The Canadian Patent Office Record and Mechanics' Magazine

Vol. I.—No. 8. NOVEMBER, 1873.

Price in Canada $1 50 per An
United States - $2 00 "

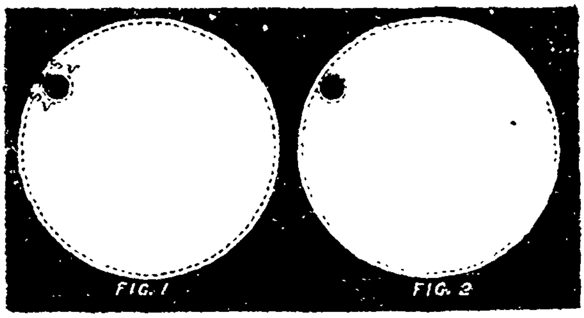
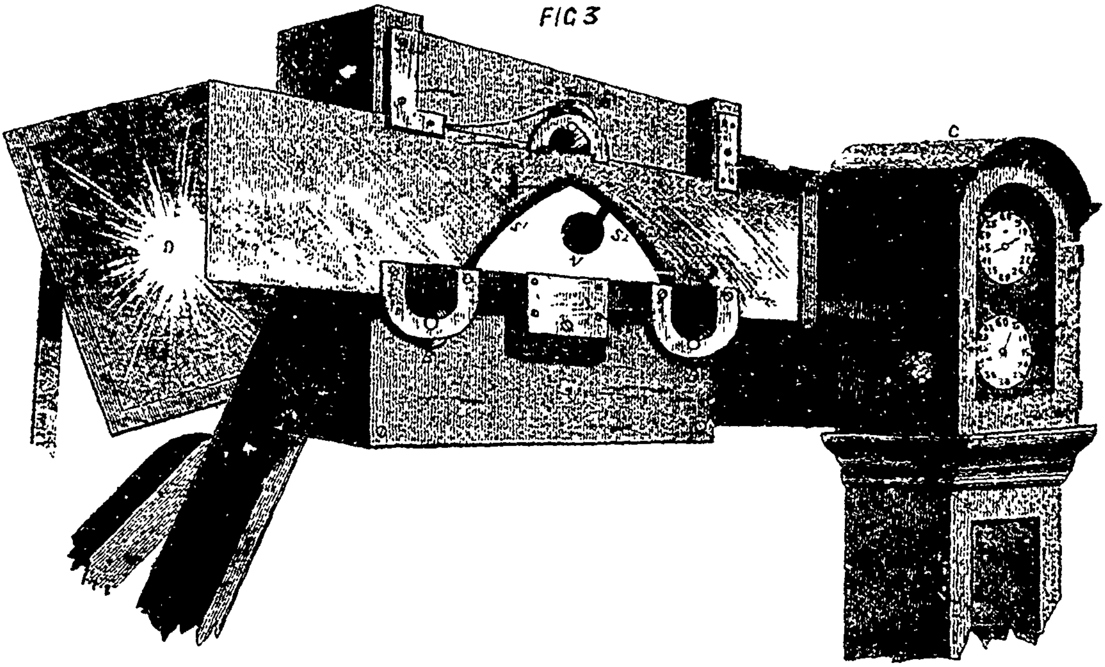


FIG 3



SIR G. AIREY'S AUTOMATON TRANSIT OF VENUS (See next page.)

SIR G. AIRY'S AUTOMATON TRANSIT OF VENUS.

The Astronomer Royal has recently designed and constructed a working model to show the phenom na of the transit of Venus, of a peculiarly complete and simple character, which we show on page 227. A few words only are necessary to enable any of our readers to appreciate its object and scope. A transit of Venus occurs only twice in about 120 years; the importance of observing this phenomenon we propose to discuss in a future article. In the meantime we would merely point out that the feature to note is the exact instant at which the edges or limbs of Venus and the sun are in contact during the passage of the former across the disc of the latter.

Very great difficulties have been found on the occasion of previous transits in obtaining reliable observations, owing to the peculiar optical effects accompanying the phenomenon and the consequent difficulties in ensuring the observation of the same particular phase in the transit by all observers, as well as the doubt arising from the exact effect of the peculiarities of each telescope and each observer. So great indeed have been these difficulties, that the observations of the transits that have hitherto taken place—observations made at great trouble and expense—have been found of very doubtful value. It is, therefore, most important that uniformity in habit of observation should be acquired by all the officers and others leaving England to observe the transit of Venus in 1874 To this end systematic practice of some kind is clearly desirable. How is this to be obtained with a phenomenon occurring only twice in 120 years? Careful observations of the transits of Jupiter's satellites have been recommended, but Sir G. Airy has met the difficulty by a device which appears to give a singularly close copy of the transit of Venus, and on which observers may try their powers to their heart's content. Before giving a description however, it is well to understand the difficulty to be dealt with in the observation of a transit of Venus. Fig. 1 represents the sun with Venus coming on to it about the moment of internal contact. There is a ligament connecting the black disc of Venus with the sky at the point of contact. This ligament is the main cause of the trouble. It is nearly, if not always seen, and is explained in the following way:—

Any brilliant object dazzles the eye, and by irradiation appears to be larger than it really is; thus, in Figs 1 and 2, we suppose the real size of the sun to be indicated by the dotted line, while the apparent disc is the size of the larger circle. So again Venus should be seen the size of the small dotted circle, but the sun so far encroaches on her that she only appears to be the size of the black disc whenever her edge is seen against the sun. But up to the moment that the entire edge of Venus enters within that of the sun the light cannot encroach at the part that as yet is not projected against the sun but only against the sky. Consequently, the limb of Venus that last enters on the sun's disc is for a time seen its full size, and the light, as the limb of the sun concealed by it, can neither encroach on the sky or on Venus. In short, at this point the edges of Venus and the sun are those shown by the dotted circles, and thus the black sky and black disc of Venus meet where the circles *s s* and *v v* meet, and thus the ligament is formed. It has been supposed that directly Venus enters within the sun's disc, as shown in Fig. 2, the light rushes in and encroachment takes place. Supposing this to occur immediately after internal contact, it is clear that when understood the peculiarity of the phenomenon would greatly facilitate its being accurately observed and recorded It is clearly necessary, however, to ascertain the truth of this supposition.

Fig. 3 shows the apparatus designed by Sir G. Airy to represent the transit of Venus, at which the officers and other observers now practise. A glass slide A A, with a black disc (to represent Venus) fixed on it, is drawn by clockwork across the opening S1, S2, cut in a screen. The curves S1, and S2, correspond to the limbs of the sun at the moments of ingress and egress. By means of the looking-glass D, the reflected beams of the sun are thrown through the opening S1, S2, and the result is that the phenomena of encroachment of light and the ligament, or "black drop," is seen as in an actual transit. The rate of motion and size of Venus are calculated so as to give the same apparent dimensions and movement when seen on the main building by observers on the top of the magnetic buildings in the Royal Observatory, Greenwich, as those of Venus at the expected transit. The limbs of the sun are brought together and make an arch, in order to give ingress and egress without unnecessary loss of time. We have said that our observers are practising daily at this model, and it may be expected that their personal equations and the effects of peculiarities in telescopes will be clearly established We may add that some rather unexpected facts have come out, which seem to indicate that a modification of the generally received explanation of the behaviour of the black drop, which we have given above, may be necessary For example, it is found that with a smaller telescope Venus is seen to leave the limb and enter within the sun's disc later, and come in contact again at egress earlier, than with a larger glass. Then, again, it is found that with a brilliant blaze of sunlight a ligament is seen in a position when with a faint light it would have disappeared This is rather contrary to the generally received ideas. It is premature, however, to say much now. A few weeks' work may establish very valuable results.—*The Engineer.*

LAKE SUPERIOR IRON MINES.

An occasional correspondent of the *New York Tribune* says that the iron interest controls all the capital, thought, and energy of Marquette, Michigan, and is the great industry of the district. Fifteen years ago the first ton of ore was taken out of the Marquette hills and sent to Detroit to be made into pig-iron; the report was that it was too soft, and therefore unfit for use. Now the mines of Marquette produce nearly one-quarter of all the iron ore mined in the United States, or 1,200,000 tons per year. It is expected that the production this year will equal 1,500,000 tons. The ores in this section are classed in order and quality as the magnetic, the specular, and the hæmatite. The two former varieties are found in immense quantities, will yield from 67 to 70 per cent. of pure iron, and can be hammered into shape almost without being reduced by heat to pig-iron, these ores are now found to be indispensable for mixing with the "cold short" ores of Pennsylvania, Ohio and other points in the West. For this reason they will always be in demand. In quality, the iron ore of Missouri, particularly that of the Iron Mountain near St Louis, resembles the specular ores of Marquette, but they yield only some 60 to 63 per cent pure iron, and are accordingly of less value. The iron ores of Tennessee, to which the attention of the iron manufacturers of the West was recently turned, have been found to be of the "cold short" variety, and although found in immense deposits, cannot be successfully used for pig-iron without mixing with the ores of Lake Superior, which are all "red short" ores, and do not become brittle when cold. Immense quantities of the Marquette ore are shipped regularly to Pittsburgh, Cleveland, Chicago, Detroit, and elsewhere in the West. The Pittsburg furnaces are universally using these ores, and cannot compete in quality with imported iron without them. Pittsburg manufacturers are also largely interested in the mines in this section, and their capital is always ready for the development of any new enterprise in mining here which possesses proper qualifications for success

Marquette enjoys a remarkably favourable situation, for it can ship its ores by water at small cost to nearly all the great iron manufacturing centres of the West; for this reason it must for ever enjoy a position in iron mining scarcely rivalled by that of any locality in the West. The attention of England's manufacturers is also turned in this direction, and a recent shipment of 3,000 tons of pig-iron to Montreal, destined finally for England, [?] will show to what extent the exportation of these ores may be carried on. Although Marquette has confined its efforts almost entirely to the mining of ore, a blast furnace and a rolling mill are now in successful operation For the manufacture of pig-iron it enjoys some advantages, for coal can be laid down here much cheaper than at Detroit The vessels employed in taking the iron ore down the lakes are satisfied to take a return cargo of coal even as ballast, or for the nominal charge of 75 cents. per ton. There are immense fields or bogs of peat in this district, and much attention has been given towards its fit preparation as a substitute for coal in the manufacture of pig-iron and for charcoal steel. Some samples of steel made by the use of peat were recently submitted to the inspection of steel manufacturers in Pittsburg, who reported that in quality and texture they were fully equal to any steel made with charcoal This fact is of great importance, and may tend to a revolution in the present process of manufacture. For making Bessemer steel no ores have yet been found in this country that possess the superior qualities of the specular ores of Lake Superior, and for this purpose these ores must always be held in high esteem. Much thought has been given recently by the iron and steel manufacturers to a new steel made by a manufacturing company of Chicago; several cold chisels for use in the mines, after trial, have been found to give better satisfaction than the tools made by the celebrated manufacturers in Pittsburg. The new steel is harder and finer in texture, and will wear better than any previously in use. It is of great value in cutting up the hard jasper-quartz and flint rocks that are met with in working the veins of ore in the mines.

