pit about 3ft. deep in which the attendant stands when the machine is at work.

DOVETAILING MACHINE.

We illustrate, on page 125 a dovetailing machine manufactured by the Sachsische Maschinen-fabrik, of Chemnitz, an excellent piece of workmanship, and an exact copy of the American machine now largely manufactured by Messrs Robinson and Son, of Rochdale. The principles of this machine are too well known to require a repetition here. It will be sufficient to point out that the saw blades by which the dovetails are cut are mounted on the discs set at an angle to each other, as shown in the engraving. For a portion of their length around the periphery of the disc they are simple blades, and for the remainder the top of the blade is bent at right angles, so that in entering the wood it may cut the bottom of the dovetail. The timber to be cut is clamped upon the table, with its edge projecting far enough to be operated on by the saws, and the table is made to advance by a feeding screw, which is also shown in the sketch. By altering the rate of feed, dovetails of varying pitch may be cut. By reversing the bent blades in the disc, the recesses for the dovetails may be cut. The table is arranged so that it can be set at an angle, and blind dovetails formed when desired.



DOVETAILING MACHINE.

THE POWER OF MODERN "MECHANISM": ITS INFLUENCE ON ART.

The world has been told more than once, and with no little authority, that we are remarkable, if for anything in this age and in this country, for our most wonderful power of "mechanism" No one, who will think about it for a moment attentively and seriously, can possibly doubt the potency of the machine: for a visitor to any one of our famous manufactories, giving but a glance at what is going on in it, must feel assured that mechanism is gradually and certainly taking the place of the human element, which has hitherto been a part, and an essential part, of mundane work. It would be very difficult, indeed, to find in the nature of things a more foundationally suggestive subject of thought, as one more capable of influencing practice and practical life, than this of the ever growing power of mechanism. The subject just now is more than usually interesting from the fact of its taking a somewhat leading part in the discussions of the various scientific bodies which meet for "conferences" at this season of the year We might specially refer to the address delivered to the Mechanical Engineers by their President, wherein the "power of machinery" is made to be all but omnipotent, even as things are, but in the future promises to be absolute master, almost of men's thoughts: and when the whole human race shall combine its powers—powers which, when isolated, accomplish such marvels—its good, and its possible evil effects may surpass even our dreams. A few thoughts, then, on "mechanism," as it progresses and promises to rule all things, even are itself, may have a special interest at the present moment, and may rouse a thinker here and there.

In the first place, to philosophise a little, it must be remembered that the time was when there was, in our present sense of the word, no "mechanism," no "enginery." Force, or power, to do heavy work, was got out of human strength. Huge bodies of men, as represented in the Egyptian drawings and sculptures, did the work of the world; and dug and brought up the materials from the earth, and moved them about afterwards. Levers and ropes were all that were used to move the huge Colossi from the quarry to the temple, for which they were sculptured; and kings even do not seem to have disdained to look on if not to "superintend" the moving of them. All the great and famous temples and public buildings of antiquity everywhere—for let us for the moment confine our attention to the mechanical force utilised in buildings—were put together, we are quite sure, without the aid of the steam-engine, that magic bit of mechanical engineering, which, but to name, is to explain the progress of modern society. In all antiquity there was most surely nothing like it, or in any way approximating to it. Yet, with all this deficiency of mechanism, did the antique times, and the men who lived in them, accomplish work which we nowadays strive our very utmost, in vain too, to rival, or even to imitate. Why is this? Is mechanism, which Mr. Bramwell so vaunted before the mechanical engineers, a thing to be regretted, or is it a thing misused, or is it indeed a something which we have yet to see into the true nature of; and to use, but not to over-use.

Tredgold, one of the founders of the age of mechanism, for this is not too strong a term to use here, said that, "Engineering is the art of directing the great sources of power in nature for the use and convenience of man." Accepting this broad definition, the president went on to prove, by a variety of proofs, drawn from every source around us, that we owe—to express the idea in one single word—"Civilisation" itself to the efforts of the mind and body of the mechanical engineer, and to the mechanism which he has created Indeed, so triumphant is the result of his labours in these latter days, that it is no unreasonable boast to add that we may confine our thoughts on it to a very limited range of time, for in mechanical engineering, unlike the work of the poet. or of the sculptor, or the painter, or the architect, we have not to go back to past ages to find its triumphs In fact, so little is to be gleaned from antiquity, that the president declares that he will not be tempted even by the great name of Archimedes to advert to ancient engineering; but will limit himself to the lives of those now present amongst us. Now, this is really to say a triumphant thing, and to mark the age in which we live with a mark which cannot be missed or mistaken—for what more can be said? Who else can make such a boast as this, and with so much of truth in it. But is it in truth, and in logical fact, the whole truth, and a thing so very much to be boasted of Ought the age, the nineteenth century, to be so very proud of this absolute supremacy of mechanism. The machine doing all things, all but thinking for us, certainly communicating and recording our thinkings. Almost monopolising them. We are inclined to think, looking about us for a brief moment, that there is far more in the nature of things than this; and that even the conversion of a "tea-kettle into a locomotive" may be surpassed, at least as a matter of human interest and feeling.

