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THE NEW GRAND OPERA HOUSE, TORONTO.

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The new and elegant Opera House now being erected by the Toronto Opera House Company for Mrs. Charlotte Morrison, under the direction of the celebrated Architect of the New York Academy of Music, Thomas R. Jackson, Esq., is situated on Adelaide Street, West of Yonge Street, the most central and desirable location in the city It has a front on Adelaide Street of ninety-one feet, and a depth of two hundred and eight feet, and is perfectly isolated from surrounding buildings by a street on the west and a lane on the east side. The principal entrance to the Opera House is on a level with the street, through a spacious corridor fifteen feet wide, fifty feet long, and fourteen feet high, to the main vestibule, twenty-four feet by sixty-five feet, and eighteen feet high, in which are the Box and Ticket Offices, stairs to Family Circle, etc. Beyond the vestibule is the inner lobby, from which access is had either to the Parquet or Balcony or by wide and easy stairs to the Dress Circle. The Auditorium is arranged with Parquet, containing 324 Orchestra stall chairs; Parquet Balcony, containing chairs; Dress Circle, containing 324 seats; Family Circle 270, and eight Private Boxes, with four chairs in each, making a seating capacity of 1,323, and campstool and standing room for 500 more, every one having a perfect view of the stage. The chairs in the Parquet and Balcony will be the latest improved folding-seat Opera chairs, upholstered with leather. The sofa seats in the Dress Circle will be upholstered with reps. There are also ladies' and gentlemen's cloak and hat rooms, crush-room, dressing rooms, etc. The Proscenium and Arch, of chaste and ornate design, will contain eight private boxes. The orchestra will be depressed below the floor, so as not to obstruct the view. The Stage, 53 by 65 feet, will be fitted up with all the latest improvements and equipped with a full stock of Scenery, Curtains, Properties and Appointments. For the necessary accompaniments of the Opera House and the accommodation of its attachés, there is a two-story building adjoining, in which are a spacious scene-room, property-room, green-room, dressing-rooms, Manager's and Treasurer's offices, etc., all above ground, with windows and entrances opening on a street, and fitted up in the most comfortable manner. The facilities for egress in case of fire have been fully provided by a fire escape, and four wide door-ways opening out of the side street and lane, and of such capacity that a full house with all its attendants can be emptied in two minutes. The entire building will be heated by steam at a low pressure from a safety boiler in a fire-proof cellar, outside of the main building; and ample provision will be made to guard against fire by placing on the stage two fire-plugs with hose ready for instant use, and fire extinguishers distributed through the building. The Auditorium will be brilliantly illuminated by a centre sun-light in the dome, chandeliers under galleries, and brackets on the walls, and lighted by electricity. The construction of the building is of the most substancial character, and the decorations and furnishing will be in the most artistic taste and style; and, taken as a whole it will be one of the finest Opera Houses on this continent.

WIRE-ROPE TOWING ON CANALS.

Towings on canals by the application of a submerged wire-rope and clip-drum has to contend with difficulties which are not, or at least to a much smaller degree, experienced on rivers of considerable depth, where the system, as on the Rhine, is in most successful operation, and has been for several years. The shallow draught, the crooked line of the water-course, the want of current, and the slow speed admissible on canals, affect the working of ordinary wire-rope tugs mainly in two ways—they reduce the steering power of the vessel to a minimum, and increase to an extreme degree the difficulties caused by the irregular tightness of the wire-rope, which in river towing can be sufficiently controlled by the steering power of the tugs. To make these points clearer we have shortly to recapitulate some of the main features of the present method of wire-rope towing.

The general arrangement of existing wire-rope tugs is the following:—The clip-drum, worked by the steam engine and suitable gear on board the vessel, is placed either horizontally on deck, or vertically on the side of the boat. In both cases the wire-rope is led along the same side by suitable guide-pulleys, and after taking half a turn round the periphery of the clip-drum is permitted to sink back again to the bottom of the river. This lateral disposition of the rope has invariably been adopted, although it offers very serious drawbacks for two reasons: It overcomes to a certain extent difficulties caused by slack rope, and it diminishes other difficulties referring to the steering of the vessel when the rope is too tight When nearing a curve the rope, which lay originally in the centre-line of the watercourse, is pulled by the tug towards the inside bank of the bend. A considerable amount of slack rope thus obtained has at such moments to pass rapidly through the machinery, and is deposited behind the tug in the bed of the river. Whilst passing over the tug this slack rope is liable to "kink," or otherwise to entangle itself, and it is only by guiding it perfectly in closed channels of a short length, and letting it sink down again into the water as soon as possible after it leaves the clip-drum, that constant and serious accidents can be avoided. For this reason alone it is highly desirable to get rid of the rope behind the clip-drum at once, which can be done conveniently by the lateral disposition above referred to, whilst it would be impossible if the rope were led over the deck along the centre-line.

But the question becomes of still greater importance with regard to the steering power of the boat. The steering of a wire-rope tug is evidently an entirely different thing from the steering of a paddle or screw steamer, quite independently of the fact that the wire-rope tug, between certain limits, is absolutely fixed to the line indicated by the position of the rope In an ordinary steamer the propelling power acts always in the direction of the keel. In the wire-rope tug it is independent of the direction given to the keel, and acts in the direction of the wire-rope. If a screw steamer is turning at any angle to its original course, it readily and without difficulty proceeds in the new direction given to the centre-line of the vessel A wire-rope tug will always show a tendency to follow the direction of the wire rope by which it is pulled. It will, to a certain extent, move broadside on, instead of straight in the direction of its keel.

The steering arrangements of a wire-rope tug must therefore contend with two distinct elements. They must give to the tug sufficient "turning power"—*i.e.*, the power of turning the vessel readily, so as to place its centre line at any reasonable angle to the direction of the pulling rope; at the same time the tug must also possess a sufficient degree of "staying power" —*i.e.*, the power of maintaining the course indicated by the direction given to the keel, without proceeding broadside on, or, as sailors would say, making lee-way.

Now there are two points which evidently influence the turning power of the tug most materially, viz., the original tightness of the rope, or, more correctly, the tightness of the back rope, and the length of rope to which the tug is rigidly bound—a length which is measured by the distance, in the direction of the keel-line, from the first to the last guide pulley. If this line could be reduced to a point, it is clear that even with an absolutely rigid rope the tug could be turned readily at any angle to it. Practically the turning power of the boat will be in proportion greater, the slacker the back rope and the shorter this line is. This, then, was the second reason for guiding the rope along the side of the vessel. If led over the centre of the deck, the line from the first to the last guide pulley becomes very long, whilst laterally disposed it can be reduced to a minimum, thus materially reducing the resistance against turning and steering the vessel. On the other side there are very serious inconveniences only partially removed by this arrangement and others directly aggravated, by it, which we can only mention here. The lateral disposition of the clip-drum and guide pulleys necessitates very considerable weights to be carried on the side and even overhanging the side of the vessel. The machinery thus projecting is in frequent danger of being knocked to pieces by passing boats, and requires powerful and heavy guards. All this made it practically impossible to build tugs of less than about 3ft. draught —a draught which on really shallow, though navigable rivers and canals, cannot frequently be obtained. Further, the tugs cannot and do not steer equally well towards both sides of the rope, having a tendency to turn less readily to the side on which the rope is attached than to the opposite one. The staying power remains as much as ever impaired as soon as the hind rope becomes tight, whilst when it is slack there remains the danger of kinks forming even at the bottom of the watercourse after it leaves the boat.

On deep rivers with considerable currents these difficulties have been found to be of no practical importance. In bends the current greatly assists the steering power of the tug, throwing the vessel powerfully towards the outside of the curve, and thus counteracting the tendency of the rope to pull it towards the inside. This not only helps to keep the boat in its proper water-course, but assists also the action of replacing the rope in its correct position. With regard to kinks, the considerable depth through which the back rope has to sink down from the last guide pulley to the bottom of the river regulates up to a certain point the delivery of slack rope. The greater speed admissible on deep rivers finally increases the steering and staying power of the tug All this is different on shallow rivers and canals, with their sharp and frequent bends, want of current, and slow admissible speed. Here the difficulties of kinks in the slack rope, the want of steering power, the consequent impossibility of replacing the rope in its original position when displaced by the direct pull of the tug, and therefore the incapability of the tug to round sharp curves readily, after a few working trips, have proved, up to lately, fatal to the introduction of wire-rope towing. What appeared to be required was greatly increased steering power, the tug being more or less independent from the tightness of the wire-rope, and the maintenance of a uniform state of tightness in the rope, which on the one side would entirely avoid kinks in slack rope, whilst on the other it would not unduly interfere with the movement of the vessel in curves.

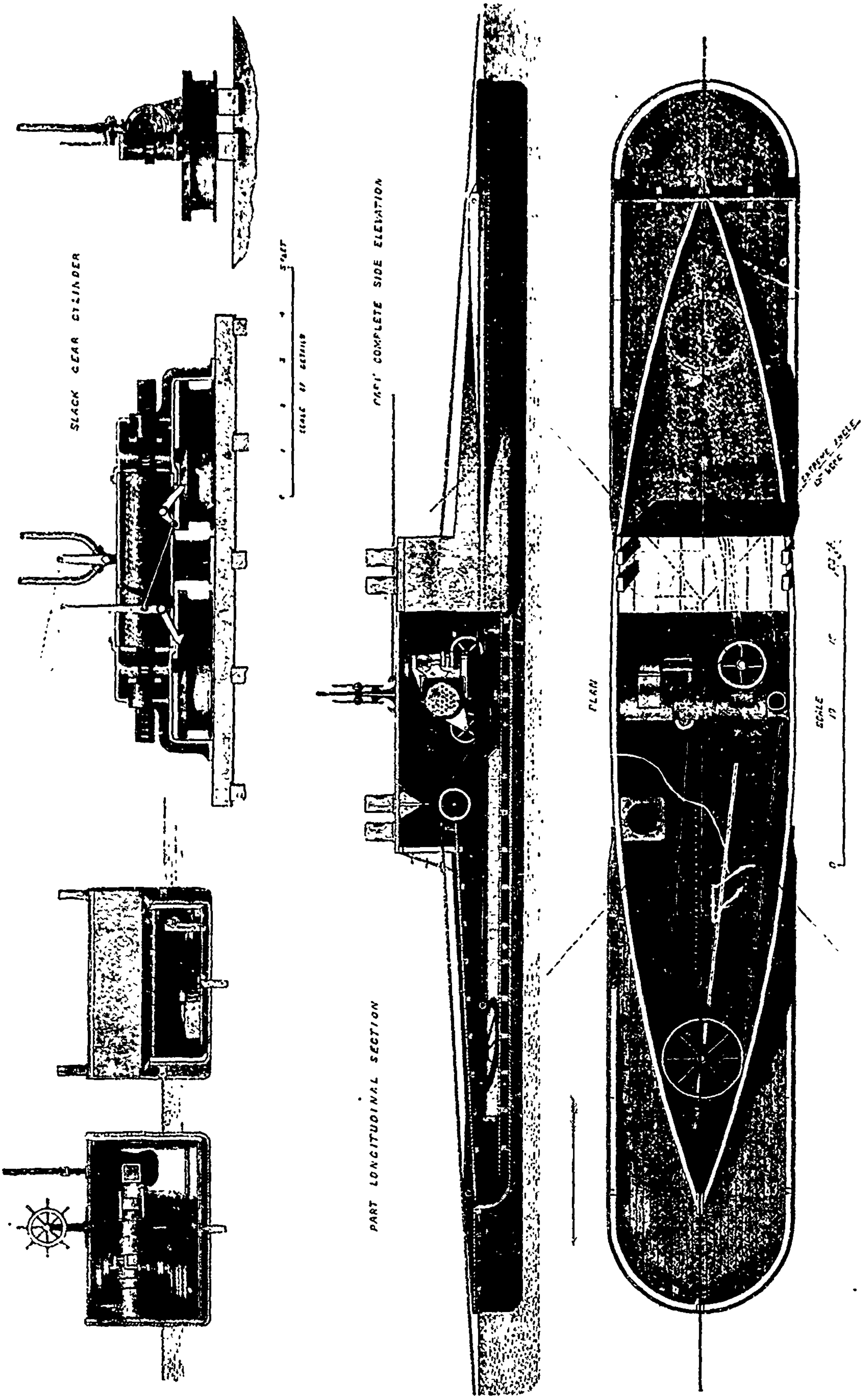
The principle embodied in Messrs. Greig and Eyth's patent offers the most simple solution of this problem. The rope, after passing the clip-drum, instead of sinking back into the water, is led over one or more "moving sheaves" of an apparatus which, altogether, is called the "slack gear." The motion of this moving sheave away or towards the clip-drum along a pair of horizontal rails of sufficient length causes a greater or smaller amount of wire rope to be stretched between clip-drum and sliding pulley, and this rope is constantly kept at a certain uniform tightness by the pressure of the piston of a steam cylinder being brought to bear on the moving sheave. Thus it becomes evident that instead of any slack rope leaving the tug, it is retained on board stretched out between the clip-drum and moving sheaves, the rope, leaving the tug under all circumstances with a moderate and uniform strain on it, avoiding every chance of kinking. On the other side, whenever the wire rope has a tendency to become too tight, the sliding pulleys recede towards the clip-drum, paying out some of the stored up rope, and restoring the original moderate tension in the back rope. It is evident how far this arrangement influences the steering and staying powers of the tug As long as the slack gear has any rope to spare the tug is not held by the back rope, and can move laterally with perfect freedom. If, combined with this, the distance from the first to the last guide pulley is of moderate length, the tug will be with regard to its steering power almost independent of the rope. There being no kinks possible and no loose ropes to contend with, the cable can now without danger be led over the centre of the vessel. The rope itself will be saved not only from kinking, but also from any undue strains which formerly were put on it whilst steering round curves, and which frequently made the towing round sharp bends an impossibility.

We now describe in detail the special canal tug illustrated on page 136 On most canals it is highly desirable that the tug should be able to run back and forward along the rope without turning, and to reverse its course with as little trouble and loss of time as possible. This makes the general arrangement of tugs for canal navigation proper, somewhat more complicated than that of river tugs, the latter being required to run forward only when at work, and to turn round at the end of their journey. Bow and stern of the vessel are therefore of exactly the same shape, each end being provided with a long and powerful rudder worked independently from the deck near the centre of the boat by a separate wheel. The front rudder is generally fixed in its central position, thus forming a prolongation of the keel and increasing the staying power of the vessel to a very considerable degree. The middle portion of the boat is occupied by the engine-room, and therefore provided with a deck of sufficient elevation. Towards both ends the deck is considerably lower, sloping down towards the rudder-posts, where it is only a few inches above the water line. This lower portion of the deck is made absolutely water-tight, and the space below it is specially occupied by portions of the slack gear. Above the rudders, for the sake of protecting them and of preventing the wire rope interfering with their movements, there is a sort of raft actually floating on the water, and thus in no way increasing the draught of the vessel, but at the same time firmly bolted to its sides. These rafts increase the steadiness of the boat, and protect it efficiently in case of collisions. In the centre of the engine-room, placed crossways, is a tubular boiler carrying a double-cylinder engine of about 8 to 10-horse power. The engine is fixed on the side of the fire-box and boiler barrel, so that the crank shaft is in a vertical position, near the smoke-box end. The smoke-box is a accessible through a corresponding opening, protected by a water-tight cover in the side of the boat. The starting and reversing handle of the engine are on deck, in easy reach of the helmsman, whilst the stoker fires the boiler from the side. The crank shaft at its upper end carries a small fly-wheel, at its lower end a pinion, working the clip-drum, which turns horizontally on a shaft underneath the boiler, and is otherwise in such a position that the centre line of the clips touches the centre line of the boat. Below and above the clip-drum there are—loosely turning on the same shaft—two ordinary rope sheaves, which we shall call the top and the bottom centre sheave respectively.

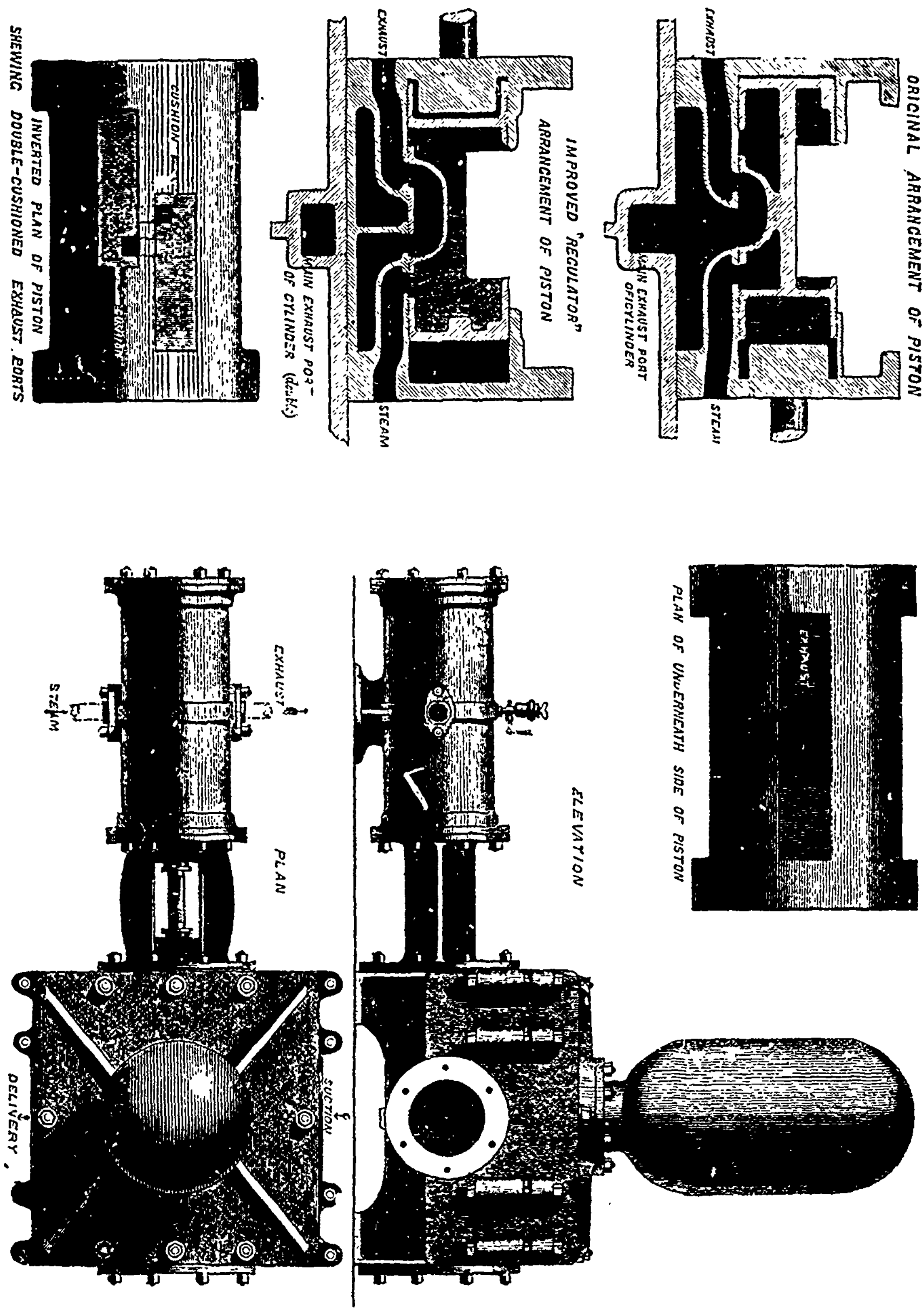
On each side of the boiler is a "moving sheave," *i.e.*, a rope-pulley, turning horizontally on a vertical stud, which is bolted to a strong flat iron carried on rollers, and thus capable of moving along a rail from the clip-drum towards the rudder-post, through very near the whole length of the vessel Attached to each end of the wagon on which the sheave rests there is a chain, which by suitable pulleys is led along the rail, and then towards the chain drums, to which the ends are fixed.

Chain-drums and slack-gear cylinders are shown on an enlarged scale. The slack gear cylinder is simply a tube, the ends being closed by two pistons. Between the pistons is an opening provided with a three-way cock, by which the interior of the cylinder can be placed in direct communication with the boiler or with the atmosphere When the slack gear is in action the boiler pressure is directly and constantly acting on the two pistons. There are toothed piston-rods to these pistons, acting like a rack and working a pinion. The pinion is keyed to a short shaft which also carries a chain drum. Each chain drum acts on one of the moving sheaves above described, the two chains coming from opposite ends of the wagon, being wound on the drum from opposite sides, so that the turning of the drum winds one chain on whilst unwinding the other, and thereby moves the sheaves wagon back or forward. The steam pressure in the slack gear cylinder constantly pressing the two pistons outwards, produces evidently a tendency to turn the drums, or, by means of the chains, to push the sheaves from the clip-drum away towards the boat ends. The opposite motion would be accomplished by pressing the sheaves towards the clip-drum with a power sufficiently great to overcome the steam pressure in the cylinder and to push the pistons back into it. A catch and a ratchet—the latter being cast to the top flange of each chain drum—are used for stopping the motion of the drums, whenever it is desirable to stop the action of the slack gear and work with a fixed or rigid system of pulleys. The two catches are connected by a link, and the handle by which they are thrown in or out of gear, as well as the handle by which steam is admitted to the slack gear, are both in reach of the helmsman. We have finally to mention a pair of vertical guide pulleys, leading the rope into the clip-drum, and two swinging pulleys the latter being the first and the last pulley over which the rope runs in its passage through the boat. They are suspended by a universal joint, which permits them to assume any angle indicated by the direction of the rope, and their position near the centre of the boat, and very little above the water-line, offers great advantages as to the handling and steering of the boat in curves. The rope is prevented from surging over the slanting decks by the strain which is constantly put on it, in front by the actual work performed, behind by the action of the slack gear.