We expected to see openings and galleries at the mines at Marquette similar to those in Pennsylvania, and were much surprised to find that the ore lay in such huge veins and outcroppings that it could be taken out as quarrymen take out sandstone or slate from the quarries in the East. The mines present the appearance of a large pit of 100 to 200 feet in depth, and of a circumference nearly equal to that of half an acre. At different points the veins are worked at an angle of 45 degrees from the bottom level, and the vein thoroughly explored from the surface of the pit to the bottom. The veins vary in size from three feet in width to 100 feet or more. At the Republic Mine we saw the miners working at the side of a hill that seemed to contain nothing but solid, pure ore, and the ore was taken out as fast as the picks could bring it to the ground. Three men's work at this mine represented for one day 20 tons of ore, dug, broken, and carted away to the stock-piles near the railroad track. The Republic Mine was opened last October, and has already produced 90,000 tons of ore. The unmined ore is believed to amount to millions of tons. The owners were offered for the property, before a pick was used in exploring it, 2,000,000 dols. by some iron manufacturers of Cleveland and Pittsburgh. In the richness of the veins, their extent, and the ease with which the ore is taken from the hills, the Republic Mine is a sight worth seeing. John Stewart, Moses Taylor, and other New York capitalists are largely interested in the iron property of this district.

The mines are surface mines generally, and are worked from the s[illegible]; but one or two mines are underground mines, of which the Champion is the best example. Here they take out the ore in drifts and breasts on different levels, leaving from 20 to 30 feet of substance between the levels. The ore is raised in ships through the shafts, the hoisting-cable for all of which is driven by the same engine. This mine is worked upon the same principle as that commonly followed in the coal mines of Pennsylvania.

The veins of ore run usually from east to west, and the mines are situated from five miles to sixty miles back from the town. The ore is brought to the docks on the railroad track in cars especially adapted for the purpose, that run out on a wooden tramway 50 feet above water-mark, when the ore is dumped into wooden pockets made expressly for loading the vessels and for storing in readiness for ships' delivery. One wooden pocket holds about 60 tons of ore; the Cleveland Iron Company's docks, this year, with their improvements, will hold full 5,000 tons of ore in pocket at once, and will allow six vessels to load at the same time. The railroad company also owns docks of almost equal capacity, the cost of which was some 400,000 dols. The railroad is making large returns of earnings from tariff on transportation of the ores, and from time to time it builds, at its own expence, side-tracks ten miles in length to the new mines, for farther development and speedy delivery.

The iron ore of Lake Superior costs about six dols a ton to mine and deliver at the lake ports; it is sold at 12 dols. to 12½ dols. per ton delivered at the ports; the profit is, therefore, equal to six dols. per ton net. This business pays better than gold or silver mining, and is adding millions to the already great wealth of some of the residents of Marquette.

It is impossible, of course, to predict the prosperity of Marquette ten years hence, or of the magnitude of this iron mining that is even now in its infancy. One railway now serves for communication between Chicago and this place. Still two additional roads are in process of construction from Detroit to Mackinaw, and thence to Marquette; the State has appropriated lands, and the telegraph poles are already in position fo. the distance of 50 miles. Marquette seems to have a great future near at hand. The following shows the production of ore of some of the largest mines during the year 1872:—Lake Superior, 185,070 tons; Cleveland, 152,607 tons; Jackson, 118,843 tons; New York, 68,950 tons; Champion 68,405 tons, Washington, 38,841 tons; Barnum, 38,381 tons; Cascade, 35,069 tons; Lake Angeline, 35,221 tons.

AMERICAN LIGHTHOUSES.

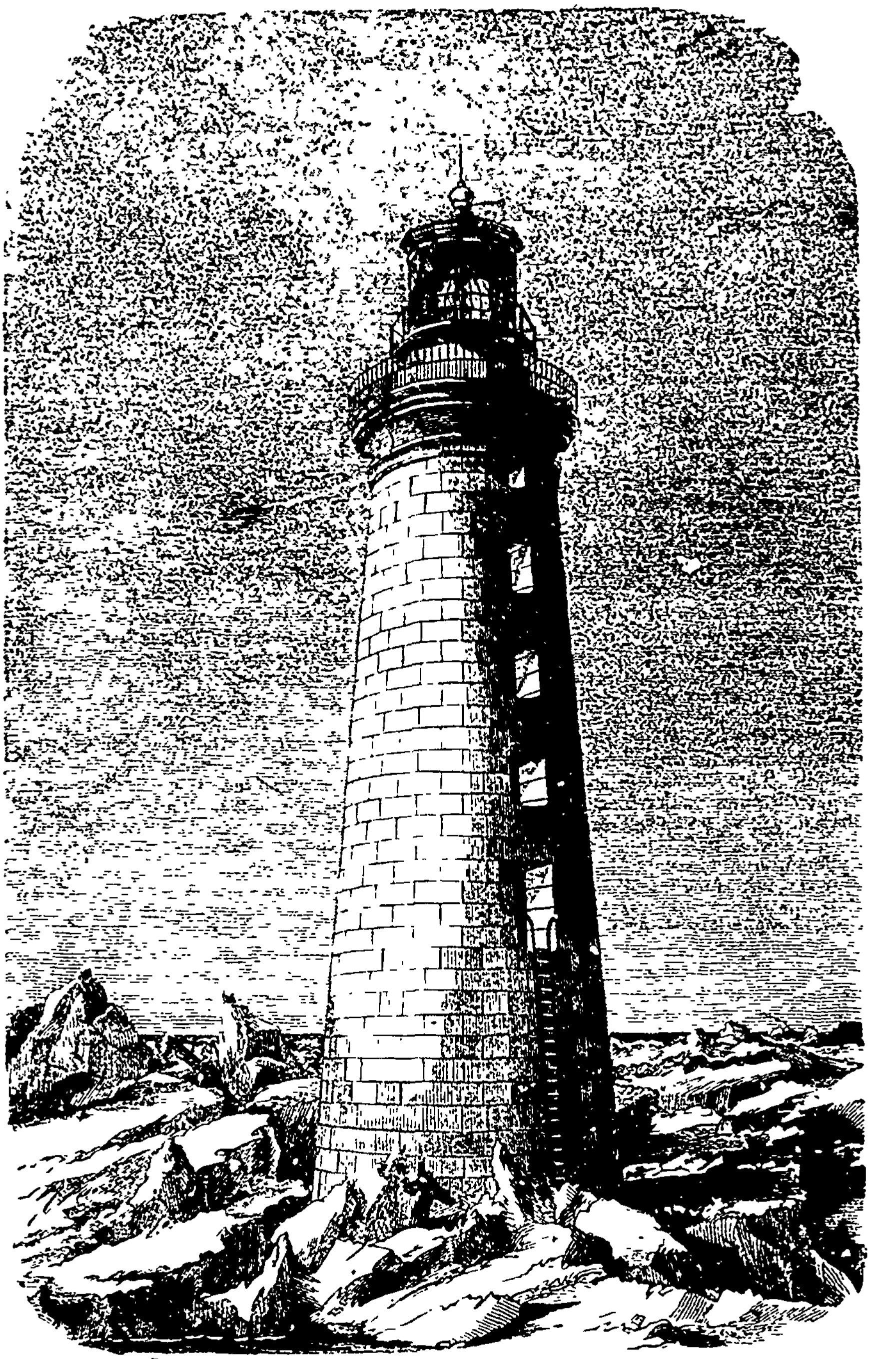
A short time since (*vide* page 203 of our last number), we illustrated two types of recent American lighthouses, and we now give on pages 230 and 231 views of two others, both connected with the lighting of the great lakes. The first of these, namely, that erected on the shores of Lake Erie at Cleveland, Ohio, requires no special description; but we illustrate it merely on account of its architectural features. The other lighthouse, namely, that at Spectacle Reef, Lake Huron, is of special interest on account of the mode adopted in establishing the foundations. We are indebted to the last received report of the Lighthouse Board of the United States for the following interesting account of the operations:

At the date of the last annual report (July 1, 1871), the crib 92 ft. square, with a central opening of 48 ft. square to receive the cofferdam which was to form the pier of protection, as well as a landing place for materials during the building of the lighthouse, was in course of construction at Scammon's Harbour. The original intention was to put the crib in position in four sections, but upon further consideration it was decided to attempt placing it as a whole upon the reef, which was successfully accomplished, as is detailed hereafter.

In order to get accurate soundings to guide in shaping the bottom of the crib, and to fix with a degree of certainty the position of these soundings and that to be occupied by the crib, the following method was pursued: Four temporary cribs, each 15 ft. by 25 ft, of round timber, were placed in from 8 ft. to 10 ft of water, in a line corresponding with the proposed eastern face of the pier of protection, and filled to the level of the water with ballast stone. These four cribs were then decked over and connected together. Upon the pier thus formed about seventy cords of ballast stone were placed ready at the proper time to be thrown into the crib forming the pier of protection. The lower two complete courses of the pier of protection, having been fastened together by screw bolts, forming a raft, constituting a ground plan of the pier of protection, were then towed from the harbour where they were framed to the reef, and moored directly over the position to be occupied by the finished pier. Its position was marked upon the temporary pier referred to above, and soundings taken at intervals of 2 ft. along each timber in the raft, thus obtaining accurate contours of the surface of the reef within the limits of these timbers. The raft was then towed back to the harbour, hauled out upon ways, and by means of wedges of timber the bottom was made to conform to the surface of the reef. The raft, now become the bottom of the pier of protection, was then launched, and additional courses of timber built upon it, until its draught of water was just sufficient to permit its being floated into position on the reef, at which time it was estimated that the top of the pier would be 1 ft. out of water.

The depth of water on the reef at the points to be occupied by the four corners of the pier of protection was found to be as follows: At north-east corner, 10 ft. 6 in.; at north-west corner, 13 ft.; at south-west corner, 14 ft. 6 in.; and at south-east corner, 9 ft. 6 in.; the position to be occupied by the pier of protection having been so chosen that the sides would correspond to the cardinal points of the compass. Mean while five barges at the harbour had been loaded with ballast stone, making together with those on the temporary pier at the reef, 290 cords (about 1800 tons) at command, with which to load the pier of protection and secure it to the reef as soon as it should be placed in position.

On the evening of the 18th of July, 1871, everything being in readiness, and the wind, which had been blowing freshly from the north west for three days previously, having somewhat moderated, at 8 p.m. the tugs Champion (screw propeller) and Magnet (side wheel) took hold of the immense crib and started to tow it to the reef, 15 miles distant, followed by the Warrington (screw propeller), having in tow the schooner Belle (the two having on board a working force of 140 men), the tug Stranger (screw propeller) with barges Ritchie and Emerald, and the tug Hand with two scows of the Lighthouse Establishment. The barge Table Rock, with fifty cords of stone on board, was left in reserve at the harbour. The con.



LIGHTHOUSE AT SPECTACLE REEF, LAKE HURON.

struction scow, with tools, &c., on board, was towed with the crib. At 2 a.m. next morning, six hours after starting, the fleet hove to off the reef awaiting daylight and the abatement of the wind, which had again freshened up. At 6½ a.m., it having moderated, the pier, with considerable difficulty, was placed in position, and after being secured to the temporary pier and the moorings previously set for the purpose, all hands went to work throwing the ballast stone into the compartments, and by 4 p.m. succeeded in getting into it about 200 cords (1200 tons). By this time the winds was blowing freshly and the sea running so high as to make it necessary to stop work for the time, but early next morning all the reserve stone was put into the compartments.