It is, by way of illustration, not a little curious to note the distinction between the past and the present, in their mode of work, and in the character of the work produced, and in what is perhaps more, the mental impression made by the work after it is, by whatever means, brought into being. Of course, we all allow, without a word, that the more easily and cheaply necessaries, of whatever kind, are brought into existence, and distributed, the better it must be for human nature generally; and did the machine but stop here, no one could say a word. But it so happens, that the machine which does one thing so well, and so cheaply, and in such quantity, may be made, and is made, to do other work, and pretty nearly all work. The all-potent mechanism can, as the engineer boasts, manufacture nails and sweet biscuits, by the ton, and that it can do almost without touch of the human hand. all we have to do is to stand by and look at it at work. It is simply marvellous. But it can also,—and here it is that the artist has good reason, now-a-days, to tremble a little,—not only make bricks, and saw and plane timber, but it moulds them into "gracious forms," and, what is more in every stage of the manufacture and making of the materials which form our garments, from the very coarsest to the very finest, it can, and does do its entire and triumphant work. From the finest lace, says the president of the engineers, to the sole of the stoutest boot! Indeed, it is even so. It is no exaggerated boast. He stops here as a faithful mechanician is almost bound to do, but we may ask again, is this all pure gain? Is there nothing wanting? Is it a complete triumph, and a national success, when it is said, that the "machine" is driving the human being fairly out of the field, and doing all his work for him?

And while this is, as must be confessed, no exaggerated or enthusiastic statement, but a sober fact, that machinary, even now, is doing almost everything, more or less perfectly, which the human hand in less advanced days did sometimes so very well, it is not enough for the future of engineering aspirations, for we know, and no man certainly can deny its possibility, that within the next fifty years "great inventions will be made," and we are sure that any one, looking back to the condition of things in engineering science at the present time, and compairing it with that which he will then know, "will wonder how it was that the men of this day failed to make many a grand discovery which, at that time to him, will be as familiar as the steamboat or the locomotive is, now-a-days, to us!" We think we might even go further than this in mechanical prophesying, for what is there to hinder the production of everything about us, or which we see, or make use of including even "gracious forms," as the president has it, but the putting the machine to it Art,—*fine art*,—for example, to take an extreme case; why, as it is, statues are all but the result of elaborate and ingenious machinery applied to the formless marble block. They may be, and are, multiplied almost indefinitely by aid of machinery. Pictures,—there are many who may not know it,—are copied, if not actually produced, both for export and import, by machine processes, the hand of man doing but little else than touch up and dovetail together discordant parts. A wonderful process, and ingenious enough. Of architecture we need but to name it, for where would the smart "ornamental moulding" of the shop be were it not for the all-potent machine which produces it by the mile? We do indeed, own, as we are reminded, our dwellings, as well as our clothing, to the skilful labours and thoughtfulness of the mechanical engineer. It would be a right curious inquiry to go through, specification in hand, a quite new and smartly-built modern dwelling-house, and note down accurately the details of work—the pure and simple work, by the hand of the workman; and on the opposite page of our notebook, the work done wholly by the power of machinery —by almost living mechanism. And then we migh go a little further with the said inquiry and afterwards quietly compare the final result when all is accomplished—the perfected modern house with a dwelling-house of the same size, built in a past age, and before any one of our modern mechanical appliances had any existence, and then note well, artistically and otherwise, the difference between them. How things change, as time goes on, and as they appear to different minds, and how that which is looked at by one human intelligence, as a dead antiquity, and a something waiting to be improved away, like a City church, is regarded by another as good "precedent" to go by, to wonder at, and even to try to copy, sometimes, by and through this power of mighty machinery.

But is this, and we ask it once more, *all* gain? It is a good thing, and an advance on the old ways of work, to bring in the mighty machine whenever and wherever it can be brought in, and to discard at the same time the hand of man? Surely it cannot be so, for a something *must* be lost by it; viz, that individuality of feeling which can only be impressed on Nature's materials by the intelligent hand of man! Such a structure as the Parthenon could not by any possibility, by any power of ingenious machinery, be produced. A mechanical dead copy of it might be, there is no doubt, quickly, and may be cheaply, produced, but the whole classic spirit of the great original must needs be lost in the mechanical processes. Of Gothic work, it need hardly be said that it is in its very essence opposed to this mechanical mode of production, and to that uniformity and sameness of detail which is the necessary result of it. The Doge's palace, to wit, could not be carved out by a machine, however, potent, neither could a copy by machinery be made of it. And may not the like be said of every real and individualised work of art, however small and apparently insignificant? It is impossible to infuse soul, or life, or poetic power, into material forms by any power of machinery The dead form may be there, but the spirit is absent.