Following now the rope in its passages over the tug, we see it passing over the first swinging pulley, down towards and slightly round the vertical guide pulley, half round the clip drum, towards and half round the moving sheave A—back again, passing underneath the boiler towards and half round the moving sheave B; once more back and half round the top centre sheave, and from thence underneath the second guide pulley over the second swinging pulley back into the water.



WIRE-ROPE TUG FOR CANAL NAVIGATION.



MESSRS. HAYWARD TYLER AND CO.'S IMPROVED "UNIVERSAL" PUMP.

Now the action of the whole apparatus will be clear. When the engine begins to pull, or when the tug approaches a bend, it will bring in slack rope; but as soon as the slackness is felt behind the clip-drum the piston of the slack gear cylinder will be able and will begin to turn the chain drums, pushing thereby the moving sheaves further out and maintaining practically the original tightness of the back rope, but causing a greater quantity of it to be carried between the moving sheaves. If on the other side the back rope becomes tighter it will at once cause the moving sheaves to slide towards the clip-drum, pushing the pistons in the slack gear cylinder back against the steam pressure. This will cause some additional rope to be paid out, by which again the normal tightness of the rope is maintained. Whether both, or only one, and which of the two sheaves acts, is immaterial. Two are required, partly to get as much a length as possible, for storing up slack rope, partly for securing the possibility of working the tug backwards as well as forward without turning as will be seen presently. If the engine would be reversed the pulling strain exerted by the clip-drum would be brought to bear on the moving sheaves, and would make them slide back towards the clip-drum, whilst an immense amount of slack would appear behind it which would be sure to produce a serious accident. The slack gear therefore has always to be stopped before reversing the engine, and this is done by the catch falling into the teeth of the chain drum as above described. To avoid all possibility of accidents the reversing lever itself is connected with the catches, so that the motion of the chain drums, and thereby of the moving sheaves, is certain to be stopped when reversing the engine. The tug then acts like any other tug without a reversing gear, which of course is perfectly admissible for short occasional movements backwards.

When, however, the tug has to start on its regular return journey, the position of the rope is altered in the following way: The half-coil round the clip drum is taken out and slipped into the empty bottom centre sheave just below it, the half coil in the top centre sheave is taken out and slipped into the groove of the clip-drum. Nothing more is wanted. In following now the rope from the other end of the boat in its passage through the pulleys, it will be seen that it again first passes clip-drum, and that the slack gear sheaves follow afterwards. The tug, therefore, returns with the slack gear in full and correct operation. With a number of tugs of this description the traffic of a canal should be worked along one rope in the following manner:—Each tug runs backwards and forwards between certain stations, or travels on so long till it meets another tug. Both tugs then turn about after exchanging the trains of canal boats they were bringing along, and again proceed till they meet their neighbours. This is undoubtedly the most convenient and economical method of working the wire-rope system on canals. On rivers towing is generally only of importance for boats going up stream. Here wire-rope tugs will best run the whole journey, returning generally empty as they do on the Rhine, and used to do on the Meuse, and leaving the rope altogether for the back journey. For such boats only one moving sheave is required, and the whole arrangement becomes considerably simpler. At the same time, the incidental and various advantages of the slack gear, offering the possibility of constructing boats of very shallow draught, giving to the boat almost perfect liberty to steer, and avoiding kinks and similar difficulties with the rope, are of the greatest importance for shallow river navigation, and will doubtless extend the application of wire-rope towing under circumstances where, up to now, it frequently has been considered unsuitable.

Rose-colored Stain for Wood.—Monnier recommends steeping the wood for several hours in a bath of 1,200 grains iodide of potassium to the quart of water, and then immersing it in a bath of 375 grains corrosive sublimate, when it will assume a beautiful rose-red color by chemical precipitation. It should subsequently be covered with a glossy varnish. The baths will not need renewal for a long time.

Experiments with a single-track elevated railway have been made in Philadelphia, and pronounced successful by a number of railroad officials present.

HAYWARD TYLER AND CO'S IMPROVED UNIVERSAL PUMP.

At the exhibition held recently at Bedford, Eng., the new patent valve gear fitted to this pump attracted considerable attention. An illustration of this modification will be found in another page. It will be remarked that the improvement relates to a method of working the piston at each end of the stroke, so that if from any cause the pump should fail to take its water no accident can happen. The cushioning arrangement consists of a modification of the exhaust passage in the steam piston, it being made double, as shown in woodcut, one portion of it being almost closed just before the termination of the stroke. Thus the piston shuts in a small amount of steam sufficient to check the momentum of the piston before the reversal of the slide. When the slide has moved the piston is cushioned, as is usual with live steam. The amount of cushion by exhaust steam is so regulated that when the pump is doing ordinary work there is no back pressure, but as soon as the work is taken off with steam full on, the great amount of steam suddenly relieved of work cannot be discharged, and the engine chokes itself.

I saw one engine exhibited tested myself, with the following results:—Steam in boiler, 40 lb; pressure on pump, 60 lb., pump running at about 64 double strokes; 8½in. steam cylinder; 6in. piston. The suction hose being then suddenly lifted out of the water, the pump went off at a slightly increased speed, the beat being of a different nature, being a series of long choking sighs. When, however, the suction pipe was again put into the water the engine recovered herself and the beat was as clean a cut-off as could be desired, not a trace of throwing could be heard. The woodcut represents the original and the improved steam piston. Also a 12in. cylinder and 12in. pump. The importance of this invention is not in its application for general pumping purposes in factories, &c., where the work is regular and constant, but for situations where the work may suddenly vary owing to the source of supply being pumped dry, or some accident happening to the rising main. Mining engineers will well understand what we mean, but there are many situations besides coal mines where the tank, pump, or caisson, as the case may be, is apt to be suddenly exhausted, and an ordinary steam pump or a steam engine without an efficient governor will run away. In the ordinary steam engine this is prevented by the governor, but in this invention the object is gained without increasing the number of working parts of the steam pump.—*Engineering.*

TORPEDO EXPERIMENTS.

THE FIRST "OBERON" EXPERIMENT

At Stokes Bay, on Thursday, Aug. 6th, took place, under the direction of the special committee of which Sir W. Jervois is president, the first of a series of experiments whose importance as bearing on the question of the defence of our harbours and roadsteads can hardly be over-estimated. The Oberon, as most of our readers are aware, has been long in preparation for a course of attack by submarine mines, to be carried on until it terminates in her destruction, the object being to test the effect of such mines under various circumstances on the bottoms of our men-of-war as at present constructed, and so to learn exactly how to place our charges to the best advantage, as well as to ascertain what constitutes a bar which ships cannot cross without being destroyed.

To carry this out the Oberon has been provided with sides and bottom corresponding exactly to those of H.M.S. Hercules, and also with a condenser taken from her Majesty's ship Octavia. The system on which she is attacked, we need hardly say, is to begin with comparatively distant charges, and gradually to approach nearer to the vessel, carefully investigating the effect in each case, so as to obtain the maximum amount of information that can be afforded by so costly an experiment. It has been decided by the Torpedo and Obstruction Committee to adopt the charge of 500lb. of compressed gun-cotton, as what we may call the normal one for the conditions most commonly occurring. It happens that the depth best suited to give full effect to this charge is about 8 fathoms of water, and this is about the depth most commonly found in the passages to be defended. Five hundred pounds of gun-cotton, it is to be borne in mind, correspond to two thousand pounds of powder.

On the 5th of August this charge was with considerable difficulty, owing to the rough weather, placed at about 100ft. from the vessel's side on the bottom at a depth of 8 fathoms of water, its place being marked by a buoy—*vide* Fig. 2. The Oberon's circumstances were as follows:—The inlet and outlet valves of her condensers were left open. The Kingston valve of her feed-pipe was closed. The water-line was 2in. higher than the top of her condenser. The original weight of her hull before fitting her with special bottom was 590 tons—as now fitted it is 920 tons. Her cables and condensers may be taken as about 30 tons. Her starboard side has forty-four crusher gauges—*a a a*, Fig. 2—fitted to it. Each crusher piston is ⅛ square inch in area, and behind it is a lead pellet hardened with antimony ½in. long and 1-12in. in sectional area. Over each side of the vessel were suspended by 2in. ropes 12ft. long six 18-pounder shot, each fitted with a crusher gauge—*b b*, in Fig 2—having a piston of smaller weight than those of the Oberon crusher gauges, but in other respects similar.

The 500 lb. charge of gun-cotton in the mine was saturated with fresh water in a service water-tight iron case. Ignition was effected by means of two Abel detonating fuzes, and placed with two dry 9 oz. discs of cotton in a waterproof bag. We believe we are correct in saying that the circuit used in previous experiments was employed in this case also; that is, a circuit was provided for testing, being constantly open, passing from the test battery through the fuzes in the mine, and out through a copper earth-plate into the water. This circuit has a point of great resistance at the fuze, and cannot act strongly enough on the electro-magnet to being the powerful firing battery into action. This latter is brought into play, however, in a service mine, either by a circuit-closer being tilted, which opens a circuit momentarily where there is very little resistance, and which, therefore, has strength enough to magnetise the electro-magnet, or by the act of an operator on shore. It was the latter arrangement only that was applied on this occasion.

The firing took place from Fort Monkton, being directed by Captain Abney, R.E., who generally performed this duty, so as to be able to arrange to take an instantaneous photograph of the column of water thrown up. On this occasion, we believe, two were got at successive instants with great success.

Fig. 1 shows a view of the column of water thrown up by the explosion of the mine taken from a boat on the same side of the vessel, that is the starboard side, which was towards Fort Monkton. Except the fact that the charge is a formidable one, the test was not a very severe one. The general form of the column of water is itself an indication of the way in which a submarine charge acts. Water is easily displaced, but it is incompressible; hence any lateral explosion is rigidly resisted, and a column of water driven upwards with very great violence, as shown in Fig. 1. Thus it is easy to see that a vessel's safety is more affected by the horizontal than the vertical distance from the charge. It is also obvious that the water above a charge requires to be a certain depth in order to develope the full explosive power—this depth being, as we had said, about 8 fathoms for 50 lb. of cotton.

Fig. 2 shows the horizontal distance of the charge and the position of the vessel, as well as a string of half shells containing Noble's crusher gauges *c c c*, at 23ft. distance horizontally on the side of the charge remote from the Oberon, these being used in continuation of a course of investigation of pressures commenced by the Torpedo Committee in 1873. The general form of the iron plate bottom of the Oberon is also seen, as well as the condenser—*d* in Fig. 2—with which we have to do presently. At the moment of explosion the vessel would have to sustain a violent lateral pressure commencing in the direction of the arrow in Fig. 2, but as the gas became formed in large volume, in a nearly horizontal direction there would be comparatively little tendency to move her, but she would have to play the part of and transmit the shock falling on the water she displaced. Failing in any way to do this, she would suffer crushing or injury in some form. It has long been suggested that a weak spot in a vessel so placed was found in her valves and condenser, for any form of pipe containing water would be a means by which a blow would be rigidly transmitted to the extremity of such pipe. On this account the condenser and valves were provided, and formed a prominent feature in the arrangements. The result of the experiment showed how well grounded was such a supposition. The vessel scarcely seemed to vibrate under the shock of explosion, though the enormous column of water rose so close to her, the solid wood forming the cases and other solid matter being thrown into the air to a distance of about 150 feet, judging from the time at which they fell —6. 6 secs. after explosion. On boarding and examining the vessel she was found to be leaking slightly from some injury inflicted on the condenser. In no other respect had she suffered seriously. The bull's-eye on the deck had been dislodged upwards and the effects of a shock were manifest throughout; but little injury appeared to be done generally, and the live stock, consisting of sheep, fowls and rabbits, were flourishing.

Further examination being impossible in the present condition of the ship, she was ordered to be towed into dock where she will no doubt have to be detained for a considerable time in order to enable a thorough investigation to be made. The result, then, of this first experiment, on the face of it, must be held to be more satisfactory to the engineer officers than the naval officers concerned, for the explosion at the maximum distance proposed has found a weak place in the vessel; and although such slight leaking to the casual observer did not appear to be a very severe penalty to pay for approaching so near to a large mine, yet a moment's thought will show that the injury might be serious in the highest degree in a vessel really under steam. It is, in fact, impossible to say whether such a shock or a very similar one falling on a vessel, might not disable her engine.

We must not, however, go too fast; some plan may be devised of saving the condensers from the blow. Condensers themselves are an old subject of grief. We are not aware of the peculiar features of the one in question, but trouble has been caused by the desire to save money on condensers, and castings have often been made in one that should have been separate and very carefully performed. We are now speaking of merchant vessels; if this be a fault with them, how much more with the Royal Navy? It would, indeed, be sad if our condensers, like the heel of Achilles, rendered our supposed invulnerability in other respects of no avail.—*The Engineer.*

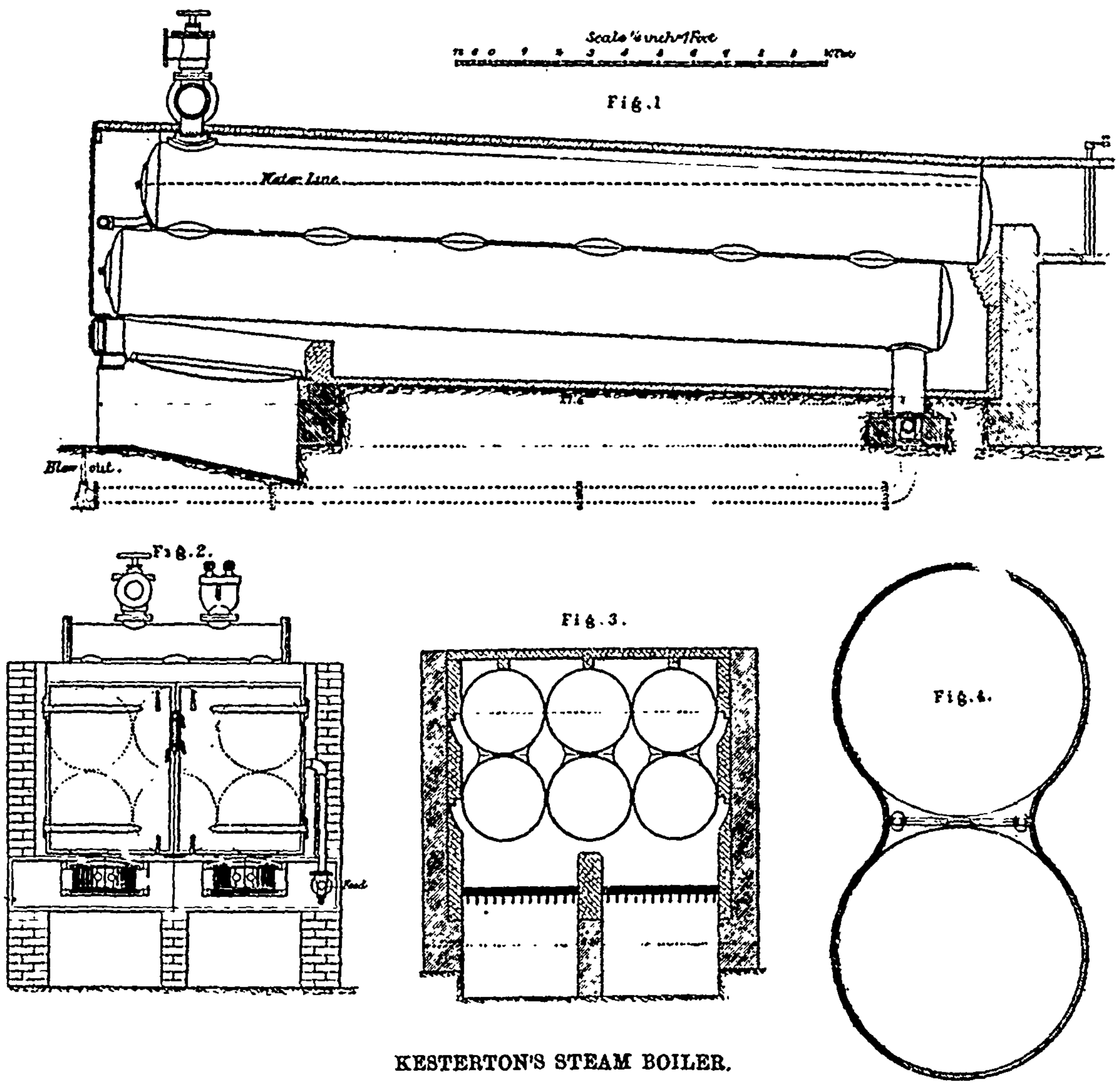
GLASS WOOL FOR FILTERING.

Our readers have no doubt heard of this new product of the glass industry Till now it has been possible only to draw out glass in threads of appreciable thickness; but now, by altering the composition of the glass mass, it has been found possible to spin it as fine as silk, and afterwards beat it together like felt. From this substance all sorts of ladies' knicknacks are made, such as lace, feathers, and even hats, and chemists also employ it for useful purposes. To put into paper filters, for instance, especially when caustic and corrosive liquids are under manipulation, it is of great value, for it prevents these substances coming into contact with the paper and destroying them.

To the photographer, in this connection, this glass wool would also be valuable; for how frequently is a glass bath ruined from the fact that the filter paper which he has employed is not altogether chemically pure! Again, no inconsiderable quantity of silver solution is lost from being absorbed by filter paper after repeated operations. A little glass wool pressed together, and stuffed into the upper part of a funnel, will suffice for the filtration of many silver baths; and when at last the wool becomes dirty from the accumulation of reduced silver and other impurities, then a little strong nitric acid is poured through it, and this at once dissolves and removes all solid matter. Washing out with distilled water will then render the filter as useful as ever.

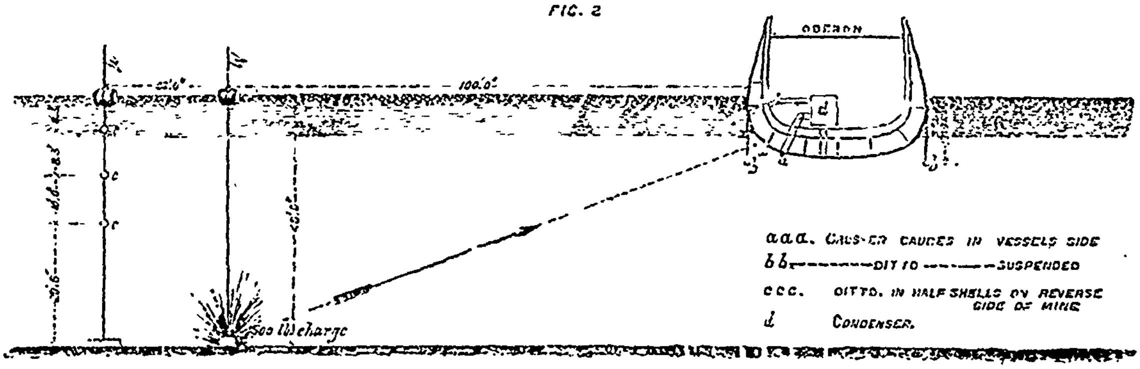
For the filtrations of other liquids the glass wool is equally suitable, such as sulphuric acid, caustic potash, chromic acid; indeed, in these cases it is without a rival. Its cost is rather heavy, being as much as six shillings an ounce: but it must be remembered that it is as light as feathers, and consequently a quarter of an ounce will last a very long time.

A Substitute for Ground Glass.—To half an ounce of white, hard varnish add two ounces of methylated spirit. Shake well up, and allow it to settle for an hour or two. Clean *very carefully* the plate of glass, and coat with the varnish. When dry, a semi-opaque film of exquisite fineness will be left on the glass, which answers well.



KESTERTON'S STEAM BOILER.

FIG. 2



TORPEDO EXPERIMENTS.—(See page 70.)

PRINCIPLES OF SHOP MANIPULATION FOR ENGINEERING APPRENTICES. *

By John Richards, M.E.

(Continued from page 50, vol 2.)

MOTIVE MACHINERY.

In this class belong steam engines, caloric or air engines, water wheels or water engines, and wind wheels or pneumatic engines. These four types comprehend the motive power, as it is termed, of the present day.

In considering these engines for motive power in a way to best comprehend their nature, the first view to be taken is that they are all directed to the same end, and all deal with the same kind of power, and, if possible, to avoid the impression of their being different kinds of power, as the terms usually employed seem to imply. For instance, we speak of steam power, water power, or wind power; but power is the same from whatever source derived, and these distinctions merely indicate the different natural sources from which power is derived.

Primarily, power is the product of heat, and wherever force and motion exist, they can be traced to heat as the generating element, whether the medium through which the power is obtained be by the expansion of water or gases, the gravity of water, or the force of wind, heat will always be found as the prime source.