The tugs Magnet and Stranger were discharged as soon as the pier was in position, but for fear of accident the Champion (a steamer of great power) was retained until all the stone was in place, when she was discharged, and started for Detroit with the barges Ritchie and Emerald in tow. The Table Rock was retained in service until the 30th July, when she was dispensed with After the pier was in position the schooner Belle was moored on the reef to serve as quarters for the working force, which proceeded to build up the pier to the required height above water (12 ft.). The Warrington having gone to Detroit to receive a new boiler, the tug Hand was retained to tow the scows carrying the ballast stone used in completing the filling of the compartments, until the return of the Warrington on the 12th of September, when she, too, was discharged. By this time the pier had been built up to its full height, and by the 20th of September quarters for the workmen had been completed upon it, which were at once occupied, and the Belle returned to the harbour. By means of a submarine diver the bed rock within the opening of the pier was then cleared off, and the work of constructing the cofferdam was taken in hand. The cofferdam itself consisted of a hollow cylinder, 41 ft. in diameter, composed of wooden staves, each 4 in. by 6 in. and 15 ft. long. The cylinder was braced and trussed internally, and hooped with iron externally, so as to give it the requisite strength. It was put together at the surface of the water, and when complete was lowered into position on the bed rock by means of iron screws. As soon as it rested on the rock (which was quite irregular in contour), each stave was driven down so as to fit as closely as it would admit, and a diver filled all openings between its lower end and the rock with Portland cement. A loosely twisted rope of oakum was then pressed close down into the exterior angle between the cofferdam and rock, and outside of this a larger rope made of hay. The pumping machinery having meanwhile been placed in readiness, the cofferdam was pumped dry, and on the same day (14th October) a force of stone-cutters descended to the bottom and commenced the work of levelling off the bed rock, and preparing it to receive the first course of masonry. The bed rock was found to consist of dolomitic limestone (confirming the previous examinations), highest on the western side toward the deepest water), and sloping gradually toward the eastern. In order to make a level bed for the first course of masonry, it was necessary to cut down about 2 ft. on the highest side, involving a large amount of hard labour, rendered more difficult by the water forcing its way up through seams in the rock. But the work was finally accomplished, the bed being as carefully cut and levelled as any of the courses of masonry. The first course of masonry was then set, completing it on the 27th of October. While setting this course much trouble was caused by the water, already referred to as forcing its way up through seams in the rock, which attacked the mortar bed. For this reason water was let into the dam every evening (and pumped out next morning) to give the mortar time to harden during the night. This mortar was composed of equal parts of Portland cement and screened siliceous sand. Specimens of it obtained the following spring, after being in place under water for seven months, were quite as hard or harder than either the bed rock or the stone used in building the tower.

The weather having now become very boisterous, with frequent snow squalls, often interrupting the work, and the setting of any additional stone requiring the removal of a portion of the most important of the interior braces of the cofferdam, it was deemed prudent to close the work for the season. This, too, would give ample time for the hardening of the mortar used in bedding the stone, and in the concrete used for filling cavities in the bed rock, as well as the space between the outside of the first course and the cofferdam (which was solidly filled with concrete to the top of the first course). Therefore the cofferdam was allowed to fill with water, the process being hastened by boring holes through it to admit the water, and it was secured to prevent its being lifted by the ice during the winter. The machinery was laid up, and on the last of October all the working force, except two men, were removed. These two men were left to attend to the fourth order light, which had been established on top of the men's quarters, and the fog signal, consisting of a whistle attached to one of the steam boilers. At the close of navigation they were taken off the pier by the lighthouse tender Haze.

The degree of success of this novel cofferdam may be inferred from the fact that although prepared with pumps of an aggregate capacity of 5000 gallons per minute, not more than a capacity of 700 gallons was used, except when emptying the cofferdam, and then only to expedite the work. Once emptied, a small proportion of this capacity was ample to keep the cofferdam free from water, and this at a depth of 12 ft. of water, on rock, at a distance of nearly 11 miles from the nearest land. Every person connected with the work may well feel a just pride in its success. All the stone which had been delivered at the harbour, consisting of the first five courses (each course 2 ft. thick), having been cut by this time, the work there was also closed.

LIGHTHOUSE AT CLEVELAND, OHIO, LAKE ERIE.

The season opened a month later in 1872 than in 1871, consequently work was not resumed at the harbour until the 3rd of May, and upon the reef on the 28th of the same month. On the 13th of May the ice in the cofferdam was still a compact mass, of some feet in thickness. Masses of ice still lay on top of the pier itself. As soon as anything could be done, the ice still remaining was cleared out of the cofferdam, the machinery put in order, the braces removed from the interior of the cofferdam, and the work of setting additional courses begun. This has continued without interruption to the present time, when the masonry is well above the water, and going on at such a rate that one entire course is set, drilled, and bolted complete every three days. If this continues, the tower will have reached a height of at least 40 ft. above the lake level before the close of the season.

It is greatly to be regretted that in a work of such difficulty and importance it was not found practicable to use granite. The first contractor to furnish stone agreed to supply granite from a quarry at Duluth, Minnesota. After a trifling effort to quarry the stone, he utterly failed, and he abandoned the contract. It was then so late in the season that the engineer was compelled either to stop operations or to go into the open market and purchase such stone as he could get. The best available was the Marblehead limestone from the vicinity of Sandusky, Ohio, and this was used. In February, 1872, proposals for the remaining stone were received, and of these the granite offered was at such a price as to exclude it, and no other suitable stone except the Marblehead limestone being offered, he was again driven to use it.

We may add that it was expected that the entire work would be completed last season; but we have not yet heard whether this was successfully accomplished.—*Engineering.*

BOILER BURSTING EXPERIMENTS.

In our last we stated that the American Government had undertaken a series of experiments on steam boilers and we promised to give the results of these experiments to our readers. The following succinct account is from the *Nautical Magazine*:—

Mr. Francis B. Stevens, of Hoboken, New Jersey, before September, 1871, had made several experiments on the strength and proper management of boilers belonging to the United Railroad Companies of New Jersey. So valuable did the results appear, that the executive committee of the United Companies, on the 11th September, 1871, voted $10,000 for the continuation of the experiments.

On the 22nd of November, the bursting experiments commenced; Mr. Stevens invited the principal steam engineers of the United States to attend. The United States Government sent three of their navy engineers to report, and the inspector-general of boilers and other boiler inspectors, professors of engineering, mechanical engineers, &c., were also among the skilled observers.

The first experiment was on a boiler that had been in use for thirteen years, and been removed as worn out. The shell was 28 ft. long; the body 6 ft. 6 in. in diameter, and the front portion, containing the furnaces, was rectangular below, and semi circular above, and this was 7 ft. 8 in. in length; so that the length of the cylindrical part was 20 ft. 4 in. The steam chest was 4 ft. in diameter, and 10 ft. 5 in high. The shell was of No. 3 gauge—that is, .26 in. thick, and single rivetted. At 112 lb. per square inch hydraulic pressure, some of the stays in the flat part gave way; but the circular part of the shell and the semi-circular top of the front stood that pressure. When subjected to steam pressure it was found that at 98 lb. pressure, the steam escaped from the seam joining the steam chest to the shell, as fast as it was made, and a bursting pressure could not be obtained.

The leak produced, pointed to the weak place in the boiler — the opening in the shell at the steam drum; and boiler inspectors should be careful to attend to that in fixing pressures.

The failure of some of the stays, in this and in all similar experiments, indicates the danger produced by constructing a boiler so that the failure of any one stay would be fatal to the whole structure. Stays are seldom fixed to take the strain equally. We have found in boilers in use stays so badly fitted, that some of them would have ⅜ in. end play when the adjacent stays were taking the strain. It is to this unequal tension of adjacent stays that we must attribute the failure of stays at a pressure much below that due to their united section, if the strain had been equally divided over all the stays. It is also on this account that the Board of Trade surveyors allow a higher strain per square inch of metal in the section of a boiler shell than per square inch of stay section.

By the hydraulic test, the shell was subjected to a strain of 16,600 lb per square inch gross section of shell. Taking the effective section of the shell at 67 per cent. of the solid plate, according to Fairbairn, for single rivetted crossed seams, the strain per square inch of the iron was then 25,000 lb. We have here an illustration of the effect of high hydraulic testing; a boiler, afte being thirteen years in use, is subjected to a strain of 25,000 lb. per square inch of iron in the shell, apparently without injuring it.

That boiler, if in a passenger steamer in this country, would, when new, be allowed a pressure not exceeding 30 lb. per square inch. After thirteen years' service, it stands nearly four times that pressure, hydraulic, and they fail to burst it at over three times the pressure by steam The public ought, therefore, to have perfect confidence in our Board of Trade boiler supervision.

The next experiment was upon a box, representing a flat water space, or leg of a boiler that had recently exploded in the steamer "Westfield," at New York. The box was 6 ft. 4 in. long by 4 ft. wide over all. The plates were $\frac{5}{16}$ in. thick, and they were stayed together by screwed stays, 1⅛ in. in diameter, and the ends of the stays were very slightly rivetted over, only to make them tight, not to act as heads. The stays were apart 8¾ in. by 9⅛ in. This box was burst by steam pressure at 165 lb. per square inch. Not a stay was broken and the threads were not stripped on either the plates or the stays. The slight rivetting was broken off every stay, and the stays were drawn through the holes, the plate, by stretching, having enlarged the holes. Had the stays been provided with nuts, the box would have borne a much greater pressure. Comparing this result with Fairbairn's experiments on a similar box, we find that the bursting pressures are equal to a little more than eight times the following:

Working pressure per square inch:

$$= \frac{40{,}000 \times \text{diam. of stay} \times \text{thickness of plate.}}{\text{Cube of distance between stays.}}$$

These dimensions are to be taken in inches; the diameter of stay is taken over the threads.

There is considerable doubt as to the proper form of the rule in this case, and the above is given subject to correction by further experiments. It is meant for flat surfaces, and for screwed stays without rivetted heads. This is the resistance to drawing through the screwed hole; and, quite irrespective of this rule, the strain upon any stay should never be more than that due to its least section.

On the 23rd of November, the day following that on which the above experiments were made, a boiler, that had been twenty-five years in use in the steamer "Bordentown," was subjected to bursting pressure. The boiler was rectangular, 15 ft. 5 in. length, 12 ft. 2 in. width, 8 ft. 6 in. height, exclusive of steam dome The stays were unequally distributed; the section of each stay was 1 square inch, and the space to be supported by each stay was in some places 228 square inches, and in other 336 square inches. Just before the boiler had been removed from the steamer, the inspector's certificate allowed a pressure of 30 lb. per square inch, or equal to 10,000 lb per square inch upon some of the stays. That is just double the strain that is allowed by our Board of Trade surveyors. The boiler burst at 53½ lb. pressure per square inch. From the pressure of 30 lb., at which in had been in use, the steam pressure increased in 11 minutes to 50 lb., at which pressure a loud report was heard, attributed to the breaking of some of the stays. Two minutes afterwards the boiler exploded with terrific violence. The steam drum, with a portion of the shell attaching to it, forming a mass of about 3 tons in weight, were hurled to a great height in the air, and fell at about 450 ft. from the original position of the boiler. Almost the whole boielr was literally torn into shreds, which were scattered far and wide. The report of the experiments, from which we have gathered these particulars, describes minutely the great destruction produced. The stays in the upper part of the boiler had broken in the welds; those screwed into the water space plates had drawn through the holes in the plates, as in the preceding experiment. There was no flashing of the water into steam, for for ground and grass and shrubs all round were found drenched with the water. The water gauge was examined only seven minutes before the explosion, and showed 15 in. of water above to top of the tubes.