May we not, therefore, conclude that one, and not the least, of the problems of the future of human nature will and must be, not how much the machine may be made to do, and how far it can be made to take the work from the human hand, but, most momentous thought, where must we stop? Where does the legitimate action of the machine really cease, and where must the hand of the workman and artist come in, and the engine cease its whirling? It is not how far the machine can be made to do all things, including even the production of "gracious forms," in the future, but where is the ability, whether natural or acquired, to distinguish between the gracious form, as produced by a machine and the same form when the result, of the *hand*, directed by the mind, of the artist workman. Then, and then only, will it be found out wherein the true and legitimate action of the wondrous modern "mechanism" lies; what it can do and ought to do, and what it cannot really do. A great problem for the future.—*The Builder.*

ECONOMY OF IRON CARS.—An iron car made of boiler tin, with a capacity of ten and a half tons, weighs but 10,000 pounds, while the wooden car of like capacity weighs 17,500 pounds— a difference so great that while 29 loaded iron cars make up a train on the Cumberland and Pennsylvania railroad, 20 loaded wooden cars make up one of equal weight. The iron cars stand the wear and tear of usage better that the wooden, come out of a wreck battered and bent but readily straightened out as well as new, where wooden ones would be shivered to pieces and burnt, and the bolts and bars carried away in a basket. And, moreover, there is about $100 in favor of the iron car over the wooden when their first cost is considered.

SCIENTIFIC NEWS.

The Carboniferous Plants of Canada have been explored by Dr J W Dawson, F R S, who has published a series of reports upon the subject, which have been reprinted from the "Transactions of the Geological Society of Canada." The work extends greatly our knowledge of the Lower Carboniferous Flora. It also contains a list of the species of the Middle and Upper Coal Measures, and discusses the character of Sigillarioid and Lepidodendroid stems.

An invention by Signor Abbiati of a new plough for clearing the tracks of railroads, is attracting attention, and the claim is made for it that it is both expeditious, thorough and cheap. The machine, which operates on the snow or ice, is a heavy revolving saw, or fan, which cuts into the opposition deeply, and sends the fragments flying. The snow is thrown to a great distance on either side or, in case of a very steep bank, it is taken up and hurled backward on platform cars, by which it can be removed.

At a private party, given at his London house during the past month, Sir Charles Wheastone exhibited some curious electrical experiments for the amusement of his friends, which would seem to throw some light on certain so-called "spiritualistic manifestations." In a dark room, by a stamp of his foot, Sir Charles produced a brillant crown of electric light in mid air, while musical instruments seemed to be played by invisible hands, whereas the sounds really came from an adjoining room, in which the player sat, and were made to appear to be produced by the instruments before the spectators by an ingenious contrivance. A contest between Science and the "spirits" in their own chosen feats would be almost as memorable as the celebrated competition between Moses and the magicians.

The Belleville *Ontario* is informed that there are fully thirty-five miles of logs in the Moira, including last year's as well as this year's cutting This one fact is a good index of our lumbering business.

The Fertilization of Gentians by Humble Bees.—The closed gentian (*Gentiana Andrewsii*) has flowers an inch and a quarter or more in length These inflated, bright blue flowers of late autumn, appear to be always in the bud, as they never open. The corolla is twisted up so as to leave no opening at the top. The flowers are all nearly erect, with two stigmas considerably above the five anthers. The writer says he sees but one way in which it can be fertilized, that is by insects, but who the writer is we are not told. "Several of my students, as well as myself, more than two years ago, have often seen humble bees entering these flowers. They pry or untwist the opening with their mouth organs and legs, and then pop into the barrel-shaped cavity, with they just fill."

Gum in Fruit-trees considered as a Pathological Phenomenon.—M. Prillieux says, in "Comptes Rendus," April 27, that the flow of gum is a real disease, which he names *gammose.* The alimentary substances, placed in reserve in the interior tissues, instead of promoting the plant's growth, are diverted to production of gum, and a portion accumulates, awaiting the instant of their transformation about gummy centres, which seem to act as centres of irritation. The case is analogous to what occurs when an insect deposits one of its eggs in the tissues of a plant, leading to production of a gall, which consists of new cells holding a mass of nutritive matter (particularly fecula) destined, not for the wants of the plants itself, but for the development of the small parasite which appears. The production of gum at the expense of the nutritive matter has no other limit than the complete exhaustion of the plant. Scarification of the bark is the best remedy. Mr. Prillieux's explanation is this:—To cure the disease the materials misappropriated to formation of gum must be brought back to their normal destination. Hence a more powerful attraction for them must be introduced than that of the gummy centres. Now the wounds of the bark necessitate the production of new tissues, and under this strong excitation the reverve matters are employed in formation of new cells, and cease to be attracted in the wrong direction.