As steam engines constitute a great share of machinery that is commonly met with, and as a class of machinery naturally engrosses attention in proportion to its importance, the study of mechanics generally begins with steam machinery. The subject of steam power, aside from its mechanical consideration, is one that may afford many useful lessons, by tracing its history and its influence, not only upon mechanical industry, but upon human interests generally. The subject is often hinted at, and its importance conceded, but no one has from statistical and other sources, so far as I know, ventured to estimate in a methodical way the changes that can be traced directly and indirectly to steam power.

The steam engine is the most important, and in England and America the best known among motive agents. The importance of steam contrasted with other sources of motive power is not due to the cheapness of cost at which power is in this way obtained, but for the reasons that the amount of power produced can be controlled and adapted to the requirements of each case, while it can be produced without reference to local conditions, and in any place; the machinery can with its fuel and water, the elements of its power, even be moved from place to place, as in the case of machinery for transporting purposes, the locomotive not only supplying power for its own transit, but carrying besides vast loads of merchandise. For manufacturing processes the main advantage of steam power rests in the fact that the power can be taken to the material, and beside other advantages gained thereby, is the difference in weight and cost between transporting the manufactured product and the raw material. In the case of iron manufacture, for example, it would cost many times as much to transport the ore and the fuel used in smelting, as it does to transport the manufactured iron; steam power saves this difference, and without steam power our present iron trade would be impossible. In many kinds of manufactures the exhausted steam, or steam drawn from the boilers, is applied to reducing, cleansing, and softening materials, so that even when other than steam power is employed, steam boilers and furnaces are necessary.

Economical reasons for the extended and general use of steam as a power, besides those already named, are to be found in the fact that no other available element or substance can be expanded to a given degree, at so small a cost as water, and in the fact that its temperature will not rise to a point that will destroy the machinery for generating and using steam, and further, in the very important property that steam possesses of protecting by its lubricating properties the frictional surfaces of pistons and valves, which it is impossible to keep thoroughly oiled because of their inaccessibility and the high temperature.

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

The steam engine, in the sense in which the term is here employed, means not only steam using machinery, but steam-generating machinery or plant; it includes the engine proper, with the boiler, mechanism for feeding water to the boiler, also for governing speed, with indicators and other details.

The apprentice must guard against the too common impression that the engine cylinder, piston, valves, and so on, are the main parts of steam machinery, and that the boiler and furnace are only auxiliaries. The boiler is the soul of the whole, the part where the power is generated, the engine being merely an agent for transmitting power from the boiler to the work that is to be performed. This conclusion would, of course, be reached by any one in reasoning about the matter, and following it to a conclusion, but the fact should, as a primary conception, be fixed in the mind as a principle of steam power.

When we look at a steam engine there are certain impressions conveyed to the mind, and by these impressions we are governed in a train of reflection that follows. We may conceive of the cylinder and its details as a complete machine with independent functions, or we can conceive of it as a mechanical device for transmitting force from the boiler, and these conceptions may be independent of, or even contrary to, specific knowledge that we at the same time possess; hence the importance of starting with a correct idea of the boiler being, as we may say, the base of steam machinery.

As reading books of fiction sometimes expands the mind, and enables it to grasp great practical truths, so may a study of theoretical principles enable us to comprehend the simplest forms of mechanism. Even Humboldt and Agassiz resorted, it is said, to imaginative speculations as a means of expanding the mind.

In no other branch of machinery has so much research, and experiment been made during eighty years past as in steam machinery, and, strange to say, the greater part of this research has been directed to the details of engines, and yet there has been no improvement made during the time that has effected any considerable saving of heat or expense. The steam engines of fifty years ago, considered as steam-using machines, utilised nearly the same proportion of the energy or power developed by the boiler as the most improved engines of modern construction—a fact that in itself indicates that the engine is not the vital part of steam machinery There is not the least doubt that if the efforts to improve the steam engine had been mainly directed to economising heat and increasing the evaporative power of boilers, much more would have been accomplished. This remark, however, does not apply to the present day, when the principles of steam power are well understood, and when heat is recognised as the proper element to deal with in attempts to economise in the cost of power.

There are, of course, various degrees of economy in steam-using as well as in steam-generating machinery, but so long as the best steam machinery only utilises one-tenth or one-twelfth of the heat that is represented in the fuel burned, it is desirable to point out where improvements in such machinery should begin.

With these remarks as to steam power in general, I will proceed to consider, in a very brief way, the principles upon which steam engines operate. A cubic inch of water, by taking up a given amount of heat, is expanded to more than 500 cubic inches of steam at a pressure of 45 lb. to the square inch. This extraordinary expansion, if performed in a close vessel, would exert a power 500 times as great as would be required to force the same quantity of water into the vessel against this expansive pressure; in other words, the volume of the water when put into the vessel would be but one five-hundredth part of its volume when it is allowed to escape, and this expansion, when confined in a steam boiler, exerts the force that we term steam power. This expansive force or power is through the means of the engine communicated and applied to different kinds of work where force and movement are required. The water, like the engine and the boiler, is merely an agent through which the energy or power of heat is applied.

This brings us again to the original proposition that power is heat, and heat is power, the two being convertible, and according to modern science, indestructible; so that the power, when used, must give off its mechanical equivalent of heat, or heat when applied, develop its equivalent in power. If the whole amount of heat represented in the fuel used for a steam engine could be utilised, the effect would be, as before stated, from ten to fifteen times as great as it is in actual practice, from which it must be inferred that a steam engine after all is a very imperfect machine for utilising heat. This loss arises from the fact that the heat cannot be directly nor fully communicated to the water.

To store up and retain the water after it is expanded into steam, a strong vessel, which we term a boiler, is required, and all the heat that is imparted to the water has to pass through the plates of this boiler, which stand like a wall between the heat and its work.

To summarise, we have the following propositions relating to steam machinery.

1. The steam engine is an agent for utilising the power of heat and applying it to useful purposes.

2. The power of the heat is obtained by expanding water in a confining vessel, and employing the force exerted by the pressure thus obtained.

3. The power obtained is as the difference of volume between the feed water when forced into the boiler, and the volume of the steam that is drawn from the boiler, or as the amount of heat taken up by the water.

4. The heat that may be utilised is what will pass through the plates of the boiler, and is rarely more than two-thirds of that which the fuel produces.

5. The boiler is the main part, where the power is generated, and the engine is but an agent for transmitting this power to the work to be performed.

6. An engine even when well constructed, utilises but a small proportion of the power due to the heat transmitted from the boiler, while the best constructed boiler, as said, can utilise a little over two-thirds of the heat represented in the fuel.

7. The losses of power in a steam engine arise from the heat carried off by the exhaust steam, from loss of heat by radiation, and the friction of the moving parts.

8. By condensing the steam before it leaves the engine, so that it is returned to the air as water, and of the same volume as when it entered the boiler, a gain is effected varying according to the perfection of the arrangements employed.

These propositions relating to steam engines, if remembered and studied by apprentices in connexion with steam machinery will lead to a reasoning about the principles, as well as of the mechanism, and render the nature of steam power more easily understood. Engines operating by means of hot air, called caloric engines, and engines operated by gas, or explosive substances, all operate substantially upon the same general principles as the steam engine; the greatest distinction being between those engines wherein generation of heat is by the combustion of fuel and those wherein heat and expansion are produced by chemical action.

With the exception of caloric or air engines, however, there is but a limited use of any but steam engines for motive power, and it may be safely assumed that the learner who has mastered the general principles of the steam engine will find no great difficulty in analysing and understanding any similar machinery acting from expansion due to heat, whether air, gas, or explosive agents be employed. This method of treating the subject of motive engines will no doubt be presenting it in a new way, but it is merely beginning at an unusual place, nothing more. And the learner who commences with first principles, instead of pistons, valves, connexions, and bearings, will find in the end that he has not only adopted the true plan, but the shortest one to understanding steam and other expansive engines.

(To be continued.)

Chloral hydrate is made by passing chlorine gas into alcohol of about 96 deg. for about twelve to fourteen days, until it attains a gravity of 41 deg. B. The product is then purified by mixture with an equal volume of sulphuric acid and distilling, a large amount of hydrochloric acid being thus driven off. The chloral is then itself distilled off, the product is again rectified by distillation, water is added to the distillate, and it is set aside to crystallise. As products. ethylene and ethylidine chlorides are produced, which are purified by fractional distillation, and also used as anæsthetics.

KESTERTON'S BOILER.

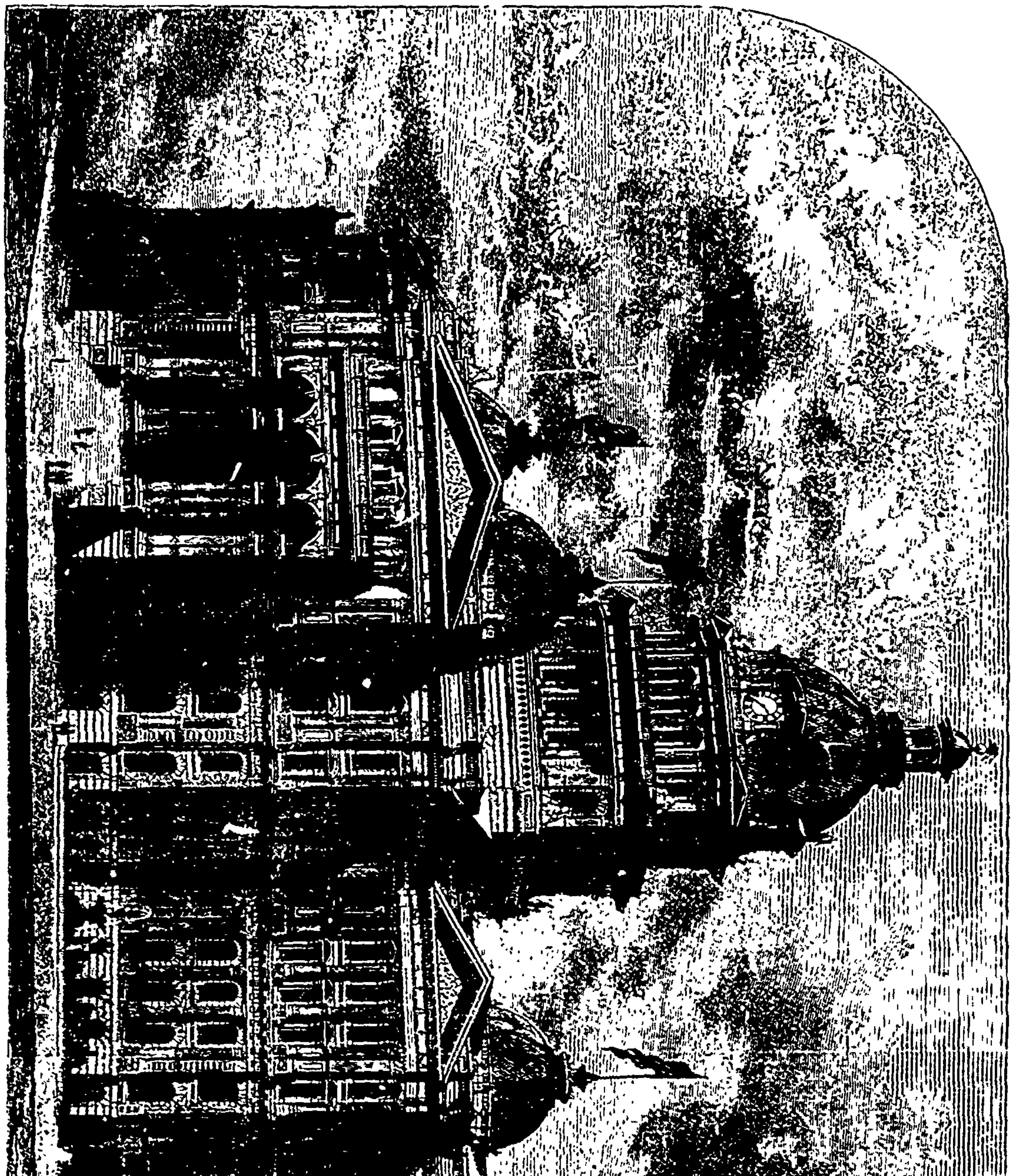
We illustrate, on page 72, a novel and very simple form of steam boiler, designed and patented by Mr. H. Kesterton, and now being manufactured by Messrs. Thomas Piggott and Co., of Birmingham. As will be seen from our engravings, this boiler consists only of a number of plain cylindrical barrels, 2 ft. 4 in. in diameter inside and 24 ft. long, these barrels being usually made with welded longitudinal seams, although of course they may be made with a rivetted seam if preferred. These barrels are arranged, as shown, in groups of two each, the two tubes or barrels forming each group being placed one above the other, and being connected at six points in the manner shown by the enlarged section Fig. 4. From this view and Fig. 1 it will be seen that each tube has six holes cut in it, and that it is bulged or set outwards at each hole in such a manner as to form a flat flanged surface capable of being united to the corresponding surface of the adjoining tube by an internal rivetted joint. The flanging, or rather bulging, of the tubes at the points of junction is effected by hydraulic machinery, which enables the work to be performed readily and accurately; while the diameter of the tubes is, as will be seen, sufficiently great to give perfect access for performing the rivetting. The connection between the tubes is altogether very substantial, and as simple as could be desired.

The groups or pairs of tubes connected as we have described, are placed side by side to form the boiler, our engravings showing a boiler composed of three such units. The firegrates are placed under the boiler at the front end, and the products of combustion pass along under the boiler, then returning to the front end between the upper and lower tubes, and finally traversing the upper surface of the upper tubes on their way to the chimney.

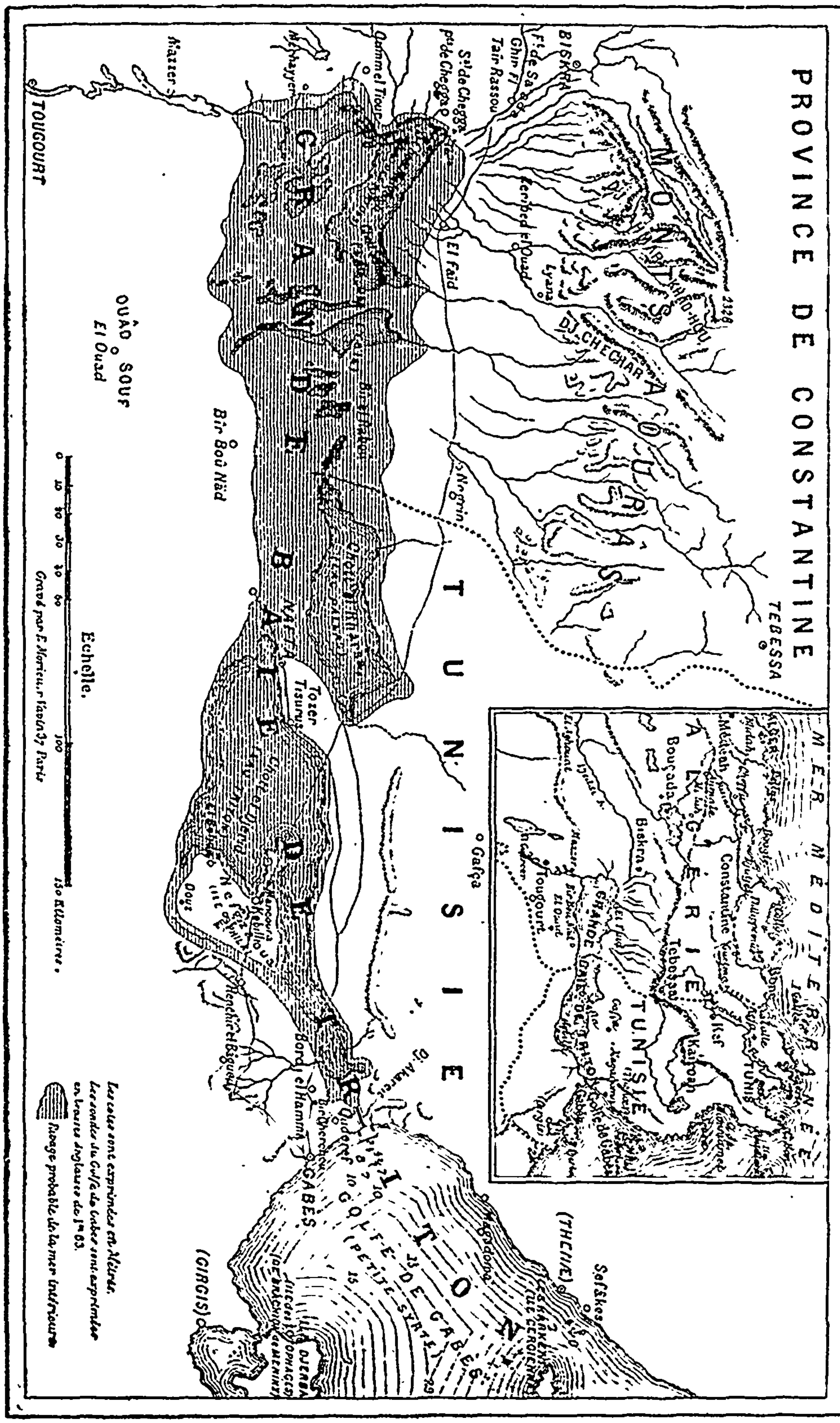
As will be seen from Fig. 1, the units are set with an inclination downwards toward the back end, and at that end of each of the lower tubes a mud collector is provided, these mud collectors—which also serve as supports for the boiler—being connected by pipes furnished with a blow-off cock. The feed water is delivered into the boiler at the front end of the upper tubes as shown in Fig. 1. The steam is taken off at the highest point, at the front end of the upper tubes, the three groups being there connected to a cast-iron cross pipe which forms the steam dome, and which carries the safety valve and stop valve as shown in Figs. 1 and 2. As shown by these views, also, the setting is closed at the front end by cast-iron doors, on opening which access is at once obtained to the manholes provided at the front end of the tubes.

As we have already said, Mr. Kesterton's boiler is of very simple construction, while the nature of its parts gives great facilities for transport and subsequent erection. Its setting is also very simple, and altogether we regard the arrangement as a very promising one, the performance of which in practice we shall watch with some interest.

The Uses of the Sunflower.—Some careful experiments have been made at Bangalore, says the *Gardener's Chronicle*, during the past two years, in testing the value of the Sunflower, *Helianthus annuus*, as a cultivated plant. Colonel Boddam who has made these experiments, reports that the seed used has been imported Giant Russian seeds, which are double the size of ordinary country seed. Six pounds of these were sown in drills one yard apart, on August 29, 1873, and the plants were harvested from December 20, 1873, to January 1, 1874. They were 7 to 8ft. in height, each bearing one large head; the largest of six taken from a plot of average growth was 35 in. in circumference, weighed 3lb. and contained 1875 seeds. The others ranged from 29 to 25in. in circumference, averaging about 1 lb. in weight, and varying from 1000 to 1400 seeds. The leaves were sun-dried and pounded, and realised about 500 lb. of dry fodder, which, when used mixed with meal, bran, &c., is very good food for milch cows; it will, moreover, keep good for a long time. The seed, after being husked, was converted into coarse meal, which was pressed for the oil—50 seers (about 100lb. avoir.) of the meal yielding three gallons of oil and 35lb. of oil-cake. Colonel Boddam, says that the empty seed heads and stalks make fine fuel, which subsequently yields 10 cwt. of ashes very rich in potash, excellent manure for coffee and tobacco.



PROPOSED COURT HOUSE AND CITY HALL, CHICAGO.



THE NEW AFRICAN SEA.

MECHANICS' MAGAZINE.

MONTREAL, JUNE, 1874.

ILLUSTRATIONS:

CONTENTS:

THE NEW AFRICAN SEA.

The active mind of the French people seems to require continually something grand or immense, on which to expend its superabundant force. This holds good, seemingly, in mechanical matters as well as in certain other respects. No sooner is the Suez canal an accomplished fact than other almost equally great projects are mooted and engaged in with avidity. The last of these projects is that of the formation of a vast inland sea in the northern part of Africa. To the south of Tunis and Algeria there are in the desert great lagoons or chotts, as they are called, the beds of which are one hundred feet and more below the surface of the Mediterranean. A glance at the French map we reproduce on page 77 will show the extent and position of these basins. It will be seen that they extend eastwards to within 12 miles of the coast of Tunis, at the Gulf of Gabes. At this point it is proposed to admit the waters of the Mediterranean, which would flow in and form an inland sea of a depth of about 150 feet in its deepest parts. There seems to be little question of the practicability of this scheme, in the carrying out of which the experience in the Suez canal operations will be of great service. The cost of the whole work, including canal, dykes piers, harbours and the expropriation of certain oases is estimated at about four million dollars. The money for the preliminary surveys has already been granted and operations will begin at once. The advantages to be derived from the creation of the sea will mainly consist, at first, of more uninterrupted intercourse with the fruitful parts of the interior, and the introduction of civilization and commerce into the heart of Africa. In the second place it is expected that the phenomenon which followed the opening of the Suez canal—the formation of clouds and a rainfall hitherto unknown—will also be experienced in this case, and that thus the extent of cultivable land in Tunis and Algeria will be continually extended and the climate improved in a corresponding degree. Such are some of the results anticipated. On the other hand there are not wanting those who predict failure and all kinds of curious results. It has been predicted, among other mischiefs, that such an inland sea, would put an end to the hot winds from Africa by which the Swiss glaciers are melted, and hence that Switzerland would return to the Arctic condition of the great ice age. Then, too, it has been said, with more show of reason, that this sea will expose a vast surface of evaporation to the sun's rays; and that as the loss of water can only be replaced by the sea through the canal, the end of the whole operation will be the formation of a thick crust of salt at the bottom, whereby all navigation will be stopped in a short time, and millions will have been spent to create a gigantic salt pit, and nothing more. It is, however extremely likely that the project will be at once carried into operation; and if as may fairly be expected, rain and vegetation follow, streams of fresh water will flow in from a fruitful country around and thus remove the most cogent argument against the success of the scheme.