We have said our surveyors would have given just half the pressure that was allowed, and some of our readers may consider that to be an unnecessary strictness. But the result justifies their practice; 15 lb. is more than one-fourth of the pressure at which the boilers exploded. Only thirteen minutes between practice and explosion is far too narrow a margin, where boilers have only one safety valve, and that may not have been opened for weeks in succession, and may be struck in its seat. The age of the shell of the boiler did not affect the result; the explosion was due to the failure of the stays, and these had been put in order just before the experiments.

The importance of these proceedings was so impressed upon the minds of those who were present, that they brought the subject before Congress, and there has been voted the sum of $100,000 to carry out similar experiments on a larger scale. The Commission appointed to conduct the experiments has just made a beginning. It is not unfairly to anticipate the report of the Commissioners, but to stir up the engineers in this country to similar activity, and to make known the character of these experiments, and create an interest in them that we give the following outline of what has been accomplished, during the last month.

A small vertical boiler, tested by hydraulic pressure to 182 lb., was fitted with a safety valve, loaded at 50 lb. pressure. It was intended to destroy this boiler if possible, by allowing the water to become so low as to permit the crown sheet to be overheated, and when the temperature of the steam had increased to 1000 deg to inject water. Unfortunately, the fire was urged too much, and one of the vertical tubes collapsed before the water was injected, and when the pyrometer showed only 750 deg. The pressure at the moment of rupture was 54 lb. The contents of the boiler were discharged without disturbing the position of the boiler.

The next experiment was made upon a large marine boiler, the shell about 8 ft. in diameter, the plates ·26 in thick. This boiler had been six years in use, and was tested to 44 lb hydraulic the day before the experiment. There was a safety valve on the boiler, set to blow at 55 lb., but it did not open until the pressure was about 72 lb.; it had struck in its seat. A little before the safety valve opened, the pressure being then 70 lb, two of the longitudinal seams opened. There had been a crack there in some places one-third of the thickness of the plate, and a soft patch had been put on the inside, a plate about 6 in wide, held by thirteen bolts on each side of the seam. The rupture followed the edge of the lap until it came to the cross seams. The plates were 32 in. wide, and the edges opened 1¾ in. at the middle, and yet the boiler did not burst. There was only the width of one plate between these two ruptures, so that over 10 ft. of the length of the boiler there was only 32 in of plate and the soft patches remaining. The patches could not count for much after the plates had parted 1¼ in. at the middle.

These ruptured plates will be removed and the boiler repaired, and it will then be submitted to a bursting pressure. These experiments were conducted at Sandyhook; the weather had become so cold that the pipes were freezing; the Commissioners, therefore, remove to Pittsburg. Three boilers, the ordinary two-flue boilers of the Western steamboats, were there in place for experiments.

These boilers were all 25 ft long, 50 in. diameter, with two flues 14 in diameter. One of these boilers, registered as No. 3, had its shell 36 in., and the flue 3 in. thick; it was single-rivetted. Four attempts were made to burst it, but when the pressure reached about 225 lb. per square inch, the seams leaked sufficient steam to prevent the pressure increasing. The strength of the boiler was its circular shell, and in no trial have they yet succeeded in bursting a circular shell by a gradually increasing pressure of steam. This is an important fact, for the circular boiler is being everywhere adopted in our steamers. The working pressure allowed on such a boiler in our passage steamers would be about 25 lb. per square inch; but, it must be remembered, that the American iron is generally better than ours.

No. 1 boiler was of the same dimensions as the last, but the shell and the flues were the same thickness, ·26 in. The shell was double-rivetted, the rivets zig-zag. At the first experiment with this boiler the pressure reached 360 lb. on the square inch, but with no other effect than simply to cause the seams to leak. On the 12nd ult., the flues were collapsed by sheer pressure, one of them vertically, the other horizontally, showing that it was not from being short of water. The flues tore from both the ends he boilers, discharging the contents from both ends, not disturbing the boiler shell in the slightest degree. The effect is described as terrifying; report not loud, but the whole atmosphere darkened by the cloud of steam; the water driven to a distance of over 350 ft., and the greatest width of its path, or "swatch," over 150 ft., the chimney, flue ends, timber, &c., sent to various distances from 80 to 200 ft. and what height is not know. The condensed steam fell in the faces of the spectators at a distance of from 60 to 110 yards at right angles to the line of discharge. The report was not loud or sharp; the appearance of the expulsion of water and steam was very much like that of a piece of ordnance when fired. The concussion of the atmosphere was felt 200 yards away, and before the report was heard. Fortunately no one was seriously injured, but one man was scalded, and his and another's narrow escape is a caution.

The boiler was situated in a sort of ravine, between two banks about 150 ft. in height. There was a bomb-proof erection three feet from the back end of the boiler. The steam gauges were placed in the bomb-proof. The spectators were down in the ravine, scattered about, at from 80 to 110 yards from the boiler, at right angles to the boiler, the boiler lying across the ravine. They had a longitudinal view of the boiler, with its chimney and firing space to the right, and the bomb-proof to the left; the door of the bomb-proof was at the right-hand corner, towards them, but hidden by a projecting bank of earth, the bank of earth being continued all round the base of the bomb-proof. These two men had been at the back of this bank waiting for the explosion; they had waited so long that they thought it was another miss, and so left that position and coolly walked round to the boiler and examined it, and then they tried the water-gauge valves. They found the pressure was so great that they could not open them. They then hurried into the bomb-proof and read three gauges there—one at 400 lb., one at 450 lb., and one at 500 lb. Seeing a number of the spectators following their example, one of the men stood in the door of the bomb-proof, and made gestures to them not to approach. All the spectators were drawing nearer, believing the experiment had failed. While he was in this position, he having just turned to shut the door, the collapse took place. He was driven back by the concussion of the atmosphere to the wall of the bomb-proof, and, by the recoil, was thrown out of it entirely. He was scalded about the face, arms, and legs, but not severely. The other man, who was within the bomb-proof, was not injured.

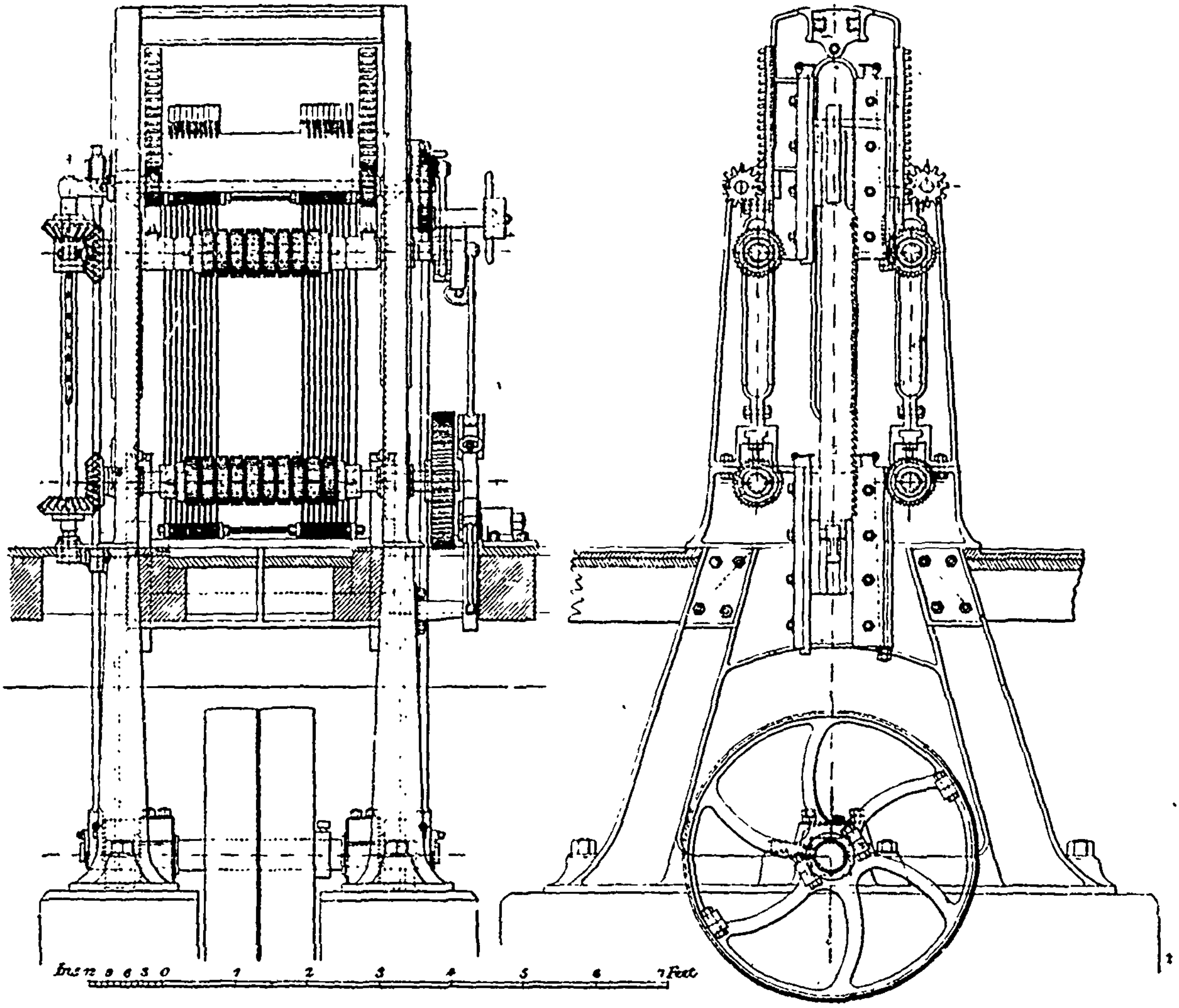
It is a fair conclusion, from these experiments, that no circular boiler was ever burst, or can ever be burst, by a gradually increasing pressure without "complaining," or giving notice of over-pressure to the engineer or those in attendance. It is not the circular shells that are dangerous, but the stayed flat surfaces, and the high-pressure circular boilers, now coming into general use, are much safer than the low-pressure boilers which preceded them.

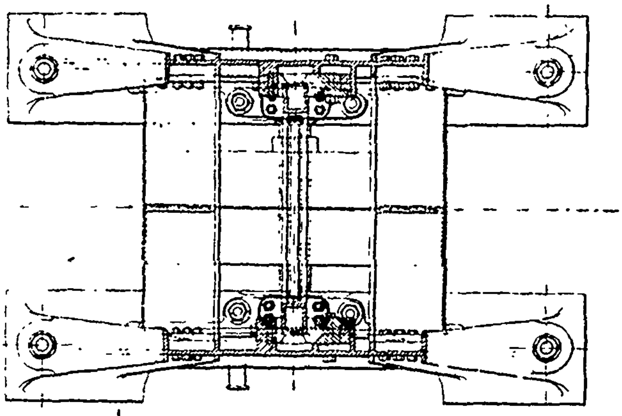
According to Fairbairn's rule, the flues of these boilers, if perfectly circular and without rings, should have collapsed at 241 lb. pressure. An average of the recording gauges, read after the experiment, showed only 350 lb, but, according to statement of the two men who were within the bomb-proof, it must have been much higher. The report of the Commissioners will no doubt explain this.