A Horizontal Pendulum.—In "Poggendorff's Annalen," C. L, p. 134, is described by Herr Zollner a series of experiments with a form of horizontal pendulum of such surprising delicacy that it seems to open a wide and fruitful field for investigation. This instrument consists of a short horizontal rod suspended by a vertical piece of fine watch-spring, and carrying at one end a heavy leaden weight and mirror. To prevent the other end from rising, a second watch-spring is attached, and fastened below. The two points of support lie, therefore nearly in the same vertical, and are equidistant, one above and the other below the pendulum. They are connected with the top and bottom of a vertical rod, which rests on a tripod, with levelling screws. If the two points lie in the same vertical, the weight will remain in any position, but if one of the levelling screws is slightly moved, the pendulum will assume a position of equilibrium around which it will vibrate if disturbed. It will act, in fact, precisely like a common pendulum, except that the effect of gravity has been greatly diminished, so that the time of vibration is increased. Its sensibility is of course readily varied by shifting the levelling screw. In the instrument actually employed, the pendulum weighed about 6 lbs, and when removed from its supports and vibrated vertically like a common pendulum, its time of oscillation was about ·25 of a second The springs were about eight inches long, and the delicacy of the instrument was such that its vibrations were easily observed when the time was increased to thirty seconds, corresponding to a diminution of the force of gravity of 14,000 times.

The most extensive deposits of meerschaum in Asia Minor (we learn from *Polytechnisches Centralblatt*), is a short way S.E. from the town of Eskischehr, the ancient Dorylæa, the population of which, is about 12,000. Armenians and Turks, are mostly engaged in the working and sale of it. It is brought from the galleries of pits 8 to 10m. in depth. In one pit there will be 40 to 50 miners; and these, forming a society, share the profits from the mineral. The size of the stones, which are generally very irregular, varies from that of a nut, to a cubic foot or more. The mineral, fresh from the ground is covered about a finger thick with red oily earth, and is so soft that one can cut it with a knife. Its preparation is slow and troublesome. After removal of the earth it is dried 5 to 6 days in the sun or 8 to 10 in a hot chamber, then it is cleaned again and polished with wax. Then the different kinds, of which there are ten, are sorted and carefully packed with wool in boxes. By cleaning and drying, the stones lose about two-thirds of their weight and volume. The largest quantities are sent to Austria (Vienna) and Germany, and the annual export is about 8,000 to 10,000 boxes, representing a value of 1,200,000 florins. The Turkish Government impose a tax of 12½ per cent. at the place of extraction of the raw material and a further tax of 12½ per cent. on the sale.

DELHI CLOCK TOWER.

The Municipal Commissioners of Delhi have effected many improvements in that city since the mutinies. the streets are now amongst the cleanest and best drained, and repaired, of any native city in the upper provinces. A town-hall, with a ball-room, museum, lecture-room, durbar-hall, measuring 80 ft long and 40 ft. wide, and an extensive Serai for the accommodation of native travellers, may be specially mentioned amongst the works that have been constructed by the municipality. Trees have been planted along the road sides, cast-iron pillars from England have superseded the old wooden posts that formerly supported the street-lamps, large tanks have been constructed; and new gardens have been formed.

The latest improvement is the new clock-tower, which stands in the centre of the Chandnee Chowk, opposite the town-hall. Of this a photograph is given in "Professional Papers of Indian Engineering," and from that we have prepared the accompanying engraving.

This building is erected on an appropriate site at the crossing of four streets, and stands 110 ft. high, exclusive of the gilt vane and final. The lowest story is about 20 ft. square externally. The materials used in its construction are brick, red and yellow sandstone, and white marble. The capitals surmounting the main corner pillars are 4 ft. 2 in. wide at top, and 4 ft. 6 in. deep; they are carved out of solid blocks of white sand stone, and each of them weighs about two tons.

The dials of the clock are sufficiently elevated to be visible from the East Indian Railway Station, and from other prominent points in the city. The clock is constructed to work five bells, placed in the open canopy above it; these give out a different peal for each quarter, the largest bell striking the hours.

The building was completed in eighteen months, at a cost, including clock and bells, of 28,000 rupees, the whole of which amount was provided from municipal funds.

DELHI CLOCK TOWER.