SPONTANEOUS COMBUSTION.

Every summer during the hottest periods there occur a number of conflagrations the origin of which is involved in mystery, but which is generally connected in some way or other in our minds with the atmospheric heat. A writer in a recent number of an English scientific paper ascribes the occurrence of many of these fires to spontaneous combustion. That this is really the cause is rendered more probable by the fact that these conflagrations occur for the most part in mills and in such places as contain quantities of matter containing a certain amount of grease, as in the case of steamboats carrying bales of wool, of dirty rags, &c.

In the Report of the British Association meeting of 1873 is a paper, which was read by Mr. Galletly, detailing a series of experiments which he had carried out for the purpose of ascertaining the heating action of various oils when present in cotton waste. According to his results, spontaneous combustion took place in cotton waste, soaked with olive oil, when submitted to a temperature of about 120 deg. to 130 deg. Fahr., in the course of a six hours' experiment. The Government inspector, Major Majendie, remarked recently on these experiments that "these facts illustrate the grave and urgent character of the risk which exists when oiled cotton waste is deposited, even in very small quantities, and for a very short time, in moderately elevated temperatures—such temperatures as exist in the majority of factories, in the neighbourhood of a steam pipe, or under exposure to the sun's rays."

The subject, however, does not seem to be very thoroughly understood as yet, cases existing of the continual transport of hundreds of tons of oil soaked cotton during the past 30 years without the slightest symptom of heating, except in the case of their becoming damped by rain, in which case the cotton has frequently to be unpacked and exposed to the air to cool down. Constant ventilation by frequent turning seems to be the only reliable remedy where substances of this nature are concerned.

A singular cause of fire may be traced to the glass of which the windows of warehouses is made. In the old-fashioned kind the "punty" mark is found. This forms a double convex lens, which, concentrating the rays of the sun, constitutes a burning glass. That fire should occur from such causes can be no matter of surprise. Water bottles exposed to the sun's rays have sometimes similarly caused fires in private houses by concentrating the heat rays on dressing-table covers, &c.

THE ENGLISH CHANNEL TUNNEL.

This great undertaking which has, for so many years, been looked upon alternately as chimerical and as about to be accomplished, again shows symptoms of vitality. The moving spirit, on the present occasion, is M. Lavalley, an engineer intimately connected with the success of the Suez Canal. Supporting him are such men as Messrs. Michel Chevalier, Leon Say, Rothschild and others. The interested parties are ready to undertake the work on their own responsibility; they will be content with a concession of thirty years instead of the customary ninety-nine and are prepared to expend a large sum on preliminary investigations. The work will be a tunnel proper the cost of which is estimated at less than £10,000,000 by the French engineers and at almost double that by the English. It is suggested that the work should be done partly by France and partly by England, and that to induce the two countries to press on this undertaking energetically there should be a bonus for the one which works the fastest. The 4,000,000 francs forming the preliminary capital are nearly all, it is said, subscribed. The French Railway du Nord will advance 1,000,000 francs, and Baron Rothschild 500,000 francs. It is hoped that Baron Lionel de Rothschild will subscribe the same sum. Mr. Ferdinand Duval offers 50,000 francs for the City of Paris; MM. Leon Say, Chevalier, and Lavalley are each engaged to supply 25,000 francs.

The immense and constantly increasing trade and passenger traffic between England and the continent has long demanded improved facilities. These are now about to be afforded to some extent by the new channel steamers of Bessemer and Dicey, but even these will hardly satisfy the present age and there seems but little doubt but that the channel will be actually bound with rails of iron in the present decade.

One of the most ingenious plans ever suggested for carrying a railway from England to France was that brought forward some ten years ago by Mr. Chalmers, a citizen of Montreal. He proposed to construct a huge circular tube of iron somewhat analogous to the tubes of the Victoria Bridge. The tube was to be built in sections and these floated out to their destinations as completed, sunk and joined together under water. The whole tube was to be carefully braced throughout and would afford a double track. The main difficulty, in a practical point of view, was the ventilation. To effect this it was proposed to build three towers in the channel, one from the centre of the tube and two others at equal distances from the centre to either shore. The towers were to act as ventilating shafts, constant fires being kept up at the base of each. Mr. Chalmers went to England and France and personally and energetically advocated his scheme; but the amount of capital demanded, some £40,000,000 deterred capitalists from risking the enterprise. The probable expense and risk, however, grow less, now, year by year as experience is gained in other great engineering works. The profits too, in case of success would be so very great that the temptation to embark in this enterprize is by no means small. A careful estimate made, at the time of the Chalmers scheme, on the then existing rate of traffic showed that 12 per cent might safely be expected on the enormous capital demanded. The traffic has since greatly increased and if the work can be done now for £20,000,000 there seems to be no reason why it should not be set about at once.

The French arrangements for observing the rapidly approaching transit are stated to be of a very perfect nature. The instruments furnished are at least equal, in power, accuracy, and ease of manipulation to those of the best equipped contestants in this scientific struggle and the French press expresses its unbounded confidence in the ability of their practical astronomers. The pavilion and instruments represented on page 80 are those intended for Yokohama. Similar apparatus will be sent to the other five stations occupied by the French observers.

THE TIME LOCK.

This is a new double chronometer bank lock attachment, comprising two independent clock movements These clock movements control a bolt in such a manner that it is released at any particular time, ranging from one to forty-eight hours, previous to which the safe cannot be opened. The two movements are employed in order that one should prove effective in case the other should stop, it being very improbable that two movements of this character should both stop during the interval from the locking of the safe to the time desired for opening it, and to which the movements have been set upon leaving the safe. When the time has arrived for opening the safe the bolt is released. The safe may then be opened at any time until the movements are again set. The attachment is not designed to be used by itself, but in connection with other locks. It is placed on the inside of any vault or safe door already in use, without making a hole through the same, or disturbing the other locks or bolt work, a vacant space of 10 inches wide by 6 inches, and 1½ inches in height being all that is required for its attachments.

It is evident that this attachment is proof against picklocks, as, even if the lock should be picked, punched, or blown off by explosive compounds, the attachment, which is distinct and independent of the lock, still remains and keeps the bolts of the door secure until the hour for opening arrives. There have, of late, been several cases recorded where the cashier or custodian of funds has been seized by masked burglars, and compelled, through fear of his life, to relinquish the key, or reveal the combination upon which the safe has been previously locked. By this means some extensive robberies have been perpetrated. With such an attachment as this in use, such robberies would be absolutely impossible, as the knowledge of the combination would not avail to open the safe, the cashier himself being unable to open it until the proper time. Robberies have been perpetrated also by surreptitiously obtaining combinations, several cases of this kind having occurred of late. It would seem, therefore, that this lock is an absolute guarantee of the impossibility of opening a safe either by inside or outside parties, except at the proper time and under the proper surroundings.

The manufacturer, Messrs. Sargent and Greenleaf, of Rochester, New York State, claim that it affords a perfect and thoroughly reliable protection against burglary of any description, when it is attached to an otherwise burglar-proof safe or vault. A catch controls the combination. Two wheels actuate it at the proper time, being numbered from zero up to 48 in two-hour divisions. Indexes at the top of these wheels guide the setting, which consists simply in placing them so that the number of hours which shall elapse from the time of closing the safe to its opening shall be indicated by the figures under the pointers. In one of the arms of each of these wheels is fixed a pin, which, at the proper time, engages a tappet arm which projects horizontally from the pivoted catch.

The practical character and the efficiency of this device, says an American contemporary, seem so apparent as to excite wonder that it has not sooner been applied and generally adopted.

FRENCH INSTRUMENTS FOR OBSERVING THE TRANSIT OF VENUS.

STATUE OF JACQUES-CARTIER.

This handsome statue has been offered by the sculptor, M. Rochet, of Paris, to the Corporation of Montreal, on the condition that the city should pay the cost of casting and the artist's travelling expenses—in all about $5,000. The offer is now under consideration by the Road Committee. The statue is to be of bronze, and will measure twelve feet in height. Seven years ago M Rochet, who is, we understand, a descendant of Jacques Cartier, made the same offer to the corporation, but it was declined.

PROPOSED CITY HALL, CHICAGO.

Another destructive fire has brought Chicago again under notice, but if they burn down there they also build up. The amount of building that has been done there within the last two years is almost past belief, and new buildings are still everywhere in progress. In 1873 designs for a new court-house and city hall were submitted in competition, and we were led to illustrate one of them as the most approved design which in reality was not so. The design actually selected for execution we illustrate in our present number. It was designed by Mr. Thomas Tilley, architect.

Mr Tilley designates the form presented by his plan as that of a "Compound Greek Cross" The whole square, bounded by Randolph-street on the north, Washington-street on the south, La Salle-street on the west, and Clark street on the east, will be occupied, the wings being at right angles from each arm of the figure. In the elevation two orders of architecture are presented from basement to second story, the Roman-Doric, and above the Composite The columns in each case are two stories in height, with fitting cornices.

Ornamentation in the form of statues in bas-relief is placed upon the corners. The entrances are four in number, situated at each corner. Massive steps lead to each entrance, terminating in a portico sustained by sixteen columns of the composite order. A hall-way leads directly to the great rotunda which is a feature in the plan. The crown of the dome will be 275 ft from the ground, and an unbroken view can be had from the rotunda. In the dome will be an illuminated clock, and crowning the dome will be the watch-tower and fire-bell, in a position to be useful in the whole city. Upon each wing will be placed a smaller dome of iron, to relieve the sameness which would otherwise be noticeable. The public hall will be in the third story and 64 ft. by 150 ft. in size, surmounted with a wide gallery. The shape and size of the building preclude the possibility of a courtyard, and light is given to the various offices, halls, corridors, and rooms by the diagonal form of the building The vaults are ranged around the rotunda, and are easily accessible. The details of the building are carefully elaborated. The architect recommends the use of limestone, sandstone, iron, and such other materials as are fireproof.

A NEW MOTOR.

According to the laws of the mechanical theory of heat, any difference of heat may be employed for production of mechanical work. If a cold body, then, be situated in air that is hotter, the passage of heat to it should be capable of giving mechanical work. The solution of this problem (says the *English Mechanic*) M. Enrico Bernardi, an Italian physicist, has recently sought to realize in the following way.

Two similar glass balls are connected together by a thin glass tube, the ends of the tube passing into the balls being bent at a right angle. One ball contains a small tube, by which ether can be poured into the apparatus, the ether is brought to boiling, and, when all air has been expelled, this small tube is closed by fusing. The quantity of ether inclosed in the system should be such as to fill about three fourths of one ball At the middle of the connecting tube is fixed a piece through which passes a metallic axis, round which the system can turn. When the ether is equally divided between the two balls, the apparatus is in unstable equilibrium. The bearings for the axis are supported on the cover of a rectangular case, and in this cover is a slit through which the turning system passes. The case is filled with water, into which the balls dip alternately on their being turned round the axis. Each ball is covered with a very fine veil. It is easy to see that this apparatus will take a see-saw motion.

Owing to the unstable equilibrium of the system, one of the balls, A, sinks, and all the ether flows into it, while the rest of the space is filled with the vapor. The ball, A, is then in water, the ball, B, in air. Hereupon the moisture on the surface of B begins to evaporate, and the ball is so cooled that the vapor within condenses, from the ball, A, more ether is evaporated, and it is condensed in B, till at length B contains more ether than A, and sinks, while A rises; and the same process is repeated. This see-saw motion lasts as long as there is water in the case to moisten the surface of the under ball

It would be rather troublesome to utilize this thermo-motor see-saw mechanically; and Mr. Bernardi has, therefore, preferred to alter the apparatus in the following way: The two balls of the above described system are connected by a tube, the ends of which are bent round (at right angles) to opposite sides Three such systems are formed into a sort of wheel, the middle points of the six balls and the tube being in one plane. This wheel is supported at its axis, on the cover of a rectangular case, in such a way that, in its rotation, it is always half within the case and half in the air The balls are covered as before, and so much water is poured into the case that, in turning the wheel, one ball is always immersed. By giving the wheel a turn, it can be set in continuous rotation, and, with a suitable arrangement of pulleys, it can be made to raise a weight, or do other work.

Such a thermo-motor wheel has, for two months, been working a clock in Mr. Bernardi's laboratory. The balls have a diameter of 0 78 inch, the distance of the middle points of two opposite balls is 3.1 inches, and the quantity of ether in each system fills three fourths of a ball. The clock maintained in motion by this wheel consumes, in 24 hours, 0 2 of a foot pound. The water level is, by a special arrangement, kept constant. Mr. Bernardi has had his see-saw working for three months without its becoming necessary to renew the water or clean the balls. He has calculated the quantity of heat which is removed by this apparatus from the surroundings. There was an average of 60 see-saw motions in 24 hours This was found to be equal to 0.12 of a foot pound, or about half the work consumed in the same time by the clock.

DRILL-GRINDING MACHINE.

We illustrate on pages 84 & 85, from *Engineering*, a very handy little machine designed and constructed by Messrs. William Sellers and Co, of Philadelphia, and which deserves to be widely known and used. The machine in question is one for grinding drills, and to obtain the best results from it, should be placed in the charge of a man whose duty it should be to grind the drills for all the drilling machines in the establishment, the men in charge of these machines returning the drills to the grinder when worn, and receiving sharpened ones in exchange. The machine is so simple that but a very brief description of it will be necessary.

It consists, as will be seen, of a bed or frame carrying a spindle provided with fast and loose pulleys and driven at a speed of about 500 revolutions per minute, there also being on this spindle a larger pulley from which a gut driving band passes to a groved pulley on a smaller spindle, carrying an emery wheel, as shown in Figs. 1 and 2. This last-mentioned spindle is capable of being moved longitudinally by means of the small handle shown and when thus shifted the emery wheel passes over the edge of the drill to be ground. The spindle on which the emery wheel is mounted is, as will be seen, carried by an arm which is hinged on the main spindle, and which can be raised or lowered by means of a screw, so as to feed the emery wheel up to its work as wear of the wheel takes place.

As will be seen from Figs. 1 and 3, drill to be ground is held at its shank end by a chuck similar to that in which it would be held in the drilling machine, while its cutting end is secured between jaws which are brought together by a right and left-handed screw, and which support it close to the edges operated on by the emery wheel. It will be seen from Fig. 3 that the drill is held in such a position as to insure the cutting edges or lips being cut to a uniform and proper angle. In our engravings a twist drill is shown as being ground, but the machine can grind fly drills equally well. Altogether the tool is very neatly designed, and is, as we have said, a very useful one, and deserves to be widely used.

PHOSPHOR-BRONZE AXLE BEARINGS.

When two bodies are rubbed against each other (under equal pressure, and at equal velocity), the harder they are, the greater is the amount of heat generated, or on the other hand, the greater the difference of hardness between the two bodies rubbed against each other, the less is the heat produced. In the latter case the harder body is more heated than the softer, if of equal size If, for instance, glass is rubbed against cork, the heating is as 7 to 1 (the copper being heated seven times hotter than the cork); if copper is rubbed against cork, as 4 to 1.

The ideal of a bearing which would wear little would be one made of the same material as the axle revolving in it, if there had not to be taken into consideration the wearing of the axle itself and the heating A bearing made of the softest material, in which an axle of the hardest material revolves, would be the ideal of a bearing which does not heat, and does not cut the axle, if the wear of the bearing, and deformation by pressure, etc., had not to be taken into consideration.

In practice the best medium must be found which

1. Does not cut the axle.
2. Wears (in itself) as little as possible, and consequently requires a minimum of lubrication.
3. Does not heat, even in case lubrication should be neglected.
4. Is capable of resisting any possible shock without changing its form, or breaking.

Some railway companies desire to use few bearings, at the expense of many axles and much lubricant—(the consumption of lubricant is always in proportion to the wear of the axle on the bearing—and therefore use bearings containing from 17 to 20 per cent of tin and 83 to 80 per cent of copper, which alloy, undoubtedly, is too hard, and must attack the axle, as has been shown on many railways. Other railway companies use alloys of lead with more or less antimony, which certainly do not attack the axles, but require much lubricant, and wear out very fast. A great number of railway companies in Germany take refuge in the so-called white metal, which, if of proper composition, appears cheap, but in the long run certainly is the most expensive. The alloys of copper, antimony, and tin, or so-called white metal, are bad makeshifts, as well as the so-called lead composition bearings of lead and antimony; for it is impossible to give these alloys a hardness approaching that of the revolving axle without rendering them brittle If an alloy is used sufficiently hard to avoid great wear, these bearings will heat much and are very brittle.

On most of the English, Belgian, German, French, and particularly on American railroads, white metal, and especially lead composition, bearings are little used, and this with good reason; for what would become, for instance, of a white metal bearing on an American railroad, where the bearings are subjected not only to heavy loads, but where they have to travel thousands of miles on rails belonging to other companies, and therefore are not much looked after.

Gun metal bearings, alloys of tin and copper, are not often homogeneous, with exception of the alloy of 17 to 18 per cent of copper, which is the most trustworthy alloy of tin and copper. In alloys containing a lower percentage of tin, the latter segregates in the form of tin spots, when the alloy cools slowly All other compositions in use for bearings, such as 12 to 17 per cent of tin and 88 to 83 per cent of copper, do not make homogeneous bearings, unless they are cast in chill molds, which in practice is impossible. This heterogeneity of gun metal bearings is dangerous, as it produces gripping, and thereby a rapid wear This specific quality of gun metal bearings (to grip) is theoretically easily explained: In cooling, the softer metal (composed of from 7 to 10 per cent of tin and 93 to 90 per cent of copper), being the less fusible, sets first, forming the skeleton of the bearing, later, the very hard and brittle alloy, containing 17 to 18 per cent of tin and 83 to 82 per cent of copper, sets and fills the pores of the softer skeleton. The particles of the harder alloy are easily torn away by the axle if the bearing is not sufficiently lubricated, and these tear the skeleton composed of the softer alloy; this I have frequently observed at rolling mills where the bearings were not sufficiently lubricated, and where particles in the form of small flakes peel off.

A good bearing which answers all purposes must not be homogeneous, but must consist of a strong and tough skeleton, the hardness of which nearly equals that of the axle, in order to resist shocks without deformation, and the pores of this skeleton must be filled with the soft metal or alloy.

The nearer the hardness of the skeleton approaches the hardness of the axle, the better the bearing will resist the pressure or shocks, and the softer the metal filling the pores, the better the bearing is in every respect. Such bearings are now made by melting two or more alloys of different hardness and fusibility together, in such proportions that necessarily a separation into two alloys of definite composition takes place in cooling.

Phosphor-bronze bearings consist of a uniform skeleton of very tough phosphor-bronze, the hardness of which may be easily regulated to equal the hardness of the axle, while the pores are filled with a soft alloy of lead and tin.

Such a phosphor-bronze bearing may therefore be considered as having its wearing surface composed of a great number of small bearings of very soft metal encased in the tough and strong metal which equals the hardness of the axle, on the planed bearing surface this molecular disposition cannot be detected by the naked eye, but, if examined with a magnifying glass, the truth of the above will at once be seen. Another practical proof can be given by exposing such bearings to a dull red heat, when the soft alloy will sweat out, and the hard, spongy, skeleton-like mass remains.

In this consist the great advantages of phosphor-bronze bearings, which is proved wherever tested, for while the axle partly runs on a very soft metal and thus obviates heating, even if not sufficiently lubricated, the harder part of the bearing, its skeleton, does not allow of wear taking place, and as the hardness is arranged to equal the hardness of the axle, wear is reduced to its very minimum.

ON MORTAR.*

By Mr. Graham Smith.

In buildings and structures mortar is employed as the agent for causing the stones, bricks, and other materials used in construction to adhere together, also to fill any crevices and irregularities in bedding them. Its use for these purposes is of the remotest antiquity, we read of slime being used in building the Tower of Babel, and asphalte in the construction of the walls of Babylon, and it is found from an analysis of mortar taken from the pyramids of Cheops that the Egyptians employed lime and sand almost in exactly the same proportions that we now do, and even the careful directions given by Vitruvius in the fifteenth century were carried out until the more modern researches of Vicat.

The remarks in this paper will be confined to the treatment of mortar formed by the admixture of lime with sand and other ingredients, and as it is the author's opinion that a few facts obtained from actual practice are of much more value than any number of individual opinions which he might offer, he will, by the kind permission of Mr. George Fosbery Lyster — member of the Institution, and Engineer-in-Chief to the Mersey Docks and Harbour Board—endeavour to base this paper on data obtained whilst studying the method carried out by that gentleman at Liverpool.