This is the first exposion of a boiler at such a high pressure that has been witnessed by spectators watching the experiment. The explosion described in the first part of this article was at only 53 lb. pressure.

The boiler experiments have been stopped until the spring of next year. During the winter the Commission will conduct experiments on safety valves. These are of the same character as those now being carried out by the editor of this magazine. In a special circular, sent out by the President of the Commission, D.D Smith, Esq., the object of the safety valve experiments is thus set forth: "To determine the best form, construction, and dimensions of safety valves, so that they may be what their name denotes, and operate automatically, so to relieve the boiler that it will be impossible, so long as the valve remains unobstructed, to explode or burst a boiler by gradual accumulation of steam when in ordinary use."

Birds Nest in a Railroad Car.—A German paper gives the following:—Even the little members of the feathered creation, generally so shy, are becoming familiar with our noisy industries. Indeed, they begin to take rides upon the railroads. A pair of red-breasts recently made their home, built their nest, brooded and fed their young, under a gravel-car, constantly plying between Duren and Capallen Gilverath. The little creatures were regularly taken back and forth, and by this their range for food was considerably enlarged. Notwithstanding all the busy noise over and around them, they were much safer than in the most peaceful inclosure within the reach of wicked boys. A nest of young wagtails have recently left their nest, where they had been raised, under the plate of a switch here. Twenty-five regular trains, besides extra trains, went daily back and forth over them, yet the shy little family did not seem to be in the least disturbed.





VERTICAL LOG FRAME.

We illustrate, on this, and the opposite page, a saw frame for cutting logs, which may be taken as the type of these machines as made by the leading manufacturers in Austria and Germany, and of which many examples were found in the Machinery Hall of the Vienna Exhibition, although Messrs. Wannieck & Co., of Brunn, the makers of the machine we illustrate, did not exhibit one.

The form which has recently been introduced in this country by the principal makers of wood-working machinery, under the name of the portable log frame, is as yet unknown as an article of manufacture on the Continent, and, as will be seen from the accompanying engravings, the log frame is mounted upon heavy foundations. The machine consists of two pairs of standards, placed far enough apart to admit of the saw blades being carried between them. Near the bottom of these standards a shaft runs in suitable bearings, carrying a fast and loose pulley, from which motion is transferred to the pairs of cranks at the ends of the shaft, from which connecting rods ascend, and take hold of the cross head to which the upper ends of the blades are fastened. This, as well as the corresponding lower cross head, slide in suitable guides formed in the vertical standards, as shown in the section on the present page.

The same view also shows the position of the four serrated rollers, between which the timber is fed into the saws, and all of which are driven, a speciality in these Continental log frames. It will be seen that the lower pair of rollers run in fixed bearings, and the shafts on which they are mounted carry at one end spur wheels gearing into a common pinion fast on the silent feed wheel shaft. Motion to this is given in the mode shown in the side elevation of the machine, from a pair of levers connected with the top cross head of one of the side connecting rods. A means of adjusting the rate of feed is provided in the screw and regulating hand wheel. The opposite end of each of the lower feed rollers carries a bevel wheel that gears into a corresponding pinion mounted on a vertical shaft, the upper part of which is provided with a keyway, in which slides a block carrying a similar pinion gearing into a bevel wheel on the end of the shaft of the upper feed roller. It will thus be evident that in whatever position this latter may be, it will be always driven from the lower roller. As will be seen from the side elevation and section, these upper rollers have bearings that slide in suitable openings in the frame, and they are also attached to brackets carrying small toothed wheels, engaging in vertical racks bolted to the frames. By means of suitable gearing on one side of the machine, the upper rollers may be raised or lowered to any desired position, and detents are provided to hold them at any point.

With reference to the tensile strength of Lake Superior iron, the Detroit *Free Press* makes a record of the following experiments with iron made from Lake Superior ores, by the Wyandotte Company. A bar of railroad iron was put under the hammer, and bent, twisted, and tortured until no resemblance of the original bar remained. An effort was then made to hammer the head of the rail from the flange, but it proved unsuccessful. It must be understood the experiments were made when the iron was cold. The experiments with the chains were equally satisfactory and showed a great power of resistance. A Bessemer steel chain, 1¼ in. in thickness, withstood a test of 121,850 pounds to the square inch. The following comparisons will show the relative tensility of Lake Superior and English iron, the trials having been made by the use of the testing machine made by Riehle Brothers, of Philadelphia, which is that used for all tests in which the American Government is concerned. A one-fourth inch chain of American (Lake Superior) iron withstood a strain of 101,750 pounds, while a chain of English iron of the same size broke at a test of 76,500 pounds. A five-eighth inch chain, American, 24,875 pounds; English, 16,000 pounds. A three-fourth inch chain, American, 38,000 pounds; English, 26,000. A one-half inch chain, American, 15,825 pounds; English, 8,500, and a seven-sixteenth inch chain, American, 10,250 pounds; English, 5,750.

Velocity of the Wind.—Light air, 1 mile; light breeze, 3 miles; gentle breeze, 10 miles; moderate breeze, 15 miles; fresh breeze, 20 miles; strong breeze, 35 miles; moderate gale, 30 miles; fresh gale, 45 miles, strong gale, 50 miles; heavy gale, 70 miles; storm, 80 miles; hurricane, 100 miles and upwards per hour

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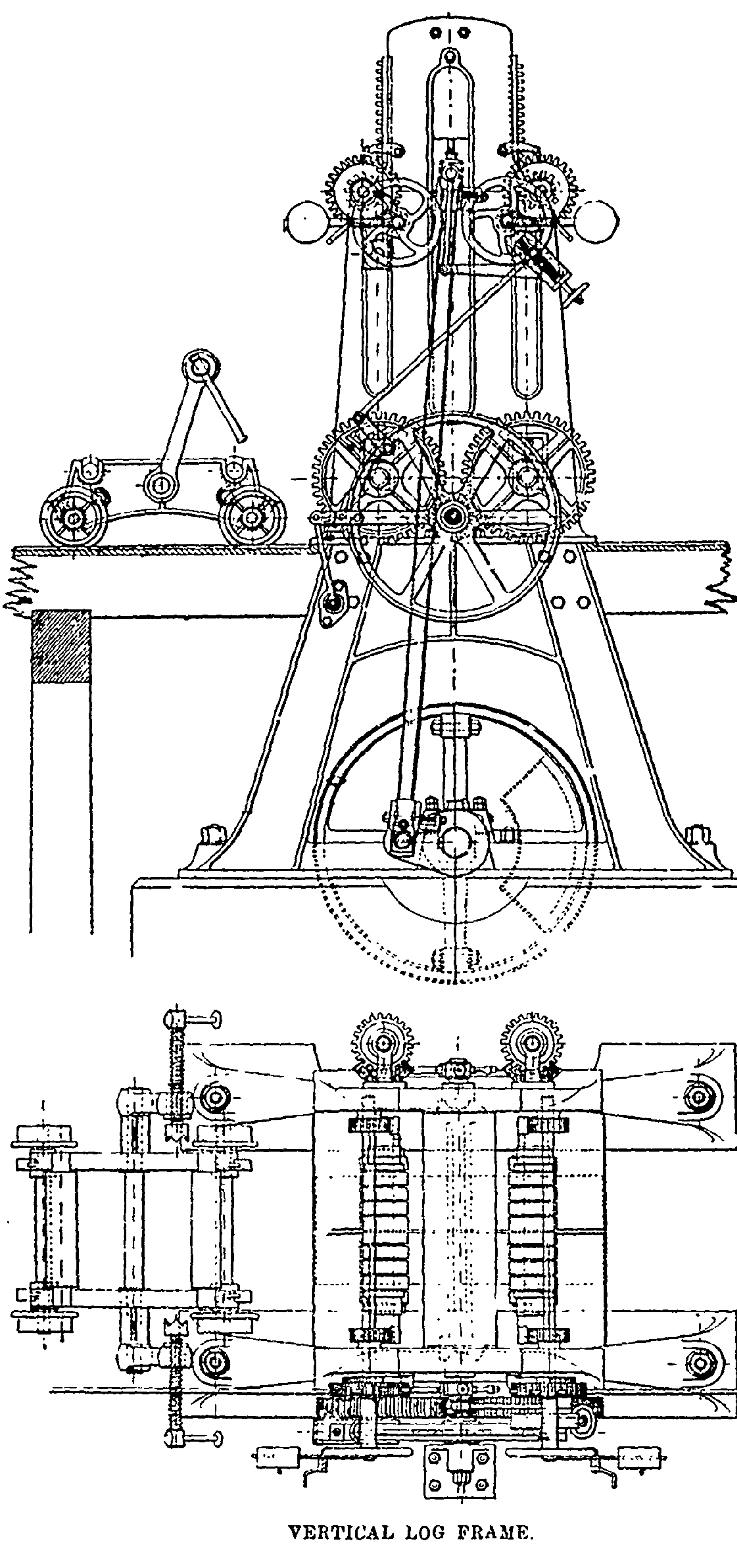
In Germany alone the manufacture of beet root sugar from 1400 tons in 1837, had expanded to 263,000 tons in 1871. There was also an increase of 150 per cent. in the amount of sugar consumed per head between these dates.



VERTICAL LOG FRAME.

THE EARLY HISTORY OF THE SEWING MACHINE.

The sewing-machine is now so common an appendage to most houses that it seems almost difficult to believe that practically its employment only dates back some twenty years. In the 1851 Exhibition there was not a single machine of the sort now used. Yet, recent as the invention is, there is a great deal of uncertainty as to the person to whom the credit for it is due. Naturally enough, in such a matter, the possessors of rival systems are anxious to claim priority each for his own method; and the question, "Who invented sewing-machines?" has been argued with considerable bitterness both here and in America. Quite recently the matter has—for the present, at least—been decided, so far as relates to the first maker of a sewing-machine. A member of a firm of American sewing-machine manufacturers lighted on an English patent, granted to one Thomas Saint, in 1790, in the specification of which a sewing-machine was described. The patent was granted for a method of making boots and shoes, and the machine was intended for use in that manufacture. So far far as can be judged from a rather meagre description and drawing, the machine worked the chain-stitch with a single thread. An awl and a needle were mounted parallel to one another in a position similar to that now occupied by the needle in modern sewing machines, and the needle was apparently notched at the end, to receive the thread and push it through a hole formed by the awl at the stitch preceding. There was a catch under the fabric, which held the loop of the thread when driven down by the needle, until the needle made a second stitch through the loop. There was also a feed-motion for carrying the articles to be sewn through the machine on a slide to which it was attached; and it may be remarked that such a device would be better suited for stitching small articles, like boots and shoes, than for producing a seam of any length. It was worked by a winch-handle on a spindle on which were tappets that engaged with pieces on the sliding-arm carrying the needle Such appears to have been the machine, which there is every reason to suppose may have worked practically enough. That its existence should never have been discovered before is decidedly very strange, considering the numerous and extensive searches that have been made through the records of the Patent Office in connection with this subject. Had the index referring to the "old law" specification (before the Patent Law Amendment Act, 1852) been prepared on the system now applied to the current indexes, of course such an invention could not remain hidden; and the incident offers another argument in favor of the speedy preparation of a new index. Such a work has, it is believed, been long under consideration, and the sooner it is actively taken up the better.

To say that such an invention as this could invalidat any of the patents for the sewing machines now in use is certainly prepo[illegible]ous; but it is very curious that this Thomas Saint should have gone so near the mark, and that his invention should have fallen still-born at the time, to be revived, in many of its principal features, nearly a century later.

But Saint's is not the only old sewing machine that has escaped the notice of most writers on the subject. There exists an early French patent, taken out apparently by two Englishmen—for the names Stone and Henderson are certainly not French. In the "Description des Machines et procédés spécifiés dans les Brevets d'Invention," is given a specification bearing date February 14th, 1804, and headed by the above names. The patent was "For a new mechanical principle, intended to replace hand-work in joining the edges of pieces of all descriptions of flexible matters, and especially applicable to the making of wearing apparel." This machine was intended to imitate hand-sewing, and in it an ordinary needle with an eye at the end was used, and this was worked by two pair of jaws, one at each side of the fabric, which passed the needle from one to the other, turning it over every time to bring the point against the fabric. Only a needleful of thread at a time was employed, and the needle was drawn to a constantly diminishing distance every stitch, to allow for the decreased length of the thread. When the thread was used up the machine had to be stopped and a freshly filled needle introduced. If required, more than one needle could be employed at the same time. It seems as if the fabric was to be automatically fed through the machine, but whether this is so or not does not very clearly appear. In fact, spite of the fulness of the description, it is not very easy to understand the exact construction of the apparatus, though the above may serve as a brief sketch of it. The specification concludes with a description of a circular building in which a number of these machines could be arranged so as to be worked from a central vertical shaft.

Next to these, in chronological order, comes an American invention, by Adams and Dodge, of Mouncton, Vermont, who produced a sewing machine of some sort in 1818, but little is generally known of it. In the same country it appears that Walter Hunt, in 1834, made a true sewing machine, but as the history of his invention is mixed up with that of Howe's machine, it may be left for the present, after the fact is mentioned that such a machine was really made, for of this there seems no doubt. In England we do not find that any true sewing machines were made in the early part of the century. There are, indeed, several patents for embroidering machines, which with a little alteration, might certainly have been made to sew However, such an idea does not seem to have occurred to any of the inventors, and none of the machines were developed in this direction. Of them Duncan's machine (1804) is the oldest It worked the chain-stitch on the surface of the fabric, and might, of course, easily have been adapted to sew together two pieces of stuff, in the same way precisely as the single thread machines now work. There were also a good many inventions, both in this country and America, in which a "basting stitch" for running fabrics together was made. Some of these were largely used for manufacturing purposes, until the introduction of the present sewing machine. But we may leave these abortive attempts—few of which as far as it is known, ever got beyond the patent-office of the various countries—and turn to the originals of the machines now in daily use.

It appears certain that the first man to construct and bring into actual use the machine was Barthelemy Thimmonier, a poor French tailor. Of this man not very much is known for certain. He was born in 1793, at Abreste, and was the son of a journeyman tailor of Lyons. In his trade he probably found hard-work expensive and slow, and was thereby induced to try and contrive mechanical means for replacing it In the end he certainly produced a wooden machine which sewed the crotchet or chain-stitch, and worked freely This was in 1839, at St. Etienne, where Thimmonier was then living. Of his previous life next to nothing is known, but from that time his history is pretty clear. At St. Etienne the machine was seen by an engineer named Beaunier, and he persuaded Thimmonier to bring his machine to Paris. Spite of his mechanical ingenuity, the tailor seems to have been but a feeble-minded individual, and Beaunier apparently took up the matter, and did for Thimmonier and his machine far more than the latter could ever have done for himself. A firm was soon established, under the title of "Ferraud, Thimmonier, Germain, Petit, et Cie.," and a factory set up in the Rue de Sèvres, and here, in 1841, eighty wooden machines were at work on a contract for army clothing. At last the sewing machine was completed and at work. But in the same year the machines were attacked and destroyed by a mob of workpeople, and the inventor himself was obliged to leave the capital. For some years Thimmonier does not seem to have had much success with his machine, but in 1847 or 1848 he got M. Magnin, of Villefranche, to take it up. An English patent was taken out in Magnin's name in 1848, and this was eventually sold to a Manchester company. Strangely enough, this machine attracted but little notice in this country. It was exhibited at the Royal Institution, where it formed the subject of a lecture, but very little practical good seems to have resulted. In the same year (1848) another workshop was set up in Paris, but the same fate befell this attempt as the former. In the troubles of that year the machines were again destroyed. In 1851 a machine was sent to the Great Exhibition, but it arrived too late to be catalogued, and so almost entirely escaped notice. After this we do not hear of any further attempt to bring forward the machine, and the unfortunate inventor died a pauper in 1857, at Amplepuis.*

His machine worked the chain-stitch with a hooked needle, the thread was below the fabric, and the needle above it. The needle passed through the fabric, and drew a second loop through the fabric and the first loop, thus making a crotchet stitch on the top of the seam. The fabric had to be moved by

* A very full description of Thimmonier's machine will be found in Newton's *London Journal* for 1852, vol. 39, p. 317, where an interesting account of the "labor saving" machines in the 1851 Exhibition is given.

hand. The machine is said to have attained a speed of 200 stitches a minute. It is noticeable that this principle has never been further improved on for sewing machines. All existing chain-stitch machines resemble rather the old one of Saint, in having a thread carried by a needle above, and a catch below for holding the loop until the needle descends again to pass a second loop through the first, and so secure it. The ingenious rotating hook of the Wilcox and Gibbs' machine is the latest and by far the most beautiful development of this idea. This, it may be mentioned in passing, was the invention of a Virginian farmer, named Gibbs, who was led by curiosity to speculate on the subject, and hit upon the device.*

But we have not yet got to the real sewing machine of our own days. Thimmonier had practically brought out a machine, but his invention had not taken real hold upon the public, and had his efforts not been supplemented by those of a superior mechanical genius the sewing machine might yet be unknown.

It was in America, after all, that the machine, as we now know it, was first made. Elias Howe is the man with whose name the origin of the sewing machine must ever be connected. The exact amount of credit due to him it is now impossible to decide, nor, indeed, can it ever be precisely known. There are two stories about his invention, one upheld by the present possessors of the Howe machine, and the other by the rival owners of the "Singer." Naturally enough each side is prejudiced in favor of its own version, and we may safely conclude that the truth lies somewhere between the two. All that the historian can do is to try and collect the facts so far as they are not disputed. The case for each side has been stated in two able and well-written articles—one in the *Atlantic Monthly* for May 1867, and the other in the *New York Galaxy* for August, in the same year. The former gave the Howe version, and the latter that maintained by their rivals.

Elias Howe was a native of Spencer, in Massachusetts, and was born in 1819. It is stated that the idea of a sewing machine was first suggested to him in 1839 by a conversation in a Boston instrument maker's shop. For five years he worked at his invention, till at last, after trying and rejecting many plans, he hit on the double thread, one above the fabric and the other below it, the lower one to be carried through the one to be carried through the loop of the upper thread by a vibrating shuttle. In 1845 a working model of the machine was finished. In the following year an improved machine was finished and patented. Still Howe was very poor, and it was only by the help of a friend, George Fisher, who joined in partnership with him, that even this step was gained. He had no means of bringing his invention forward, and nobody seemed inclined to take it up. This induced him to bring his invention over to England, where he sold it to Mr. Thomas, a staymaker in Cheapside. An English patent was taken out in Thomas' name, in 1846, but it was found that considerable alterations were required before the machine could be considered a practical success. One of the principal of these was the feed motion, invented by Johnstone.

Such is a brief outline of the history of Howe's invention. Now comes the great question as to the originality of that invention. It seems proved beyond any reasonable doubt that, in 1834, an inventor named Walter Hunt had constructed a machine on precisely the same principles as Howe's. There was a curved needle with an eye in the point and a shuttle; in fact, the machines, were in their main points identical, but whether Hunt's was a practical working machine cannot now be said. Hunt sold his machine, and with it his patent-rights, to one George Arrowsmith, who, however, neglected to patent it, and so nothing came of it; nor did Hunt himself attempt to develope his invention. He was one of those eccentric geniuses who are always striking on new ideas and never following them up. His sewing machine was only one of a host of ingenious but undeveloped inventions, so that there is nothing strange in the fact that he should thus have forgotten what might have been a source of wealth and credit. When Howe was first bringing forward his invention, an account of this abandoned machine came into the hands of Isaac M. Singer. He looked into the matter, got hold of one of the original machines possessed by Arrowsmith, and caused Hunt to construct one on the same model. The natural issue of there being thus two rivals in the field was that there was considerable litigation, into the details of which there is no need to enter here. The end of it was that Singer agreed to pay a royalty to Howe, and thus the dispute ended.

That Howe had ever heard of Hunt's machine there is no evidence whatever to show, and it may be considered certain that the similarity of the two machines was purely accidental; indeed, the original Hunt machine is said to be in some respects superior to Howe's first apparatus, and this alone disproves any allegation of plagiarism. Looking at the matter with the fairest impartiality, it may be said that Howe was not the first man to conceive of a lockstitch machine, but he certainly was the first to bring it really before the public. After all, it is not the man who first developes an idea, but he who first turns an idea into practical use and benefit that is the real benefactor of his race. This Howe did, and in that sense he must be held the real father of the sewing machine.

One other curious fact remains, which it may be worth while to mention, and that is, that in 1844 a machine which was really a sewing machine, was made and patented in England.

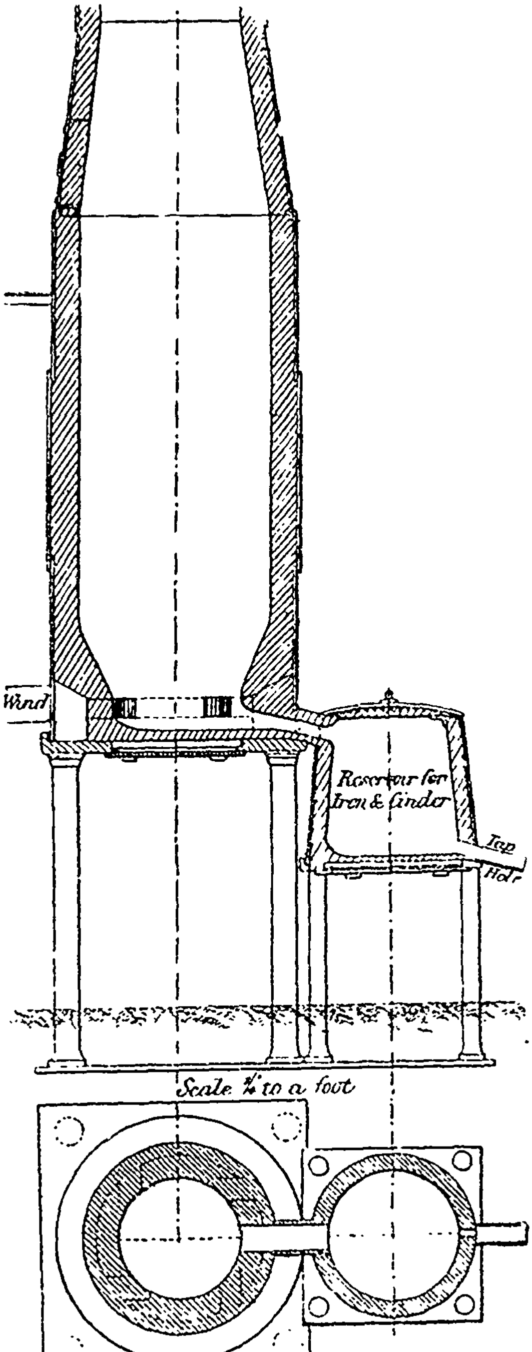
In December, 1844, Messrs. Fisher and Gibbons, of Nottingham (of whom the former was the inventor), took out a patent for "working ornamental designs on lace or net and other fabrics by machinery, in such manner that two threads are caused to loop together, one thread passing through the fabric and the other looping therewith on the surface, without passing through the fabric."