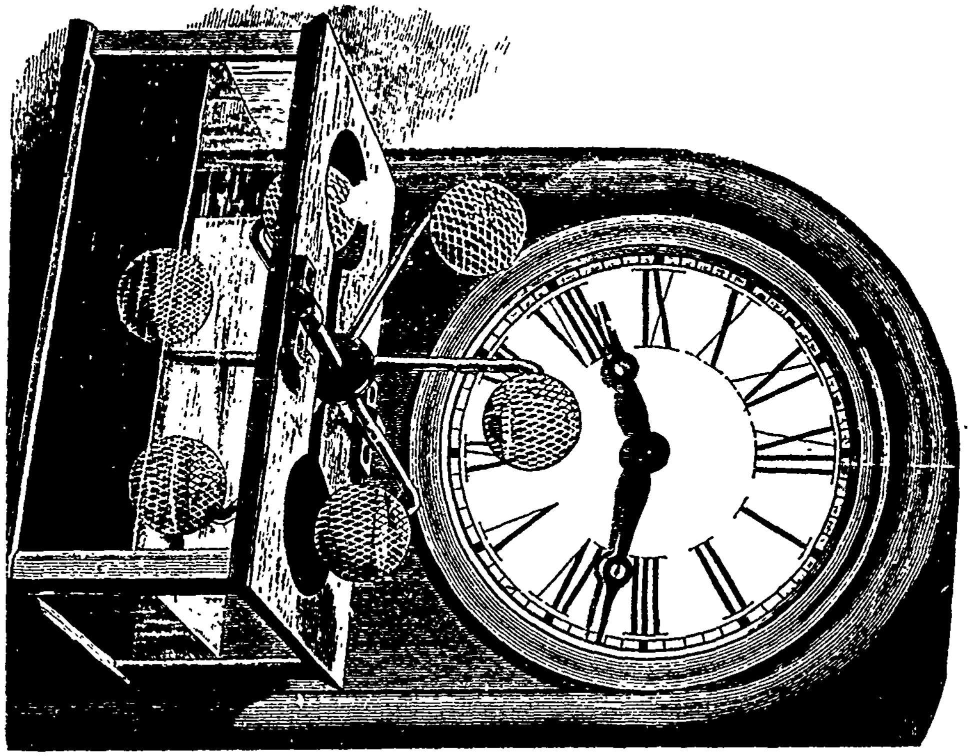
The limestone, which has been here employed for the past forty years in carrying out the most extensive hydraulic works, is obtained from quarries situate in the Halkin Mountains, Flintshire, and is that ordinarily used in Lancashire, Cheshire, the West of England, and Wales.

It is found by an analysis by Dr. Musprat of Liverpool to be composed of 75 per cent. of substances soluble in nitric and hydrochloric acids, and 25 per cent. of those insoluble. The soluble substances are:—Carbonate of lime. 7 20 per cent., carbonate of magnesia, 1 3 per cent., proto-carbonate of iron, 3 0 per cent, sulphide of iron, 1 0 per cent., alkalies, 0 7 per cent Those insoluble are:—Silicic acid 20·0 per cent., alumina 3·5 per cent.; sesquioxide of iron, &c., 1 1 per cent., water and carbonaceous matter, 0 4 per cent.

The limestone, in order to expel carbonic acid, is calcined in kilns, on plan oval 18ft. by 12ft, and 20ft. in height from the firebars, which dimensions give a capacity of 3,400 cubic feet The interior is lined with firebricks, and the usual dome top is here dispensed with; three such kilns are built into one rectangular construction of rubble work, each of which is provided with a hoist for the purpose of lifting the limestone and fuel to the summit of the structure when filling the kiln. The charging is done in the following manner.—A few shavings are placed on the fire-bars, upon which is spread a layer of coke about 6in. in thickness, limestone is then thrown in until a thickness of 1ft. 10in. or 2ft. is attained. This is followed by another layer of coke, and so on alternate layers of coke and stone until the top of the kiln is reached, the layers of stone gradually increasing in thickness to 2ft. 6in. at the top, with the exception of the uppermost, which, owing to its being exposed to the atmosphere, is made only 9in. or 12in. When completely charged, the shavings are lighted and the whole allowed to burn for six or seven days, as experience may direct, after which time not a trace of the coke is perceptible. The fire-bars are then withdrawn and the burnt lime raked out of the aperture thus formed on to the floor of an adjoining shed, where it is slaked with water, and produces a lime of moderate whiteness, after which, owing to the irregular size of the stones put into the kiln, it is occasionally found that some of the stones are not sufficiently burnt. When this happens they are picked out and reburnt, but by care in having the stones reduced to about the same size in the first instance this is of seldom occurrence.

In burning lime care must always be taken not to reach too high a temperature, as, owing to the fluxing properties of the lime, the silica and alumina would combine and form a species of glass. The stones should also be broken to a comparatively small size, in order that the heat may more readily penetrate to their interior, and thus effect a saving in fuel. The amount of limestone put into the kiln is 113 tons of 1930 bushels, and the requisite amount of coke is 14½ tons. This produces 75 tons or 1170 bushels of burnt lime, which, with 15½ tons of water necessary to slake this quantity, yields 98 tons of slaked lime or 3411 bushels From these quantities it will be seen that the slaked lime has nearly three times the volume of the burnt lime which produced it, and that its weight is nearly 9 per cent. more than that of the burnt lime and water together. Limestones, when calcined, produce rich limes, hydraulic limes, and cements. Rich limes are produced from stones consisting almost wholly of carbonate of lime, such as chalk. They slake freely, and during this process augment from two and a half to three and a half times in volume. These harden slowly in air and not at all in water, and the mortar formed from them is liable to be affected by changes in the atmosphere. Hydraulic lime is obtained from stones containing 15 per cent to 30 per cent. of silicates and sometimes magnesia These do not slake freely, give off little heat, and will harden slowly under water. Some stones, containing 40 per cent to 60 per cent. of silicates, produce cements which do not slake, but which, when ground and mixed with water, will set in air or water in a few minutes. The agency to which mortars owe their power of setting is not generally understood, but it is commonly considered that this action in rich limes is due to the evaporation of water and the gradual absorption of carbonic acid from the atmosphere, thus forming a crystallised carbonate of lime. In hydraulic limes it is believed that the setting takes place from a chemical union of the lime with the silica and alumina, thus forming an insoluble crystallised double silicate, without which mortars, placed in positions where air cannot penetrate, would never harden. The author therefore considers that the quantity of carbonic acid gas in the atmosphere being limited will to some extent account for the slow setting of rich limes, and as the atmosphere cannot penetrate to a great extent into thick walls and masses of concrete, it would be unadvisable to use for these purposes anything but hydraulic limes or cement, for the hardening of which the influence of the atmosphere is comparatively unimportant From the analysis of the Halkin limestone, it will be seen that the components producing setting and indurating under water exist to the extent of 25 per cent., and being evenly distributed through its entire mass, produce a mortar most favourable to the formation of an insoluble crystallised double silicate. To obtain good mortar, as much depends on the character of the ingredients and the manner of mixing them as on the goodness of the lime itself. It does not necessarily follow that because a lime is good that the quality of the mortar will be good also. The best lime ever burnt would be spoilt by the custom common among some builders—to mix with it alluvial soil and rubbish taken from the foundation pits of intended buildings. The sand should be hard, sharp, gritty, and, for engineering purposes, not too fine; it should be perfectly free from all organic matter, and with no particular smell. Good sand for mortar may be rubbed

* Read before the Edinburgh and Leith Institution of Engineers.



BERNARDI'S THERMO-MOTOR.

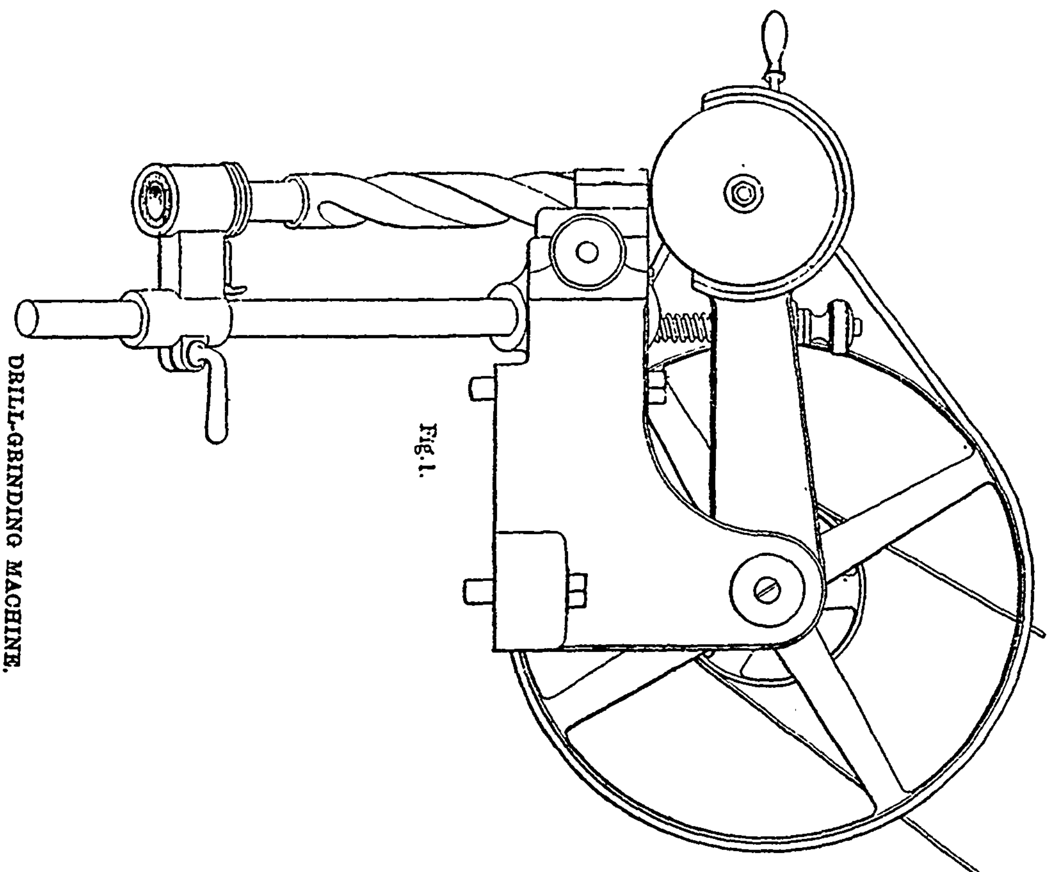


Fig. 1.

DRILL-GRINDING MACHINE.

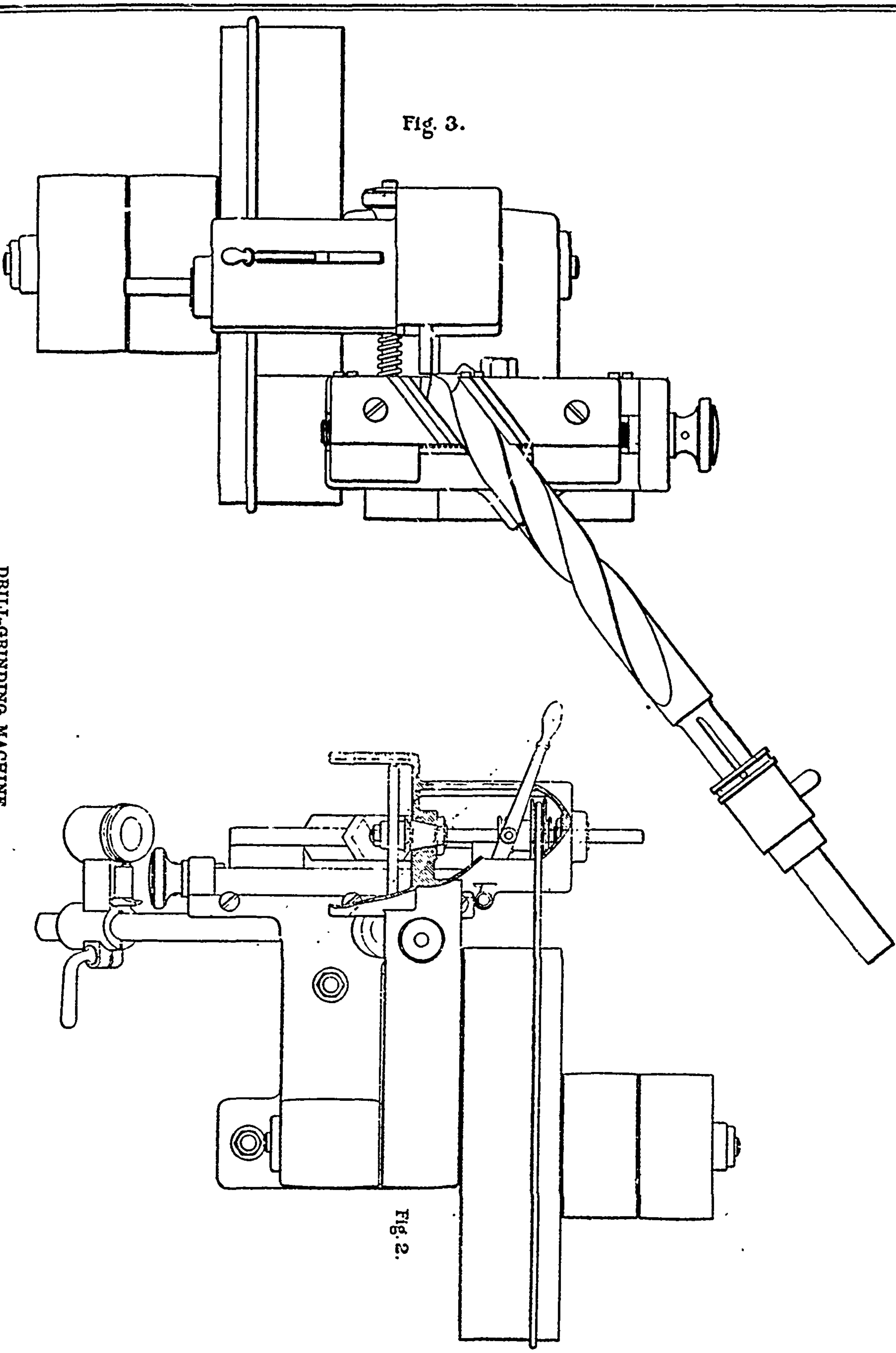


Fig. 3.

Fig. 2.

DRILL-GRINDING MACHINE.

between the hands without soiling them. The water should also be free from all organic matter, and on this account should never be taken from stagnant ponds. The presence of salt in sand and water is not found to impair the ultimate strength of most mortars, nevertheless it causes the work to "nitrate," or, as it is commonly termed, "salpetre," which consists of white frothy blotches appearing on the face of the structure It also renders the mortar liable to moisture, and for these reasons should never be present in mortar intended for architectural purposes, although for dock walls and sea works it may generally be used with advantage and economy.

Sand is used to increase the resistance of mortar to crushing, to lessen the amount of shrinking, and to reduce the bulk of the more costly material, lime Water is the agent by which a combination is effected, and, as sand does not increase in volume by moisture, it necessarily follows that no more of the aqueous element should be employed than is absolutely necessary to fill the interstices between the sand, and render the whole into a paste convenient for use, and the greater strictness with which this is adhered to the more compact and durable will be the mortar The mortar made from the Halkin lime is mostly employed on the Mersey Dock Estate in the construction of dock and river walls, for which purposes it is always mixed with salt and water and sea-sand. The lime, within one to four days after being slaked, is taken to the mortar mills, which are cast iron circular pans 7ft. in diameter, caused to revolve by suitable spur gearing at the rate of twenty revolutions a minute. In each pan are placed two rolling stones 4ft 6in. in diameter. There are fourteen such mills to each set of three kilns, which are driven by an engine of 60 indicated horse-power, and it is generally calculated that one mill requires 3½-horse power to work it, as the mills are seldom all working at the same time. The engine before mentioned is found adequate to drive the mills, lift the stone and fuel to the top of the kilns, and to pump from an adjacent dock the required quantity of water for mixing the mortar. The pans of the mills are provided with false bottoms, in order that they may be replaced when worn out, the average life of these being about three months. In mixing the mortar the lime is first ground in the mills in a dry state for three minutes, and the sand is then added, and after five minutes from the commencement the water is turned on, and as the necessary quantity is gauged by the tap, it is allowed to run the whole time, which, for the ordinary mortar, is about thirty minutes; the quantity made at each mill in this time is a quarter of a cubic yard. In some cases the amount is actually measured in order to ascertain if the men are making their full quantity. One man has to carry from an adjoining shed sufficient lime, sand, and ashes to make five cubic yards of mortar in a day, for which he is paid 3s. 6d. The ordinary mortar used in the construction of rubble masonry for dock walls is mixed by volume in the following proportions:—One part slaked lime, two parts sand, and one third of a part smithy ashes. And the proportions for that used in brickwork are: One slaked lime, one sand, and one smithy ashes. For the sake of convenience, in laying before you the experimental results obtained by these compositions, the author will term them respectively "masons mortar" and bricklayers' mortar" in practice the ingredients are not measured, as it is found that three average spades of lime, sand, or ashes are equivalent to one bushel. The mode of testing pursued was as follows · Bricks, the quality of which will be described in each individual case, were accurately cut to 4½in. in width; these were in all cases thoroughly wetted, and bedded crossways, with a mortar joint 5-16in. thick and 4¼in. by 4¼in, giving a testing area of 18 square inches. On the same arriving for testing, which, unless otherwise mentioned, was in every instance 168 days, or six lunar months, stirrups were passed round the ends of the bricks, two of these were attached to a beam, and on the remaining two was hung a bucket, into which perfectly dry sand was allowed to run from a hopper, the door of which was immediately closed when the joint parted; the bucket and sand were then weighed, and this was taken to be the breaking weight of the specimen. In order to ascertain the difference which would exist in practice from the employment of bricks of various texture, two qualities were experimented upon, namely, common bricks, similar although slightly harder than those known about London as "ordinary stocks," and fire-bricks, very hard and much the same as Staffordshire blue bricks. The "masons' mortar," with common bricks, broke with 496lb, with fire-bricks 433lb. The "bricklayers' mortar," with common bricks, 640 lb., with fire-bricks, 516lb. These are the average results of three experiments in each instance, from which it would appear that soft porous bricks are preferable for work subjected in any way to a tensile strain. It being the author's impression that mortar when used in a structure would bear a greater test, owing to the compression caused by the weight of the superincumbent mass, some results were obtained by subjecting the samples, twenty-four hours after being bedded, to a pressure of 56lb, and following this up with an additional 56lb every day until 4cwt. was placed upon each The "masons' mortar" under these conditions, with common bricks, broke with 683lb., with fire-bricks, 403lb. The "bricklayers' mortar," with common bricks, 372lb.; with firebricks, 423lb These are not average results, one experiment only having been made with each. The first instance is the only case in which the author's theory holds good, the remaining three cases being considerably below the respective averages of 433,610lb before mentioned This may be accounted for, as the author fears that in placing on the weights the mortar was disturbed after having partially set, in which case it will never bind together a second time In the case of mortar remixed with water six days after the first mixing, it was found that with common bricks the "masons' mortar' broke with 432lb, against 496lb. obtained with the same mortar when first mixed; the "bricklayers' mortar" broke with 440lb. against 610lb., the advantage is thus shown of using mortar when first mixed

The importance of the admixture of ashes with mortar to be atmospherically dried will be shown by the following results:—The bricklayers' mortar with common bricks after a lapse of 84 days broke with 570lb.; where sand was substituted in the place of ashes, that is, when the proportions were one slaked lime, two sand, and no ashes, it only required 257 lb to tear asunder the bricks. These are the averages of three experiments. This is, no doubt, attributable to the ashes being porous; they thus allow greater facilities for the absorption of carbonic acid from the atmosphere. By testing with a Michell's lever cement testing machine, one of which is now before you, brickettes having a testing section of 1½ by 1½ = 2 25 square inches, the average result of three experiments was found to be 248lb, which will compare very favourably with the results obtained by Mr Grant with Portland cement mixed in the proportion of three of sand to one of cement, which broke with an average of 270lb. From the foregoing it will be seen that nothing like these high results can be depended upon in actual practice, as the maximum breaking weight with bricks and mortar was 780lb, or 43 3lb. to the square inch against 110lb. obtained by breaking brickettes. Although no experimental tests have been made with this mortar of any great age, still, from the pulling down of old work it may with confidence be asserted that it fully complies with the old Scotch rhyme—

> 'When a hundred years are past and gane,
> Then good mortar grows into stane."

On the Mersey Dock estate every stone and brick is properly bedded, jointed, and covered with mortar and "grout," which is simply the mortar reduced by water to a proper consistency. It is poured over the work, and penetrates into the body of the masonry, thus filling all cavities and assisting to keep the work moist during its progress, thereby producing an even settlement. It may be well to mention that this work is not done by contract, in which case the author considers so free a use of "grout" would not be advisable, as probably it would be made to perform imperfectly what ought to be done thoroughly with mortar. When using bricks they are in all cases moistened, as, if set dry or warm, the mortar would be robbed by absorption of the necessary moisture for its proper hardening. From practice it is found that a cubic yard of rubble work contains one-third and brickwork one-fourth of a cubic yard of mortar. The paper was concluded by a few remarks on the selenitic patent process of mixing mortar, the practical manager of the company being present to explain the method, which, owing to his absence this evening, the author has thought it well to omit.

The whole production of the precious metals throughout the world during 1873 is estimated to have been worth nearly 220,000,000 dollars.

SCIENTIFIC NEWS.

M. Laborde states, in *Les Mondes*, that the disagreeable rasping tone peculiar to some violins may be avoided by placing a small strip of wax on the upper portion of the bridge. The notes are immediately rendered sweet and soft, and can be suited to the ear by regulating the size of the piece of wax.

A French journal connected with the metal trade gives the following curious estimate or the value of a piece of iron costing in its rough state 1f., after being employed for different manufactures Made into a horseshoe it is worth 3f., into agricultural implements, 4f., forged into ornaments, 45f., converted into needles, 75f., into steel buttons, 900f., employed as polished steel for decorative purposes, 2000f., and made into shirt studs, 9000f.

The *Bulletin Thérapeutique* says that in order to use old and worn out pieces of india-rubber scraps left from factories, manufacturers having easy consciences, wash the material first in a solution of subcarbonate of soda or potash, and then, when dry, pulverise between cylinders. This powder, placed layer by layer between sheets of new rubber and heated to a certain degree, forms a homogeneous mass, in which the fraud cannot be detected The mixture is, however, weak in tenacity and elasticity, and is unfit for surgical use, while dangerous for belting or other industrial employments.

G. T. Eberts, in the *Pharmacist*, says that the methods and suggestions for powdering camphor and retaining this refractory body in its powdered state, have not alone been numerous but curious.

Glycerine is the simplest and most efficient substance to keep camphor in a finely divided state. Take camphor 5 ounces, alcohol 5 fl. drachm. Glycerine, 1 fl. drachm. Mix the glycerine with the alcohol and triturate it with the camphor until reduced to a fine powder.

Proffessor Bache, in his coast survey reports, mentions that the tides of the United States are divisible into three distinct classes. Those on the Atlantic coast are of the ordinary type ebbing and flowing twice in twenty-four hours, and having but moderate difference in height between two successive high or low waters, one occurring before and the other after noon. Those on the Pacific coast also ebb and flow twice in twenty-four hours, but the morning and the evening tides vary considerably in height. The intervals also between successive high and low waters may be very unequal. The irregularities are due to the moon's declination, as, when the moon travels to the north of the equator, the vertex of the tide wave follows her, giving the highest point of one tide in the northern, and the highest point of the opposite tide in the southern, hemisphere. Hence, when the moon is in northern declination, the tide at any place in the northern hemisphere caused by her upper transit will be higher than that caused by her lower transit. This variation in the heights is called the diurnal irregularity, and has a period of one lunar day.

Red dyes must neither colour soap and water nor lime water, nor must they themselves become yellow or brown after boiling This test shows the presence or absence of Brazil wood, archil, safflower, sandal wood, and the aniline colours. Yellow dyes must stand being boiled with alcohol, water, and lime water. The most stable yellow is madder yellow; the least stable are anatto and turmeric. fustic is rather better. Blue dyes must not colour alcohol reddish, nor must they decompose on boiling with hydrochloric acid. The best purple colours are composed of indigo and cochineal, or purpurine. The former test applies also to them. Orange dyes must colour neither water nor alcohol on boiling, green, neither alcohol nor hydrochloric acid. Brown dyes must not lose their colour on standing with alcohol, or on boiling with water. If black colours have a basis of indigo they turn greenish or blue on boiling with sodium carbonate, if the dye be pure gall nuts, it turns brown. If the material changes to red on boiling with hydrochloric acid, the colouring matter is logwood without a basis of indigo, and is not durable. If it changes to blue, indigo is present.

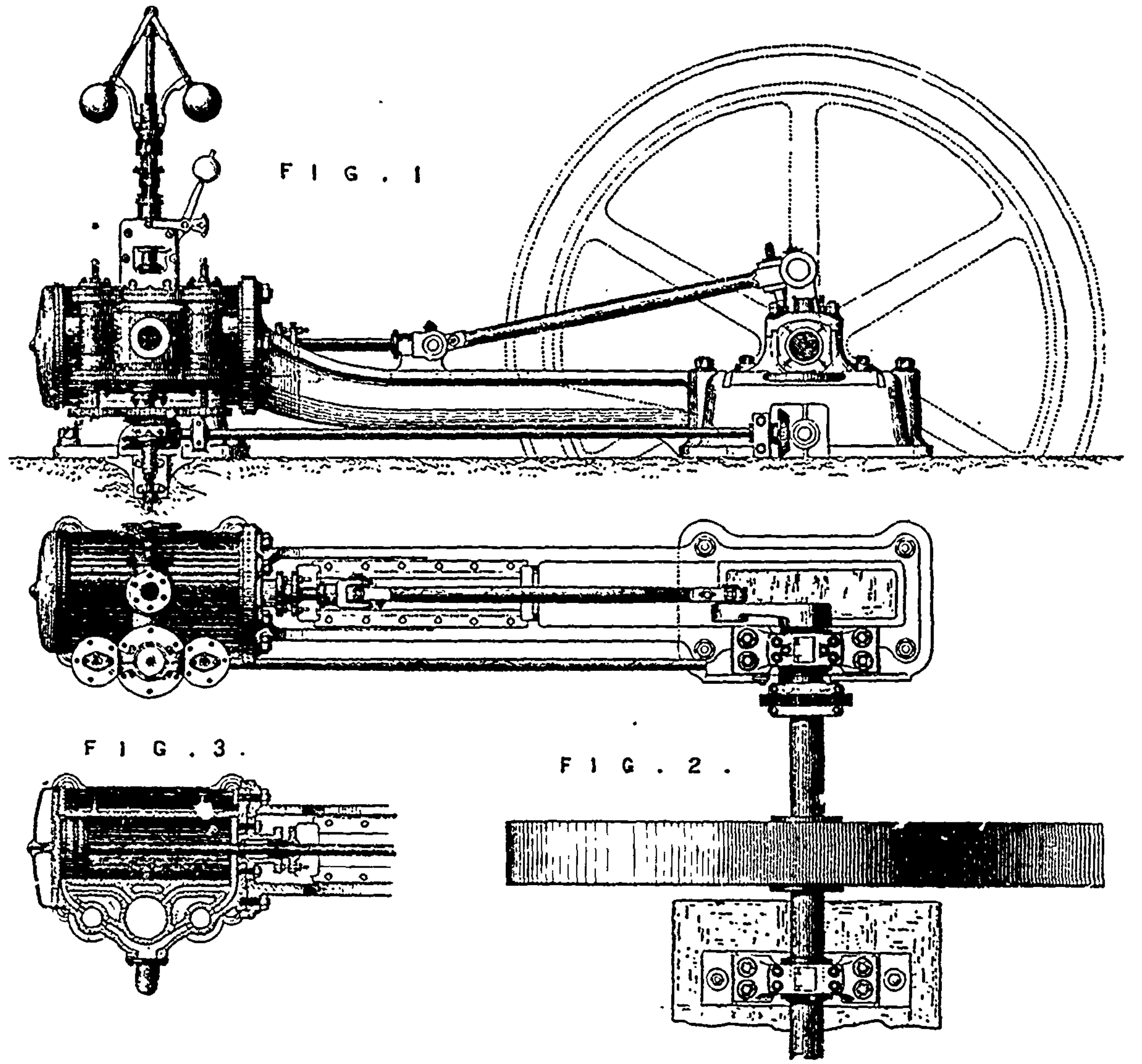
The *Scientific American* calls attention to a curious problem which some one has found in a work published many years ago, and which is as follows:—"A man at the centre of a circle 600 yards in diameter starts in pursuit of a horse running round its circumference at the rate of one mile in two minutes; the man goes at the rate of one mile in six minutes, and runs directly towards the horse in whatever direction he may be. Required the distance each will run before the man catches the horse, and what figure the man will describe." Perhaps some of our readers may attempt a solution.

Alloys of Tin.—The number of alloys into which tin enters is legion. Tin alone is not adapted to making castings, but, added in small quantities to other metals, give them hardness. A few of its most important alloys are given below, together with the usual proportions.—Britannia metals average nine parts tin and one part antimony, pewter, six parts tin and one part antimony, with various other metals, as bismuth, copper, lead, zinc, soft solder, equal parts of lead and tin, two parts tin, and one of lead, or one part tin and two of lead. The less lead it contains the lower its melting point will be. Bronze consists of copper and tin, or copper, tin, and zinc; the chief varieties are bell metal, gun metal, and statuary metal. Ordinary bell metal consists of seventy-eight parts copper and twenty-eight of tin; gun metal of ninety parts of copper and nine of tin; the statuary bronze used in the statue of Louis XIV., at Paris, made in 1699, consists of copper, 91·40; zinc, 5·53; tin, 1·70; lead, 1·37. An alloy of tin and mercury has long been in use for mirrors.

It may interest some of our readers who reside near the sea-coast to learn that there is considerable commercial value in the common sea-weeds which are thrown up so abundantly on the shore. In addition to their uses as a manure and for packing, quantities are now converted into artificial ebony. The process consists in first treating the plants for two hours with dilute sulphuric acid, then drying and grinding them up To sixty parts of this product, five parts of liquid glue, five parts of guttapercha, and two and a half parts of indiarubber are to be added, the latter two being first dissolved in naphtha. Afterwards ten parts of coal-tar, five parts of pulverised sulphur, and five parts of pulverised resin are added, and the whole heated to about 300 deg. Fahr. When cooled, a mass is obtained which in colour, hardness, and capacity for receiving a polish, resembles ebony, and is much cheaper. This material is now actually made on a large scale, and used for nearly all the purposes to which ebony can be applied.

Crystallised Glass.—Some curious specimens of crystallised glass were lately sent to M. Peligot by M. Vicleau, director of a glass factory at Blanzy, which were taken from a furnace which had been for some time out of use. These crystals differed completely, both in aspect and in mode of formation, from all the specimens of devitrified glass heretofore examined by M. Peligot. They were well developed prisms, twenty to thirty millimeters in length, and recalled in appearance crystals of sulphur and of bismuth crystallised from fusion. Their analysis threw some light upon the obscure question of devitrification. While certain chemists maintain that this result is nothing but the separation in crystals of a definite silicate in the midst of the vitreous mass—a true segregation—others affirm that devitrification is a simple molecular change, in which the entire mass of the glass crystallises, a phenomenon analogous to the change by which arsenious oxide becomes opaque. Peligot's analysis of these Blanzy crystals supported the former hypothesis, by showing that the crystallised portions differed in composition from the original glass. They contained no sodium, but had an excess of magnesium, corresponding to the pyroxene group. The crystals were altered by exposure to the air. They fused at a much higher temperature than the normal glass out of which they came. M. Peligot called the attention of the Academy to the large amount of magnesium present, suggesting its agency in the transformation.

M. Du Moncel has recently been experimenting on electrical transmission through wood. His results are given in *Comptes Rendus*, of 6th inst. Prisms of various kinds of wood were inserted between two platinum plates, which were in a circuit, and could be pressed towards each other. The effect of heating and drying the wood was also studied. M. Du Moncel considers that the relative conductivity of wood is due, in great part, if not wholly, to moisture absorbed through its pores. The effect of pressure was greatly to increase the conductivity, the two surfaces superposed being then brought into closer contact.



HORIZONTAL ENGINE WITH RADINGER'S VALVE GEAR.

HORIZONTAL ENGINE.

We illustrate, on these two pages, a small horizontal engine constructed by the Maschinen and Waggonbaufabriks Actien Gesellschaft, in Simmering, late H. D. Schmidt, and which is fitted with valves and valve gear arranged upon a system invented by Professor Radinger, of Vienna.

About the engine itself we need not say much. The bed-plate is carried along underneath the piston and connecting rods; the guide plate and the plummer block are cast with it. The cylinder is not overhung, but is supported by a substantial foot, which is made separate, we presume, on account of the complexity of the cylinder casting.

The valves are three in number, and are arranged on three parallel vertical spindles, the whole of them deriving a continuous revolving motion from a horizontal shaft driven from the crankshaft by spur gearing, the proportions of which are so arranged that all the valves have the same angular velocity as the crankshaft, that is, that they rotate revolution for revolution with the engine. The centre valve is double, consisting of two cones revolving one within the other *in opposite directions*. The outer cone governs the steam admission, and may therefore be called the induction valve, the inner cone governs the cut-off, and may be called the expansion valve. The governor is so arranged, as will shortly be seen, that the motion of the balls alters the relative positions of these two valves, and by this means alters the cut-off in a way analogous to that in which it is altered by the common right and left-handed screw arrangement for flat valves. The other valves are in shape not unlike the exhaust valves of a Corliss engine—that is to say, they fill up more than half the chamber in which they rotate; each one governs the exhaust from one end of the cylinder. Fig 3 shows the relative position of the valves in plan, and the manner in which the ports are arranged.

The bevel pinion on the end of the horizontal spindle gives motion in opposite directions (see Figs. 3 and 4) to two bevel wheels. The upper wheel is fast to a bush, which forms the lower end of the induction valve. The lower wheel is keyed on to a spindle, which passes right up through the valves, perfectly unattached to anything, until at the top it forms the spindle of the governor. There is a slot in the governor spindle, near its upper end, and a cross piece, which is connected at each end to the pins in the sliding bush of the governor, passes through this slot. Between the governor spindle and the sliding bush there is another bush, which, being carried downwards (in several pieces), is rigidly connected with the expansion valve. This intermediate bush has a slot on each side, through which the cross piece above referred to passes; these slots are placed *spirally*, however, at a small angle to the vertical. The expansion valve is driven by the pressure of the cross piece against the sides of these

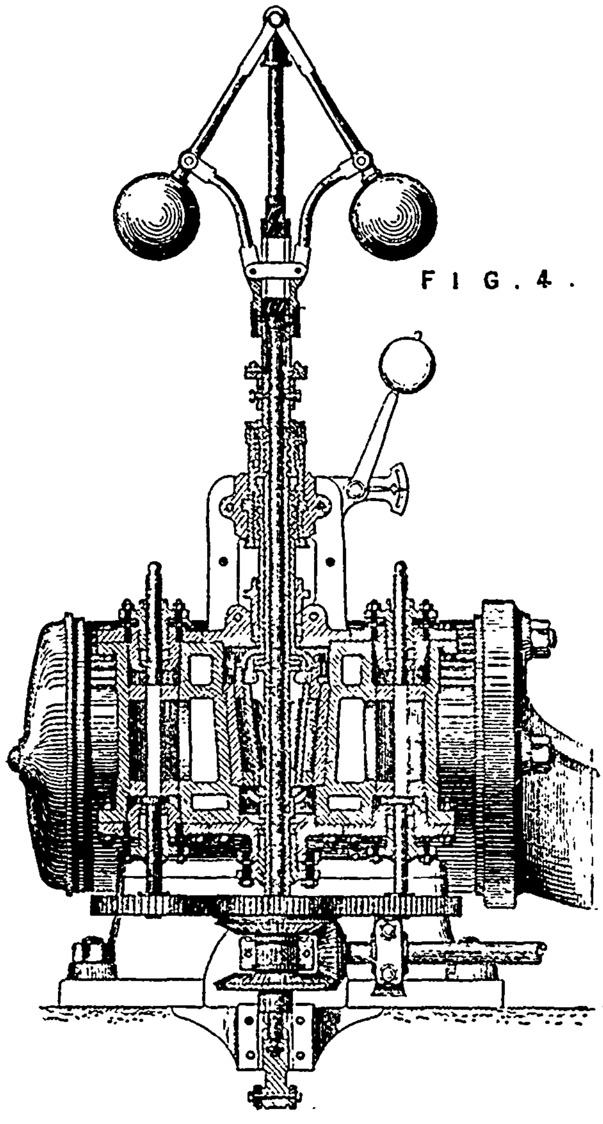


FIG. 4.

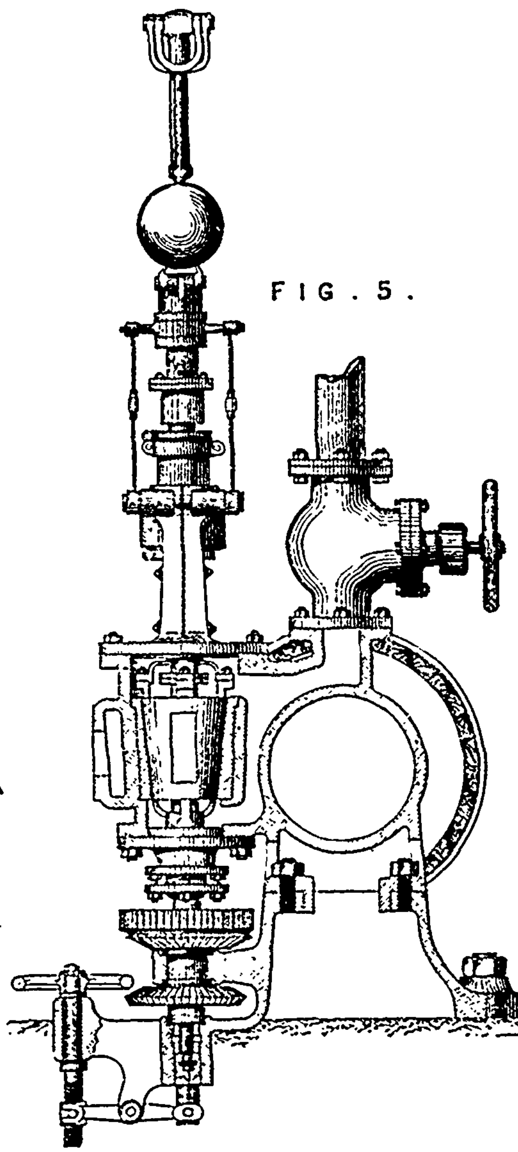


FIG. 5.

HORIZONTAL ENGINE WITH RADINGER'S VALVE GEAR.

slots, and therefore its rotation corresponds exactly with that of the governor spindle. When, however, the governor balls move out or in, the cross piece is raised or lowered, and in consequence of the oblique slots just mentioned, the expansion valve receives a small angular motion relatively to the governor spindle. We know that the angular motion of the induction valve is equal and opposite to that of the spindle, and therefore it is obvious that as long as the expansion valve moves exactly with the spindle, the cut off must always take place at the same time But by the action of the governor just described the relative positions of the expansion valve and the spindle can be altered, and consequently the precise point in the revolution of the induction valve at which the edge of its opening passes the edge of the expansion valve, in other words, the precise point at which the cut-off takes place, is altered also, thus leaving the cut-off entirely under the control of the governor The governor itself is of the ordinary type; it is connected with an index (Figs. 1 and 4), which shows at any moment the degree of expansion at which the engine is working. The two exhaust valves are driven by spur gearing from a wheel fixed upon the bush of the induction valve. Upon the top cover of the centre valve chest, which is made in halves, is cast a bracket, which supports an elaborately constructed nut, by means of which the induction and expansion valves can be adjusted vertically relatively to each other, and relatively to the seat in which the former works, in this way it is intended that the wear should be taken up. The lower end of the governor spindle is carried in an adjustable socket bearing, so that whenever the wear on the valves renders it necessary to bring them down a little, the governor spindle may be lowered too, otherwise the action of the governor would be rendered less perfect.

Professor Radinger's system of valves and valve gear is certainly ingenious, it is quite correct in theory, and has been very carefully worked out. By means of it the engine will have a constant lead, an expansion accurately controlled by the governor, a very quick cut-off, and points of release and compression entirely independent of lead or cut-off—all of them matters of considerable importance. It cannot be denied, however, that the apparatus by which these advantages are gained is complicated and expensive, will require careful attention, and is awkward to take to pieces. On these accounts we are afraid it will not come into general use, certainly not for engines so small as the present, where even if a large percentage of saving in fuel is possible, the money value of this saving is still insignificant.

The engine is well made and beautifully finished, though without superfluous polishing. The cylinder is 265 millimetres

(10·43 in.) diameter, and 630 millimetres (24·8 in.) The ordinary cut-off is ·33 of the stroke, variable from 1 to 6 by the governor. The working steam pressure is intended to be 60 lb. per square inch, and the revolutions 65 per minute.—*Engineering.*

GLUE.

Glue is a highly useful and important substance, and its manufacture is carried on upon a large scale, as follows:—The parings of hides, and pelts from the tanners and furriers, and the clippings of hides, hoof, horns, feet or calves, cows, sheep, pigs, and various membranes, are the substances from which it is extracted in Britain. These are first placed in a lime-pit, and when sufficiently steeped, they are carried in baskets to a stream of water and washed, after which they are placed on hurdles to dry. Whatever lime remains adhering to them is converted into chalk by the action of the air; and though lime would be injurious to the after processes, yet the presence of a small portion of chalk is immaterial.

The pieces having been thus cleaned, the next process is the extraction of the gelatine from them by boiling. For this purpose, they are placed in a wide-mouthed bag or net, made of rope, and spread open within a large iron cauldron. A light framing of iron within the cauldron prevents the bag from sticking to its sides. Water is then added, and gradually brought to the boiling point; as the animal substances sink, fresh quantities are added, the whole being occasionally stirred up and pressed down with poles. The state of the substances is tested by occasionally taking out a portion, and setting it aside to cool; if a clear mass of jelly be produced, the boiling has been sufficient. The mouth of the bag is then closed by means of cords, and the bag is slowly hoisted by machinery until it rests against, or partly coils around, a beam immediately over the cauldron, which helps to press out the liquid. In this state, it is left to drain. Meanwhile the contents of the cauldron, if not strong enough for glue, can be further evaporated by continuing to apply heat. The contents of the bag are boiled a second and a third time for making size, and when the solutions are too weak for either glue or size, they are economically used instead of water. The last remaining refuse is sold for manure. Thus, every portion of animal substance is turned to profitable use.