It is not necessary to describe the machinery by which this was done. Suffice it to say there were two needles, one on each side of the fabric, one curved and the other straight. After giving a description of this machinery, the specification of the patent goes on to describe other machinery for "sewing thread, yarn, gimp, cord, or fabrics in pattern on the surface of fabrics." This machinery is "similar to the preceding, except that the upper needle and loop guide are removed, and instead thereof a shuttle is used, carrying a thread, gimp or cord. A reciprocating motion is imparted to the shuttle, so that at each ascent of the needle it will pass between the thread and the bent part of the needle, leaving its own thread, which is sewed or fastened down by the thread of the needle, on the latter descending. When the needle again rises, the shuttle will pass between the thread and needle in the opposite direction, leaving its own thread as before, and so on until the pattern is completed. If desired, a second fabric may be placed on the fabric to be ornamented, and when sewed together, the former may be cut away between the figures or patterns."

If this was not a true sewing machine, what is? After Howe's invention became known in England, Fisher altered his machine, and made a sewing machine of it, while even as it was, it was sufficient to invalidate Howe's (or Thomas's) patent, parts of which were accordingly disclaimed.

We have now reached the time when the attention of mechanicians began to be turned to sewing machines, and numerous inventions were in consequence brought forward. One of these is noticed in the following, which appeared in the "Journal" of July 1st, 1852:—"Sewing by machinery.—A machine of American invention, has been introduced into this country by Mr Darling, of Glasgow (at whose manufactory numerous examples of it are now in operation), which carries the mechanical principal into a fresh department of human labor, namely, that of common hand-sewing. The machine is extremely simple in construction. Its framework is of cast-metal, and it occupies little more space than two cubic feet. The right hand of the worker turns a small wheel, which puts in operation two needles—one an upright needle, the other a sort of semicircular one—and a strong tabular surface, at the left hand extremity of which these two needles work—the upright above and the circular under—the cloth is laid with the left hand, and propelled between the needles as the machine proceeds with its stitching. It is said that the machinery is not liable to become deranged, and that any breakage of the thread can be rectified with very little loss of time. The machine can be driven by foot, after the manner of a turning lathe, and in this way the rate of work by hand, which is 500 stitches per minute, would be doubled." Many such appeared about the same time, but as the object of this article is merely to sketch the early history of this remarkable invention, a period has been reached at which it may fairly conclude.—*Society of Arts Journal.*

* Full description of this and other machines will be found in a paper read before the Society of Arts, in 1863, by Mr. E. P. Alexander, "Journal," vol. xi., p. 348



CUPOLA FURNACES.

For some time Krigar's cupola furnace, with a separate receiver for the molten metal, has been attracting much attention on the Continent, and the results obtained from it are stated to be exceedingly favourable. This being so, many of our readers will regard with some interest the subjoined illustration showing a cupola furnace on a similar principle, which was erected as long ago as 1858-59, at the Broadway Foundry, St. Louis, U.S. This furnace was constructed under the directions of Mr. W. B. Cogswell — now of the Franklin Ironworks, Oneida Co., U.S., — and it was provided with a large wind-box built inside the casing, as shown, this arrangement being adopted for the purpose of forming a bosh, and reducing the bed. The tuyères were 6 in. square, and were inserted tangentially. The separate reservoir for the iron and slag was an attachment patented in the United States, by a Mr. McFarland. As shown in our sketch, for which we are indebted to *Engineering*, the reservoir was made tapering.

When melting was finished the bottom of the cupola was dropped; but the top only of the reservoir was taken off, this top being held by suitable clamps. The bottom of the reservoir was not dropped until the next morning, when the cinder would break off with a slight touch. One great advantage of the reservoir was that it formed a place where iron could be kept hot much longer than in a ladle, while in case of any accident to a mould, or other source of delay, the furnace could be kept melting. The iron also was found to be cleaner than when tapped from the furnace direct. We are informed that the cupola, of which we have been speaking, worked admirably, and with great economy, the fuel used being gas coke.

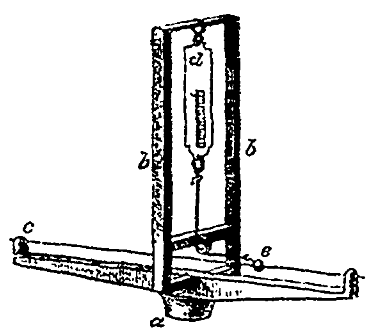
A DEVICE FOR DEMONSTRATING THE LAWS OF THE CENTRAL FORCES.

(From the *Journal of Franklin Institute.*)

By Prof. E. A. Dolbear.

The want of definiteness in the conditions under which experiments are usually made with the common turning-table, especially when applied to the demonstration of the laws of the central forces, has led me to devise the following modification of the apparatus for this work. The performance is good, and I therefore submit a description of it, for the benefit of those who teach mechanics, and especially for those who may study it in any of the various physical laboratories.

The usual form of apparatus for this work, as it is constructed by instrument makers, is too well known to be described here. The subjoined figure will sufficiently well indicate the modification, so that any one possessing the common arrangement for raising a weight by the centrifugal force of a ball running upon a wire, can adapt his instrument to it. The framework *a*, which is screwed to the shaft, has the upright posts *b*, *b*, and the frame *c*, having a wire stretched upon it for the ball *e*, to move upon. Instead of the usual weights to be raised I substitute a common spiral spring balance *d*, which hangs from the top bar and is connected to the ball by a stout string tied to its hook, passing round the small pulley at the bottom and thence to the hook upon the ball.



It is evident that when the ball *e*, moves towards the end of the wire the index of the scale will indicate the number of pounds pull. When the machine revolves the ball is driven outward, and of course pulls upon the scale, which in turn directly points with its index the number of pounds, or, in other words, the centrifugal force. It may be thought that when the scale itself is turning fast the index could not be seen; but, if one stands in such a position that the light from a window or a lamp will be reflected from its face to him, the index and figures can be plainly seen, no matter how fast it goes. The radius of the circle described by the ball *e*, can be found by adding to its distance from the centre of revolution, when at rest, the measured distance from zero on the scale to the number of pounds indicated. Then, if the weight of the ball itself is known, all the data for the demonstration are had at once. This form will easily permit of graphical construction for the results, which is quite an advantage for a learner.

THE FIRE-LESS LOCOMOTIVE.

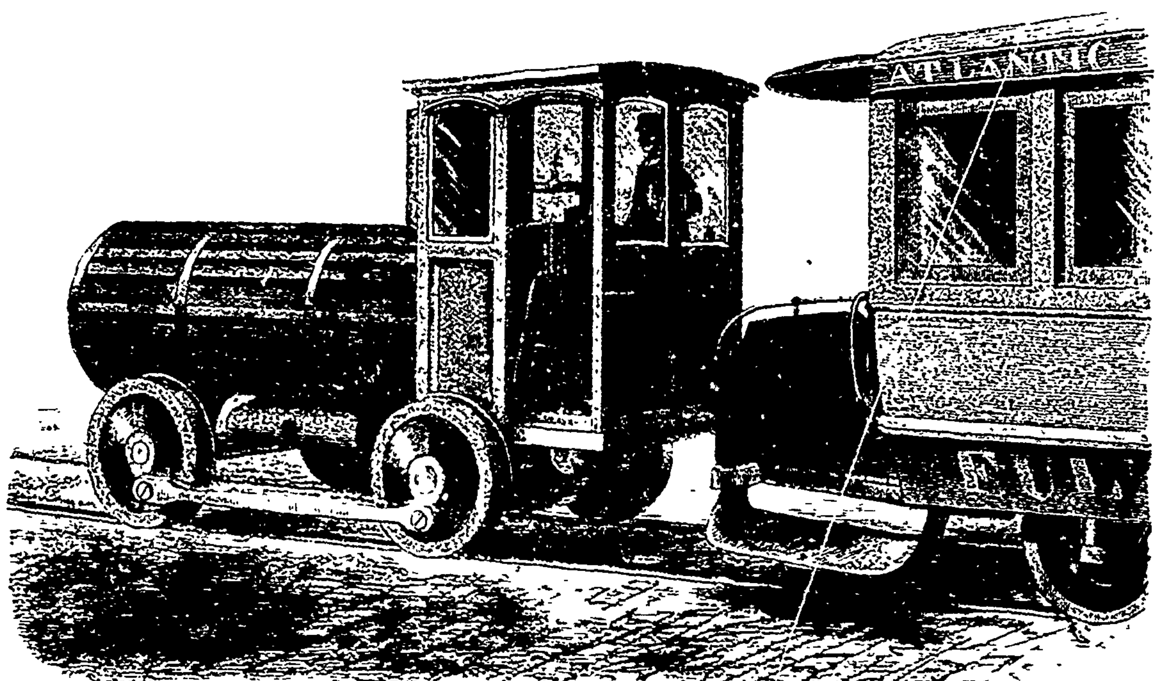
The daily press has already given our readers some idea of the fire-less locomotives which are rapidly coming into use on the tramways in the United States. The following description of an experiment with this system is from the columns of the *American Artisan*, to which journal we are also indebted for the illustration below.

Lamm's system, it is well-known, consists in charging a receptacle of sufficient strength with water at a high temperature and pressure, heated at stationary boilers at the necessary intervals along the route, the heat stored up in water thus obtained sufficing for power to the next station. The stationary boiler in this case is situated at the junction of the Canarsie Railroad and Atlantic Avenue, East New York. It is a Harrison boiler, and was fired up to a pressure of 175 lbs. The receptacle of the machine was connected at the bottom with the boiler by a two-inch pipe, and the gauge on the receptacle marked about the same pressure as that on the boiler. The receptacle was already charged when those invited to witness the experiment arrived, so that the charging process was not exhibited. It was stated, however, that the receptacle could be connected with the boiler, and, starting at forty-five pounds pressure, be heated up to 150 pounds in five minutes.

The receptacle is a cylinder ten feet long by forty-six inches in diameter, and should, consequently, contain about 115 cubic feet of water, weighing about 7,200 pounds. It was, however, filled only to the upper gauge, and the water actually carried may be fairly estimated at 6,000 pounds. Starting with 170 pounds of steam the distance to Canarsie, three and a half miles, was made in thirteen minutes, most of the way a down grade, some portions so much so as to require no work from the engine. At the end of the trip the gauge marked 108, showing that sixty-two pounds had been consumed. The engine drew one of the Canarsie Railroad open cars containing, we should judge, eighty persons. The return trip, up grade, was made in seventeen minutes, and the pressure remaining in the reservoir was forty-five pounds. The amount of heat consumed, therefore, in the round trip of seven miles was 170 —45 —6,000 = 750,000 heat units, which is equivalent — (966 heat units evaporate one pound water, from boiling point) — to the evaporation $\frac{750000}{966}$, or about 775 pounds of water, or 12.4 cubic feet. The evaporation of a cubic foot of water per hour is the usual estimate per horse-power, and it is a very liberal one, whence it will be seen that the machine at starting had available heat for 124 horse-power for at least one hour, or about twenty-five H. P. for the time run.