The glue in the cauldron, when thick enough, is drawn off into a vessel called a settling-back, and maintained at a temperature which will keep it liquid. This gives time for the deposition of solid impurities, and for further clarification by the addition of such fining substances as the manufacturer may prefer. The glue is then run off into wooden coolers about six feet long, one foot broad, and two feet deep. Here it becomes a firm jelly, which is cut out by a spade into square cakes, each cake being deposited in a sort of wooden box, open in several slits or divisions to the back. The glue is cut into slides by passing a brass wire, attached to a kind of bow, along the slits. These slices are placed upon nets (the marks of which are seen on the dry glue), and stretched on wooden frames, and are thus removed to the glue-maker's field, where they are placed in piles, with proper intervals for the admission of air, each pile being roofed in as a protection from the weather. The glue is turned two or three times a day, and for this purpose the roof is lifted off the pile, and the uppermost frame placed on the ground. The cakes are turned one by one, and then the second frame is lifted off and placed on the first. The operation is thus repeated until a new pile is formed near the spot where the old one stood, when the roof is replaced.

During the drying, the glue is more likely to receive injury than at any other period. In very warm weather, the cakes are liable to become so soft as to lose all shape and unite with the frames or they may even melt entirely, and flow away. A thunderstorm sometimes prevents a whole field of glue from hardening, while a thick fog may make it all mouldy. A brisk drying wind may harden it so suddenly as to render it unsightly and unfit for the market. A hard frost, by freezing the water in the glue, may cause it to crack in all directions, rendering remelting necessary. Thus the manufacture has many vicissitudes to suffer, and can only be profitably and conveniently carried on in temperate and equable weather. The drying, however, is not entirely finished in the open air. When the glue is about three parts dry, it is removed to lofts, where, in the course of some weeks or months, the hardening is completed. But as the surfaces of the cakes become mouldy and soiled, it is at length necessary to scour them with a scrubbing-brush and hot water, and set them up to drain. They are then finally dried off in a stove-room at an elevated temperature, which, when they are once solid, only serves to harden and improve them.

After stove-drying, the glue is fit for the market, where it is judged of by its strong dark colour, and freedom from cloudy or black spots when held to the light. The better sorts of glue are transparent, especially the thin cakes of the Salisbury glue, which are of a clear amber colour. The best glue swells without melting when immersed in cold water, and renews its former size on drying. The method of softening it for use is to break it into small pieces, soak twenty-four hours in cold water, and then melt slowly over a fire with frequent stirring. When prepared in this way it cools down into a stiff jelly, which requires only a little warming to fit it for use. Glue must not be used in a freezing temperature.

A strong compound of glue is made by infusing common glue in small pieces with isinglass in spirits of wine, just sufficient to cover the mixture. Heat is then cautiously applied, and when melted, powdered chalk is added, making the whole of an opaque white. A strong glue, which will resist water, is also obtained by adding half a pound of common isinglass to two quarts of skimmed milk, and evaporating the mixture to a proper consistency. If gelatine, which has been swelled in cold water, be immersed in linseed-oil and heated, it dissolves and forms a glue of remarkable tenacity, which when once dry, perfectly resists damp. Ordinary glue may thus be dissolved, and a small quantity of red lead, in powder, added.

It appears from the observations of Mr. Schattenmann, a glue-maker, that fresh glue dries much more readily than glue that has been once or twice melted; and that dry glue steeped in cold water absorbs different quantities of water according to the quality of the glue; and the proportion of water so absorbed may be used as test of the quality of the glue.

It appears that fresh glue contains water of composition, or water more intimately united with the glue than water mixed with it in the process of melting, which admits of being readily disengaged by evaporation. The combined water of dry glue disappears in the course of successive meltings and solidifications to which glue is subjected. Glue in thin plates is usually of better quality than thick ones, even when made with the same kind of gelatine, because the thin plates admit of a more complete drying than the thick. In applying M. Schattenmann's test, dry glue is immersed for twenty-four hours in water at the temperature of about 60° Fahr. A jelly will thus be formed, the qualities of which will fairly represent those of the glue. For example, the finest ordinary glue, or that made from white bones, absorbs twelve times its weight of water in twenty-four hours, so that a plate weighing three grammes produces thirty-nine of fine elastic jelly. Glue from dark bones absorbs nine times its weight of water, and produces not quite so fine a jelly. The ordinary glue of Alsace or of Germany, made from animal refuse, absorbs five times its weight of water, producing a soft brown jelly, without elasticity and consistence, and falling to pieces when handled. The common glue of Boulogne absorbs three and a half times its weight of water.

Well-dried glue is much less hygrometric than badly made glues, or those made of inferior materials. The latter are liable to putrefaction. The water of composition seems to be injurious to the strength of glue, which increases in proportion to its dryness.

Glue or gelatine has lately been applied, with great success, to the formation of moulds for castings. The difficulties attending the use of sand, clay, plaster of Paris, wax, &c. in forming moulds for casting, are very great where the objects to be repeated are complicated in form. About the beginning of the present century the Germans introduced the use of glue for making moulds, which was not employed in this country until about the year 1826, when Mr. Douglas Fox used it to take casts from his anatomical preparations, calcareous concretions, vegetable preparations, &c., and in order to give greater elasticity to the moulds so obtained, and to keep them in a fit state for use during a long period, he mixed treacle with the glue; this, however, was found to discolour the surface of all white bodies, and its application being limited by this objection, the plan was abandoned.

About the year 1844, attention was again called to the subject by the production in France of a series of casts in imitation of ivory; and about 1846 the Society of Arts, London, offered a prize which was awarded to Mr. Franchi for his specimens of casting in plaster composition in imitation of ivory. At the time the award was made the nature of the material used by him was not known; but it has since proved to be pure gelatine, and owing to the skilful use of his material some exquisite electrotype casts deposited in the Geological Museum were obtained from objects greatly under cost Mr. Franchi has since found that he can obtain from a gelatine mould a cast in gelatine in relief without losing any of the sharpness of the original. This has enabled him to apply objects modelled on flat surfaces to cylindrical bodies, thus saving the labour and expense of modelling. One great advantage of gelatine moulds is, that casts without seams can be taken from them.

Diamond Cement, or white fish-glue, is made of isinglass dissolved in dilute spirits of wine or common gin. The two are mixed in a bottle loosely corked, and gently simmered in a vessel containing boiling water; in about an hour the isinglass will be dissolved, and ready for use. When cold, it should be an opaque, milk-white hard jelly; it is remelted by immersion in warm water, but the cork should be at the same time loosened. After a time a little spirit should be added to replace that lost by evaporation.—*The Boston Cabinet Maker.*

DOMINION.

There are now in Nova Scotia 47 establishments for canning lobsters.

The Louisburg, C. B., telegraph line will be open for business in a few days.

Mr. Trutch's party of surveyors left Victoria on the 14th August, to survey a line from Hope to Burrard Inlet.

A party from Toronto has recently been at Devil's Creek, looking for minerals. They took back several specimens of iron ore, and also some very fine specimens of marble.

The total shipping of Prince Edward Island on 31st December, 1873, comprised 280 vessels, registering 38,914 tons. Since the 1st of April, 1874, there have been built in the Island and registered at Charlottetown 23 vessels of 4,217 tons, and re-registered 18 vessels of 935 tons.

The Sackville *Post* says:—The Marine and Fisheries department is active in improving the shores of Albert County. Buoys are being anchored at Five Fathom Hole and at other places along the shore for the protection of mariners. The steam whistle on Cape Enrage will be in operation in a few days. The building and machinery cost about $5,000.

The Sackville *Post* speaks in favourable terms of the result of Mr. Hickman's explorations and discoveries at East Springhill. It says.—"The seams are apparently regular, without fault or breakage, and, although small at first, have increased in size to such an extent as to lead to the belief that East Springhill will develope into one of the most productive districts in the country. Professor Selwyn, Chief of the Geological Survey of Canada, who has lately been visiting the coal areas of Cumber, gives a flattering opinion as to the value of Mr. Hickman's discoveries. We trust that the fullest expectations of those interested in it will be realized, because another Springhill means more wealth, more population and more prosperity for this portion of Canada.

Joint for Pipes.—The following is said to be a German plan: Instead of the usual projecting end, the pipes have channels around them When placed in contact end to end, a strip of soft lead is bound about them, and pressed tightly against the pipes by a wrought-iron ring. The advantages claimed are that the pipes are lighter and more easily cast, less lead is required to make the joint tight, no heat is required for applying it; it is quickly done; and especially that the joint is somewhat elastic, and will last longer in soft ground, or when heavily loaded.

RAILWAY MATTERS.

An Ohio lady, Mrs J. R. Carson, is superintendent of the Toledo, Wabash and Western Railroad.

Pullman Cars in Italy.—A fifteen years contract has been definitely closed at Milan, Italy, for putting Pullman palace cars on all trains and lines in Upper Italy. This covers the great routes of pleasure travel *via* the northern lakes.

The British steamer Tagus is now taking on board, at the Jersey City wharf, opposite New York, ten large locomotives, built at the Grant locomotive works, Paterson, N. J. They are for a Russian railway and are to be delivered at Taganrog, on the Sea of Azof They are said to be splendid examples of American mechanism.

French Railway Cars.—Some of the double deck cars which are quite common upon French roads, exhibit a most extraordinarily small proportion of dead weight. One on exhibition at Vienna, with a capacity of 90 persons, weighed only 11.75 tons Freight cars weighing but 10,000 lbs. carry 20,000 or even as much as 30,000 pounds.

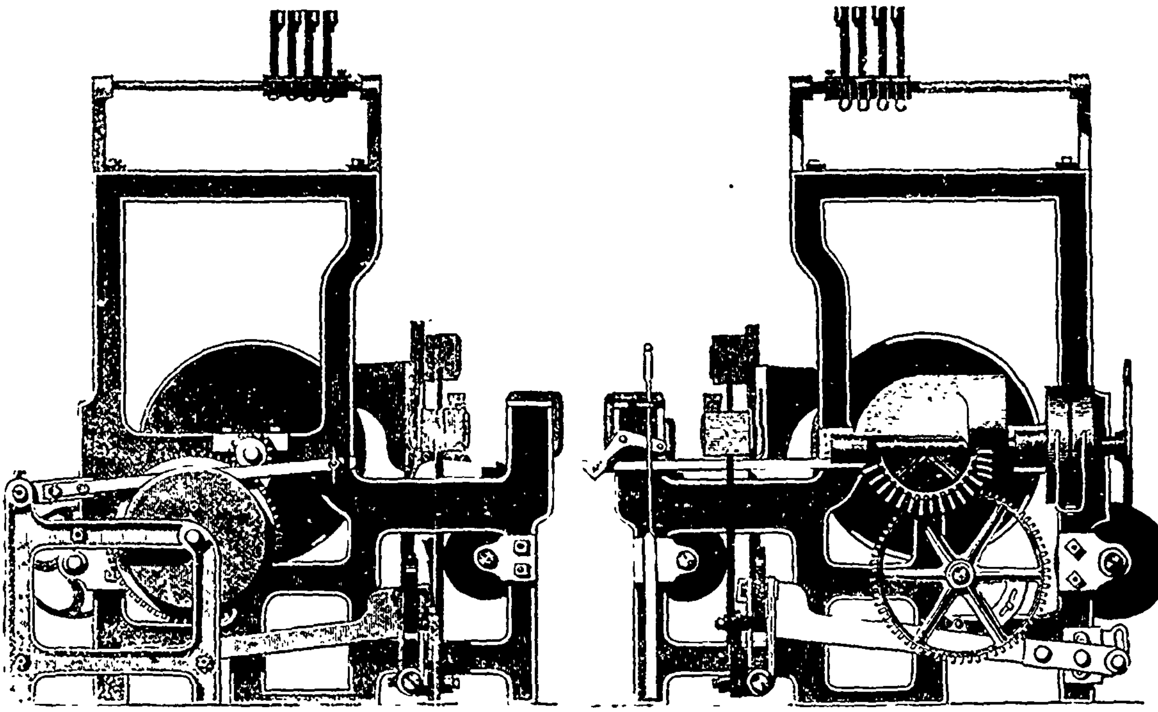
The abandonment by the Russian Government of M. de Lesseps' railway project, for the connection of Russia with India by a line through Turkestan, is announced. The Government now favours a line communicating with China through Central Asia.

A proposal has been made to construct a tunnel through Mont Blanc. It comes from M. Ernest Stamm, an Alsatian engineer, and is intended to make a connection between France and Italy independent of Swiss territory. It is said not to be attended by greater difficulties than was the Mont Cenis tunnel.

The completion of the iron bridge over the Saco river at Biddeford, Maine, affords, says the *American Manufacturer*, an admirable example of the American system of building iron bridges—that of interchangeable parts and pin connections—as contrasted with the system of connection with rivets. The bridge was built by the Phœnixville Bridge Company, and completed ready for traffic within forty days from the date of the order, at which time the iron lay in the form of puddle bar The bridge has three spans of 133ft. each, and two spans of 100ft. each, costing about 40,000 dols.

The first locomotive that ran on a railroad in America was imported from England by the Delaware and Hudson Canal Company; was ordered in England by Horatio Allen, assistant engineer; was shipped from Liverpool, April 3, 1829, on board the packet ship John Jay; arrived in New York 17th of May, 1829; was sent up the river to Rondout, and arrived the 4th of July 1829; from thence was transported by canal and arrived at Honnesdale, July 23, 1829; on the 8th of August made the trial trip. This locomotive was built at Stourbridge, and the boiler is now in use at Carbondale, Pennsylvania.

The Detroit *Free Press* of recent date says. "Three or four nights ago, after a freight train on the Detroit and Milwaukee Road had left the junction, a stranger was found on the top of the train and when questioned by the brakeman he said that he was an old brakeman out of money, and wanted to go to Grand Rapids He was apparently deserving, offered to do what he could to compensate for the ride, and was not put off. The brakeman did not think to tell him about the several bridges on the route, not expecting him to do much, and this fact nearly cost the stranger his life, causing him one of the closest escapes on record. About midnight the engineer discovered cattle on the track and whistled for brakes. The stranger was first up from the caboose, and in running over the cars he detected the dark form of a bridge close above him. There was no time to think or act, but instinct caused him to jump. He was not a second too soon, the bridge being almost over him as he leaped. He struck the side of an embankment, fell down and then rolled to the track One of the wheels caught his boot heel, crushed it off close to the sole, and the man was whirled around by the shock until he lay beside the rail, and before he could move his head a piece of the brim of his hat was sheared off. When the train stopped he was at hand to climb into the caboose, not being harmed in the least.



TWENTY FEET LOOM FOR WEAVING FELT.

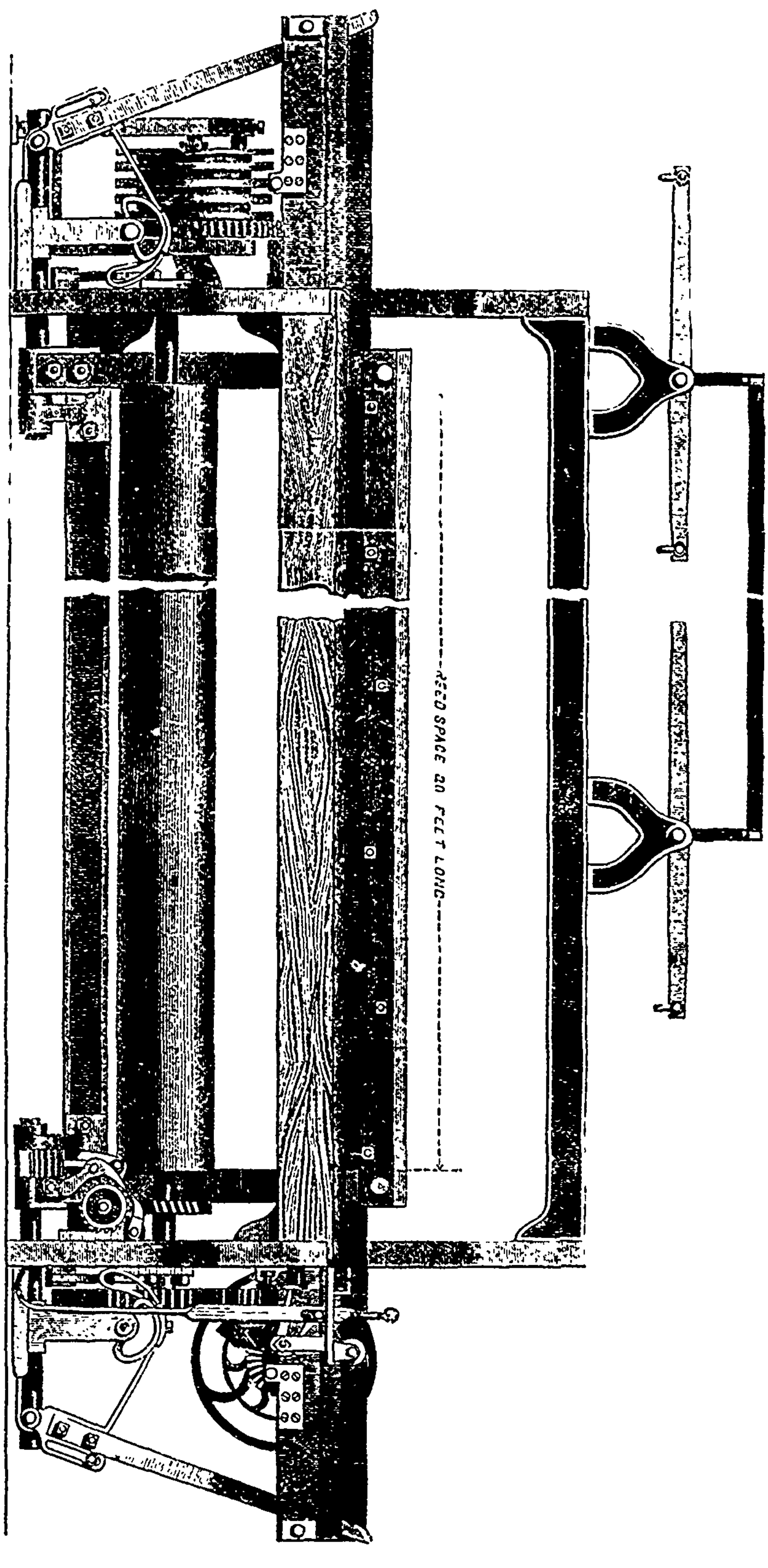
Our illustration on these two pages represents the largest loom in the world. This loom is at work at Bury, Eng., and produces a fabric 20ft. wide, known as woollen "felt" for paper machinery. The shuttle is a sled shuttle without wheels, and the loom makes thirty-five picks per minute. There is worm and wheel taking-up motion and 12in. diameter lagged cloth roller; the yarn beam is 15in. diameter. There are four shaft tappets, four to the round. A 3½in. diameter wrought shaft goes right through the loom, with tappets for working the slay. The tappet shaft is 2½in. diameter, driven by compound gearing, and to drive the loom a 16in. diameter pulley with only a 2½in. strap is used. There are three headles, though but two are shown in our engraving. The loom is provided with apparatus for winding on the warp without taking the warp beam out of the frame. The weight of the whole is 6 tons 16 cwt. 1 qr. and 5 lb.

AUTOMATIC STEAM FIRE-EXTINGUISHER.

It is not necessary to quote dry statistics in order to show what amount of valuable property there is yearly destroyed by fire. Every one who reads newspapers must be quite impressed with the frequency with which his eye meets accounts of the destruction of property more or less extensive, nor does it need statistics to prove that by far the greatest proportion consists of manufacturing premises. Fire-proof construction is still a matter of controversy; no engineer or architect has as yet, so far as we are aware, succeeded in constructing his buildings so as to resist destruction by fire, and the design that will do so has yet to be brought to the practical test, if, indeed, it is in existence. The occasional perfect helplessness of structures under fire appears strange sometimes, usually, however, a little closer inquiry explains all. This is strange when we consider the very great strides that have of late years been made in perfecting the means of extinguishing fires. Not only are our fire-engines very much superior to what they were, but we have well-trained and effective fire-brigades which are only waiting for the moment to act. This does not, of course, apply to country places; but there is scarcely a village which has not its organisation provided for such emergencies. In spite of all that, enormous losses, not only individual but national, occur again and again, each and all representing so much capital of which the nation is deprived. If, then, our means hitherto available to check this destructive agent, have been brought to such a state of perfection that the ordinary observer is altogether hopeless of seeing any further improvement, it is but natural that we should inquire for a remedy of a character different to that used hitherto, either as a total or partial substitute for that in present use. It seems at first sight almost discouraging to find nothing better than water—the medium at present almost exclusively employed—discouraging, when we consider how efficiently it masters combustion in nearly every instance when it is experimentally applied, we say nearly, because there are substances the combustion of which water cannot possibly prevent; we advisedly also use the word "experimentally" because, when we come into actual practice, we find affairs subject to very different conditions. Thus, while there is nothing more certain than the extinction of all combustion on any piece of wood for instance, if sufficient water is applied, in practice there are the difficulties of obtaining *sufficient* water, to have at hand the necessary apparatus to apply it at all, and lastly, to apply it at the right place. And these are not the only difficulties; the number increases with the variation of the material to be operated upon, so as not to destroy it with the medium applied to extinguish the combustion. It is a fact that very much more damage is often done by water than by the fire, if the latter is not very extensive; and if it is, the amount of property destroyed by water alone is sometimes quite appalling.

Undoubtedly the great point is to detect the fire immediately after its outbreak, and before it has reached any considerable dimensions, because the less in quantity there is to deal with the easier will the dealing be. This suggests at once, that if fire could be made to signal its appearance, and still better if it could be made to actually start an apparatus operating against it, that this must be the acme of perfection. To do this, when water is the only substance at our disposal for quenching the fire, is practically impossible; and this must be so apparent that it is unnecessary to waste any space upon it. It requires for the purpose a material much more elastic, one that will distribute itself, and not one that cannot get beyond the spot on which it drops.

Such a medium we have in steam. That is the medium which Messrs Sanderson and Proctor make use of with their self-acting apparatus. Before describing the latter, however, it will be necessary to say a few words about steam as regards its efficiency when applied to putting out a fire, though its use for that purpose is by no means new, although it is very little,



in fact scarcely at all, known in that capacity; and there is much in the circumstance, no doubt, that steam has been known for such a long time, and is only now seriously proposed as a means to extinguish fires, that the people whom it should benefit shake their heads and look sceptically. It does not, however, require intricate arguments to prove steam an efficient fire-extinguisher in theory, and not only that, but that it is much superior to water. Nor does theory stand alone and unsupported. In a former impression we cited a case, in which steam had proved the only saviour, and there are many more instances of steam being even practically and crucially tested with success

We must state in a few words why steam should in theory be a more efficient fire-extinguisher than water. There are only three fundamental principles upon which combustion can be stayed, viz., by preventing the access of air, intercepting the supply of combustibles, or lowering the temperature. The action of water depends solely upon the latter, its cooling property, and acts simply by absorbing the heat which would otherwise be expended in raising the temperature of the combustible to the temperature of combustion for its evaporation. Combustibles covered wholly or partially with or containing water cannot ignite, because none have a temperature of ignition so low as that at which water can exist Steam acts similarly; on issuing from the pipe it expands, gives off its heat, and is converted into water, but held finely divided in the form of mist or spray; in that state it is distributed over the whole of the surface exposed, and then acts the part of water—*i.e.*, it absorbs heat by being re-evaporated. The quantity of heat which steam already contains is so small, compared with the quantity and intensity required for the ignition of combustibles that it may be practically neglected and the objection which is sometimes urged that steam, on account of its heat, rather assists than checks combustion can only come from individuals who do not comprehend the natures of steam and of combustion. The superiority of steam in this respect consists in its aptness to be easily applied, it can be stored in a pipe ready for immediate action, spreads all over the surfaces in the space where it is discharged, and does not strike them with such destructive violence as water. The even distribution is a point of considerable importance, which will be understood by supposing a combustible, say a piece of wood, burning all over, and water, although meant for the whole, is only applied to one half of the surface, when the other must of course continue to burn unchecked, gradually evaporating the water on the other half and re-igniting if it there is not a continued supply. With steam the supply is continuous; its action is less sudden, but it is enduring and continuous.

The action of steam as an interceptor of the air supply, is however, of much more importance than its cooling power, and as such water rarely ever, in ordinary cases never, acts. This is easily and forcibly explained Suppose a fire in a room ; steam is turned on, and in two or three minutes the whole space is filled with steam of atmospheric pressure, the supply, however, continues, and if the pressure in the room is not to augment, it must issue through some opening or crevices, and if this is the case it will be obvious that no air can have ingress unless forced in as by a blast-pipe. This is, however, an extreme case, for it is known that even before a room is completely filled with steam of the same pressure as the atmosphere, the air becomes so pregnant with moisture that it ceases to support combustion. There would be no danger of the steam-pressure becoming excessive in the room of a building, because buildings are always of such a nature as to allow of sufficient escape for its equalisation, or of keeping it at a moderate pressure ; and the idea that walls would be blown in and roofs lifted off, is perfectly ridiculous. Nor is the danger of converting a room into a blast-pipe of any consequence, because it will be seen that the steam would have to blow out of one or more openings, while there was one or more opposite, at which air would enter through the impulse created by the steam flowing in a body and in one direction A comparatively small quantity of moisture would, therefore, suffice to prevent access of air, when we consider that one part of water occupies 1,600 times its original space if converted into steam of a pressure equal to that of the atmosphere. It is well known also that fires only attain their full power when the buildings or particular rooms are entered through doors which give increased facilities for the admission of air. This danger is entirely avoided with steam, because no one has occasion to enter a compartment in which there is a fire, if it has been provided with steampipes. From the same fact, the danger associated with carrying water, either in vessel or hose and jets, to burning apartments is entirely avoided. One important fact must not be omitted. Those acquainted with conflagrations are well aware of the very destructive and dangerous action which water has upon cast iron, which now enters so largely in the construction of buildings. Sometimes a heavy ceiling or roof is solely dependent on one or more cast-iron columns, which are only too liable to become very hot in a fire, and if highly-heated cast-iron is struck by a jet of water, either accidentally or intentionally, it is well known that it flies like glass, the more so if under a strain. No such consequences would result from the use of steam, on account of its gradual action. Steam also has the advantage of operating upon all kinds of combustibles; water, it is well known, has no power on hydro-carbons, especially fluids, such as oil, and the only remedy against these is the interception of the air supply. This steam will accomplish In a paper published in the *British Architect*, and subsequently discussed by the Scientific and Mechanical Society, Manchester, the advantages of steam over water are thus summarised by Mr. A. Hildebrandt: 1. Steam affords the opportunity of all arrangements for its application being made beforehand, and thus ready to operate without a moment's delay 2. Its use does not give increased facilities for the access of air, as is the case with water when it has to be carried in vessels or hose and get to the apartment where the fire is, thus necessitating opening doors and other air inlets. 3. Its action is certain and unfailing in all cases wherever it is possible to apply it, since it operates upon any kind of combustible with effect. 4. It does not in its successful application destroy property contiguous to the fire. 5. It entails no danger to life and limb of the operator as when applying water. 6. It does not require pumps or other appliances and machinery to convey it where it is required. 7. If proper provision for its use has once been made it does not require any further human labour.

As regards the condition of the steam to be used, theory points to high-pressure steam as the most efficient, although it contains rather more heat in the same weight of water than steam of lower pressure, for which reason it has been advocated to reduce it by means of a reducing valve We, however, should deprecate the use of such an appliance if the object was to make steam suitable for the purpose under consideration, because steam so treated becomes slightly superheated. We should, however, not object to reduced steam being used if it was nearest at hand in the case of fire. The efficiency of steam as a fire-extinguisher proved, an apparatus which in case of fire should, without human intervention, admit the same into the apartment where it occurred, must unquestionably be an immense boon both to proprietors and insurance offices ; and this Mr. Sanderson has succeeded in supplying in his self-acting apparatus which we illustrate in fig. 1. It will be seen at a glance that its action depends on the expansion of bodies by heat and on electricity. Fig. 1 is an apparatus shown complete in itself for the sake of illustration. The wire CI, of an electric circuit is inserted into the bulb of a thermometer T, fixed on the ceiling C, of a room, and the other end, CII, of the same into the top of the thermometer tube, projecting far enough to correspond to a certain temperature to which it is desired to adjust the same, and which should be one that is not reached under ordinary circumstances, but quickly produced by a fire. If the mercury rises to touch the wire, CII, the circuit is complete, the galvanic battery B, supplies power to the electro-magnet to attract its armature, A, which is one arm of a lever holding at its other extremity the pin of a faller weight, F, which is thus liberated, and falls upon the lever, L, causing the other end of the same to rise, a pin on the rim, R, of the valve-wheel, which is being held by the lever, L, escapes from its hold, and revolves in the direction in which it is drawn by a weight, W, thus opening the valve V, in the pipe P, branching off in each room from the main pipe, M, and thus admits steam into the room until the valve is closed again, which may be done at pleasure if desired.

It is obvious that the number of thermometers in the same circuit can be multiplied *ad libitum*, care being taken that each may form a circuit independent of any other. It will be seen, therefore, that one battery is sufficient for any number of thermometers in one room, and for any number of rooms.

In figs. 2 and 3 we show plan and longitudinal section of a mill-room, to which the apparatus is applied. The thermometers, T, are fixed from 10 to 15 inches apart, the aperture, O, of the branch-pipe, for the issue of the steam being in the centre, and near the top of the room, with a deflecting-plate, D, below, to avoid a direct rush of steam on any one standing under the opening at the time of discharge. It is obvious, however, that no general rule can be laid down for these particulars, but that the number of thermometers, the position of the opening, O, &c., will vary with circumstances ; the latter should always be central, between any possible openings or escapes for air or steam. Our arrangement shows an extra valve, V, between the boiler and the main steam-pipe, worked by the same circuit, but it has its own apparatus, and is so connected as to be actuated every time in addition to the valve in the room in which contact has been made, in order to admit steam to the branch valves A boiler is shown dotted, simply to remind the reader of the necessity of one being in or near the premises. The main steam-pipe is shown, 6-inch hose, the branch-pipe 4-inch. A steam-whistle is fitted to the former, in any convenient place, so as to give an alarm which is especially useful at night and other times when the hands are away from mills, and to tell the watchman to make more fire, but under the boiler, so as to generate more steam

The idea of the apparatus is at once simple and beautiful, and as for its liability to get out of order we do not think it is more so, if as much, as an ordinary fire-engine. Should contact be made accidentally, for instance, through lightning, the valve can at once be closed by hand if it should happen during the time that the place were attended ; but even if this were not the case, not much damage could be done, the damping of the place and the goods it contained could not possibly be a serious thing.

The only thing which obstructs the adoption of this apparatus in cotton-mills and other concerns is, we imagine, the scepticism of millowners in the efficiency of steam for the purpose of extinguishing fires, but the experiments which led the inventor to patent the apparatus have so satisfied him and the firm in which he is a partner, that they are now anxiously waiting for the offer of mill-rooms to be placed at their disposal to try both steam and the apparatus, at their cost and risk, and to prove its utility practically, and on a large scale. We trust this opportunity for trying an appliance which promises to be so very useful, and likely to save a large amount of valuable property, will not long be wanting. We commend it warmly to the attention of insurance offices as likely to prove of considerable value to them. We shall watch the trials with interest, although instances of success with steam are, as we have said, not wanting, while that there are other people besides the inventor and makers of this apparatus, who have great faith in steam, is shown by the fact that there are instances where the owners of mills would not permit firemen to enter the burning building after the steam pipes, which happened to be in the burning part, had been forcibly broken. We know of instances where mills have been saved by steam from destruction by fire on three occasions, which surely is more than theoretical proof.—*Iron.*

MISCELLANEA.

The deepest boring that has ever been made for coal was made in 1853-7, at Mouille-longe, where the drills reached a depth of 1006½ yards, when the tools broke at the bottom of the hole, and the work had to be abandoned.

The exhibition building at the Centennial at Philadelphia in 1876 will be built almost entirely of iron, and already the contract for completing the work has been given out. A combination, consisting of Clarke, Reeves, and Co., the Phœnix Iron Company, the Keystone Bridge Company, and the Union Iron Mills, Carnegie, Kloman, and Co., gave in a tender for 1,397,000 dols., but as a Mr. J. R. Dobbins quoted 922,595 dols., he secured the order. He will get his iron from New Jersey.

Mr. William Rosenbaum, Cheyenne, Wyoming Territory, has patented a device for detaching horses at any moment from carriages, buggies, waggons, reapers, mowers, or other vehicles, so that not only the individuals, but also the vehicles, are protected against injury from runaway or vicious animals. The invention consists of a lever attachment to the pole or tongue of the vehicle, which may be operated from the seat so as to detach a clevis with wedge-shaped end to which the double tree is applied. In case of any accident or danger, the horses may be instantly detached by pulling the hand lever back which forces the sliding bar beyond its guide recess and gives sufficient play to the wedge clevis to slide out. The horses carry then the double tree along with them, leaving the vehicle behind.

Premium for the Best Circular Saw.—The Board of Commissioners of the Fifth (1874) Cincinnati Industrial Exposition offer a special premium of $100 in gold for the best circular saw. The competition is to be determined under conditions as follows: All saws competing shall be of uniform diameter, namely, 56 inches. They may have either solid or inserted teeth. The gauge to be at the option of the exhibitor. The eye of the saw to be 2 inches diameter; the pin holes, ⅝ inch, and 3 inches from centre to centre. Each saw is to be submitted to a thorough practical test, upon a left hand mill provided for the purpose. Diagram cards are to be taken from the engine during the trial of each saw, by a disinterested expert, selected by the jurors. The test is to be made during the week beginning September 21, 1874. Other details of the examination are to be determined by the jurors.—*Scientific American*

Water Proofing Linen.—Professor Kuhr gives the following directions for this purpose. Pass the linen first through a bath of one part of sulphate of alumina in ten parts of water, then through a soap bath, of which the soap is prepared by boiling one part of light colored rosin and one of crystallized carbonate of soda with ten parts of water until the rosin is dissolved. The rosin soap thus formed is to be separated by the addition of one-third of common salt with one part of soda soap, by boiling it in 30 parts of water. From this bath pass the articles finally trough water, then dry, and calender. Made-up articles maybe brushed with the solutions in succession and be rinsed in the rain. Wooden vessels may be employed.

Reaping Machine Competition in France.—Two great international trials of reapers have just come off in France, the latter terminating on Saturday night. The first took place at Soissons, the othert at St. Dizier, in the Department of Upper Marne. The leading English, French, and American makers competed, but the real contest was between the English and Americans. At each trial, however, the Americans came off only second best—the Howards, of Bedford, gaining the first prize at both contests with their "International." The second prize was taken at Soissons by Osborne, America, and at St. Dizier by Johnstone, America. Samuelson, of Bambury, came in third at Soissons, and W. A. Wood, America, third at St. Dizier. The drivers were brought over from America as well as England, so great was the interest in the contests.

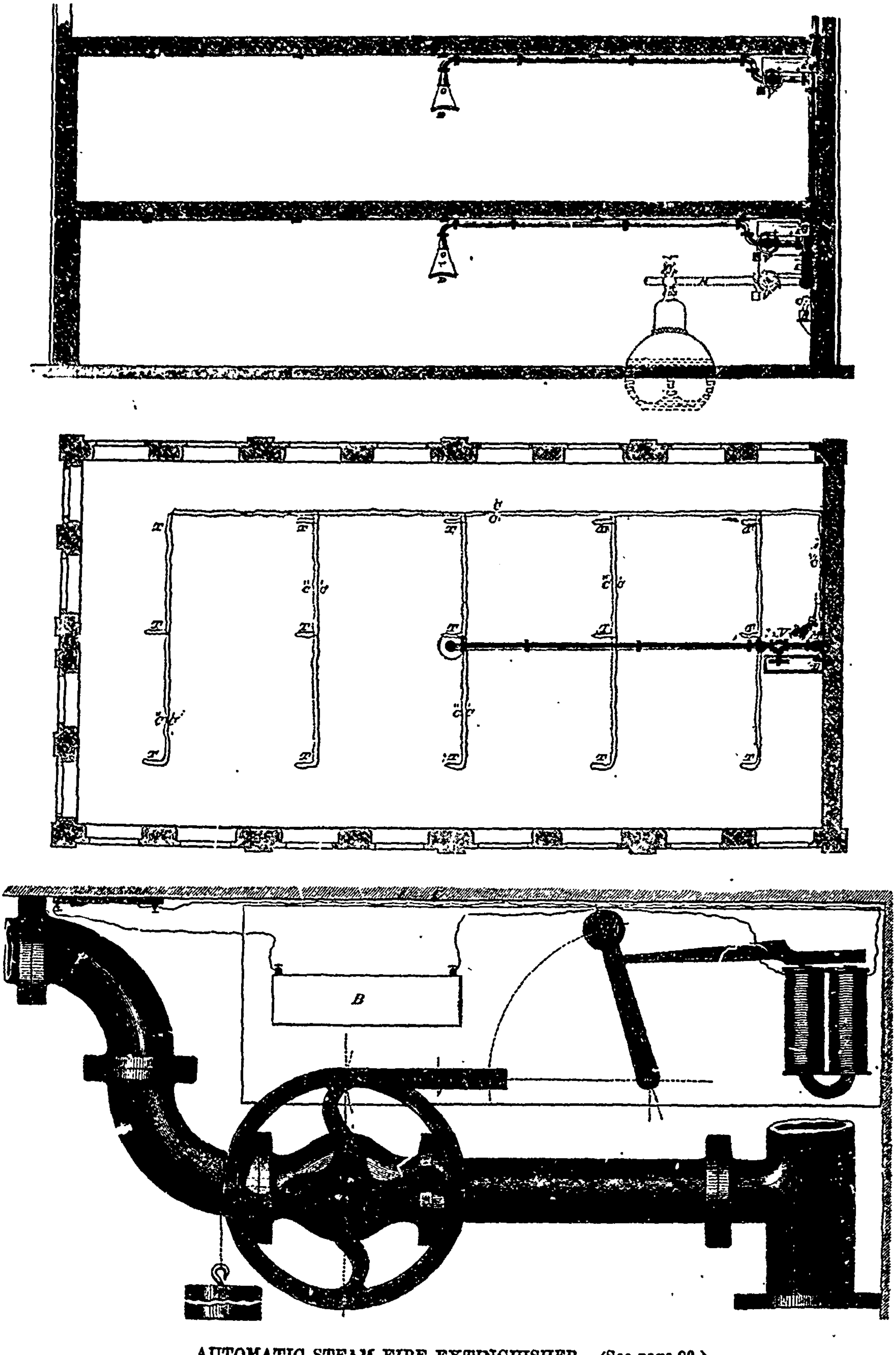
Says the Morrisburgh *Courier.*—Mr Morton, of Molson's Bank, showed a specimen of paper pulp manufactured from poplar wood at the Waddington paper mills. This pulp seems to be a good article, and from which a first-class quality of printing paper can be made. The bank of the canal here has been lined with poplar wood, which was brought in by our farmers during the sleighing season. It is the property of Mr. James, proprietor of the mills at Waddington. Poplar is rather a scarce article in this locality, but we are informed that it abounds in large quantities in the vicinity of L'Orignal. Since it is likely to become so useful in the manufacture of paper, we opine that when the Coteau and Ottawa Railway is opened there will be quite a large traffic in the shape of poplar wood.

The Weathering of Coal.—That coals lose considerably in value by exposure to the weather is well known, but few, probably, are aware of the extent of the damage. Dr Varrentrass has ascertained a loss of more than one-third in the weight of a sample of coal exposed for some time to the air, and he states that the quality of the coal had undergone a still greater deterioration. The loss is due to a slow combustion of the volatile elements of the coal, which gradually diminish in amount, whilst the proportion of carbon, ash, and sulphur are increased. In some experiments made the gas furnished diminished 45 per cent., and the heating power 47 per cent. in a coal which had been exposed, and the same coal under shelter lost only 25 per cent. as a gas generator, and 10 per cent. as a heat producer. Anthracite, as might be expected, suffers least from exposure to the atmosphere, and the bituminous coals are those which lose most.—*Globe.*

How to Iron Linen.—A *Hearth and Home* correspondent says linen that is placed immediately after being ironed near the stove or in the hot sun, is stiffer when dry than if it is permitted to dry slowly. It is a good plan to lay collars and small articles on a waiter, and set them on a kettle or other support on the stove, till they are quite dry. Sometimes the iron will stick in a manner perfectly unaccountable; if it is rubbed on a board on which fine salt has been sprinkled, and then passed over a brown paper with wax in its folds, the sticking propensities will be checked. A bowl of clear water and a clean old linen cloth, is useful to remove any specks the linen may acquire before or while being ironed.

A New Needle.—A lady in San Francisco, the *Chronicle* of that city says, has invented a new needle, the improvement consisting in making a needle of any size without an eye for the thread, but with, instead, a hole bored longitudinally into the head, or larger end thereof, to the depth of a quarter of an inch or thereabouts, which hole is arranged with a screw thread. The needle, it is claimed, will carry any kind of thread, and can be used for every purpose. It is thought that it will be valuable also, as a surgical needle, as it will require but one thread, the advantage of which will be that a smaller hole will be made in passing the needle through any substance than would have to be made by the partially doubled thread of the ordinary eyed needle.

Lake Titicaca.—Lake Titicaca, on the crest of the Andes, is the highest large body of fresh water, and the lake never freezes over. Two little steamers of 100 tons each do a trifling business. Steam is generated by llama dung, the only fuel of the country for there are no trees within 150 miles. The steamers actually cost their weight in silver, for their transportation (in pieces) from the coast cost as much as the original price. A steamboat company has asked from Bolivia the exclusive right of navigating Titicaca and the Rio Desaguadero to Lago Pampa, with guarantee of six per cent. on the capital, and a share of all new mines discovered. Professor Orton, the latest traveller in the region, calls attention to the fact that Lake Titicaca is not so high as usually given in geographical works by about 300 feet. Its true altitude is 12,493 feet, and in the dry season it is 4 feet less. This fact has been revealed by the consecutive levellings made in building the Arequipa railway just finished, which reaches from the Pacific to Lake Titicaca. Lake Titicaca is about the size of Ontario, shallow on the west and north, deep towards the east and south.



AUTOMATIC STEAM FIRE EXTINGUISHER.—(See page 92.)