Taking the weight of the machine at 6,000 pounds, the water at 6,000 pounds, the car at 6,000 pounds, and the loads at 10,000 pounds, twenty-one horse-power should, if properly applied, be more than sufficient to take the whole up a grade of sixty feet to the mile at the rate of fifteen miles per hour. The road over which the trial was had being, as has been stated, a down grade one way, it is easy to see that the power was largely thrown away. With a machine properly devised and constructed the power in the reservoir at the beginning of the trial should take the machine and load at least eight miles at the rate of fifteen miles per hour up a grade of sixty feet to the mile, or should take it on a level twenty-five miles at the same rate. In the above computation no allowance has been made for radiation, for the reason that if the reservoir, pipe, and cylinders are properly protected the radiation should be a very small item for the time of the experiment. The reservoir in this machine is coated first with asbestos, and over this with hair, the whole incased in sheet-iron. It was stated that the radiation had been tested by charging the reservoir up to eighty pounds pressure, and allowing it to stand for sixteen hours, when the pressure was found to have fallen to forty pounds, or two and a half pounds per hour, at which rate the radiation during the experiment should have been about one per cent.

It is unnecessary to call the attention of any practical mechanical engineer to the difference between the conditions under which a machine works in the Lamm system and the conditions of an ordinary locomotive. The latter makes its own power as it goes along, works under an approximately equal pressure, and must exhaust its steam at a sufficiently high pressure to make the necessary draft. The former has its power for the trip stored up in the reservoir to start with, is required to work at very unequal pressures, and no draft is needed. For economy, no less than to prevent the puffing so objectionable in public streets, the steam should be expanded clear down to atmospheric pressure, which cannot be done where a draft is needed.



THE FIRE-LESS LOCOMOTIVE.

MECHANICS' MAGAZINE.

MONTREAL, NOVEMBER, 1873.

ILLUSTRATIONS :

CONTENTS :

THE FILTRATION OF THE WATER SUPPLY, A PREVENTIVE OF WASTE.

Dr. Baker Edwards has reported to the Chairman of the Water Committee of this city, that, in his opinion, the amount of water wasted in consequence of imperfect fittings, due to their abrasion by sandy and flinty particles, and vegetable spongy spicules, is so great, that the filtration of the water, through beds of gravel and sand, would prove a large saving of water to the city, and have all the practical benefit of an increased water supply; at the same time effecting a much required sanitary improvement. This might be effected, he states, at a very moderate outlay as compared with an enlargement of the water works and an additional supply. In Great Britain it has been found that water may be *saved*, by checking waste, to the extent of more than one-half the consumption per head of the population, and at a cost of one farthing per 1000 gallons saved, whilst the cost of an additional supply is estimated at not less than 5d to 6d per 1000 gallons.

A most valuable series of tests for leakage have been applied recently in Liverpool, England, which prove that an extraordinary waste of water has taken place there during the night or early morning when households are supposed to be asleep. The waste between the hours of 1 a.m. to 4 a.m., equalled in some districts 30 gallons per head per day and the total consumption in these districts amounted to 58 gallons per day. The consumption for the total population amounted to 30 gallons per day, which was reduced by a system of constant supply and district meters, after the repair of defective fittings, to an average of 12 gallons per head per day! which proves to be an abundant supply.

In view of the steadily increasing population of large cities, and the decreasing supply of water, observable all over Great Britain, the economy and proper distribution of the water supply is a matter of paramount and urgent importance in every city, and as "necessity is the mother invention," we are glad to find in Mr. Deacon's Waste Water Meter, a complete solution of the mechanical difficulties. In our next issue we shall give illustrations on this invention and an abstract of a valuable paper on this important subject by Mr. Deacon, C.E , Borough Engineer of Liverpool, England, and we commend a scheme which has been so eminently successful in Liverpool to the consideration of our municipal authorities, and to the Board of Health.

RAILROADS IN THE PROVINCE OF QUEBEC.

Perhaps the most generally satisfactory part of the recent budget at Quebec was that part relating to the granting of aid to railroads. There is no more certain sign of the civilized condition of a country than its roads. A high state of civilization is always accompanied by the best roads which the mechanical genius of the people can construct. This Province has generally been regarded as somewhat behind the sister province of Ontario, but leading journals there are now remarking with pleasure the rapid strides now being made in this direction in Quebec. The efforts of the people aided to a certain extent by Government grants have already achieved certain results, but the progress of these undertakings is being outstripped by the increasing desire for greater facilities of intercommunication. That this is the case is proved by the number of projects at present sanctioned by the Legislature, and by the fact that the provisional boards consist almost entirely of leading men in the localities through which the lines are to run, these localities having for the most part pledged themselves to contribute very largely towards the construction of the works. These railroads have hitherto been aided by grants of land, but during the last session the Government introduced a series of resolutions, and subsequently a Bill founded upon them, changing the nature of the aid to be given to railways, which, instead of receiving large land grants, will be aided with a subsidy of $2,500 per mile of continuous road completed. The following lines are named in the resolutions :—Quebec and Lake St. John ; Levis and Kennebec ; South Eastern ; Philipsburg, Farnham and Yamaska ; Missisquoi and Black River Valley ; Quebec Frontier ; Quebec and New Brunswick ; St. Francis and Megantic ; Bay of Chaleurs ; Sherbrooke ; Eastern Townships and Kennebec ; Waterloo and Magog ; and Montreal Northern Colonization Railway. Under the Act, the last named Company, for building a railway from Montreal to Aylmer, will be aided with a sum of $751,366, and the North Shore Company, similarly, to the extent of $1,248,634.

At a meeting held recently in London, England, under the auspices of the Royal Colonial Institute, Mr. Peter Lund Simmonds read a paper on "Colonial Aids to British Prosperity." Mr. Simmonds, is an authority on colonial matters and has written a great deal on the subject. We have space only for part of his lecture for which we are indebted to an able report in the *Toronto Globe*. The extract will be found below.

EXTRACT FROM MR. SIMMONDS' LECTURE ON "COLONIAL AIDS TO BRITISH PROSPERITY."

The Canadian Dominion has coal fields of immense extent in the Provinces on both its coasts, and it is believed that the largest coal deposit of the world lies under the surface of its rich and immense tracts of prairie lands east of the Rocky Mountains. The sales of coal in British Columbia from the local mines have been upwards of 330,000 tons in the 10 years ending with 1870. The Governor of Newfoundland, in his last report, states that coal exists over a large area on the western side of the Island. And this must be reckoned as an exceedingly valuable discovery. In 1868, Professor Bell, of Canada, visited the neighbourhood of St. George's Bay, and found a fine workable seam of coal. Mr. Murray, the island geologist, calculates that the area of this solitary seam, even supposing there were no others to be found, is 38 square miles, and allowing a thickness of three feet, there would be nearly 55 millions of chaldrons of coal. It is not to be supposed that the whole of this is accessible, but there can be no doubt that most of it is within working depth. The proximity of this splendid coal-field to Canada, and the facilities it presents for coaling passing steamers, need not be hinted at. Governor Hill adds that during the past few years, proofs as to the existence of valuable mineral deposits have multiplied so rapidly, that there are not unreasonable grounds upon which to base an affirmation that the Island is destinated to become one of the world's great mining regions. We should not, therefore, depreciate or slight any one of our possessions. In the revolutions of commerce, of settlement or exploration, we know not of what future importance they may become. An article of necessity for which we are largely dependent on our colonies is timber. Although iron has come so extensively into use as a building material, it has not yet superseded wood; indeed, the demand for timber is more extensive than ever, arising from the enormous building operations carried on throughout the country. In Canada, according to a report of the Hon. James Skead, the average quantity of timber got out yearly is nearly 87 millions of cubic feet. The timber trade employs in the forest above 15,000 men, and in the partial manufacture of timber over 2,000 miles and at least 10,000 men. It further employs at Quebec about 1,200 vessels of an aggregate freight capacity of 700,000 tons, besides 500,000 of lake and canal tonnage. 17,000 seamen are engaged in carrying its products from Quebec to Europe, and 8,000 men in their transportation on inland waters. In British Columbia and Vancouver Island, the Douglas pine, with its straight, uniform trunk, often 200 feet high, and exceedingly tough and pliable, furnishes the finest masts and spars for the largest class of vessels. Of animal food products our supplies from the Colonies are increasing year by year. From British America we receive cured pork valued at £155,000, 30,367 cwt. of bacon and 4,552 cwt. of hams from Canada, 5,200 cwt. of salted beef from Canada, and 55,500 cwt. of butter; of cheese 110,420 cwt. The Canadian Dominion has fisheries of enormous extent, the richest in the continent, both on its Atlantic and Pacific coasts—the produce of the River and Gulf of St Lawrence fishery, valued officially at £250,000, that of Nova Scotia at £750,000, New Brunswick at £150,000, and Newfoundland at £1,500,000. The river and lake fisheries which supply local demands only are not adverted to, but preserved salmon, lobsters, turtles, a large quantity of isinglass, and the produce of the whale fisheries (still carried on to a small extent on the coasts of some of our Colonies) should not be overlooked. The languid state of some of the Colonies would be invigorated by a fresh infusion of the parent blood, and strengthened by her wealth, railroads, canals, telegraphs, and other evidences of prosperity would be even more extended, and the people of Great Britain learn what a precious inheritance they have slighted and almost thrown away. The apparent apathy of the Mother Country to her Colonies has arisen in great measure from he[illegible]nt of knowledge of their value. The generous impulses of the British people are at variance with such indifference. And let it once be known how sadly they have been mistaken, what a noble estate they have yet in possession, what strength, if properly managed, it would add to the parent arm, and what vitality to the whole system; let these things be made known, and the national heart will throb with affection and yearn for its distant children. Nearly all our Colonies and possessions are contributing largely to the wealth and comfort of the Mother Country, as well as their own advancement. All appear to be flourishing, all highly prosperous and progressing, all prosecuting with untiring zeal their endeavour to draw forth the latent energies of the soil. The Canadian Dominion, with its wheat, its wool, and its timber; the Lower Provinces, with their ship-building, fisheries, and minerals were never so prosperous as now. Let us not fold our hands under the idle persuasion that we have Colonies enough, that it is mere labour in vain to scatter the seed of future nations over the earth; that it is but trouble and expense to govern them. If there is any one thing on which the maintenance of that perilous greatness to which we have attained depends more than all the rest it is colonization, the opening of new markets, the creation of new customers.

THE SNOWDON IRON MINE.

We understand that the proprietors of the Snowdon Iron Mine, encouraged by the very favourable reports of the scientific men who have investigated the prospects of the mine and analysed the ore, have decided to push the enterprize vigorously, and that arrangements are now being made to form a Joint Stock Company with a view to raising sufficient capital to fully develop the property. It is proposed, in the first instance, to build a cold blast furnace of sufficient capacity to smelt ten tons of iron per day, and to erect all the necessary works for carrying on a smelting operation to that extent. These works, and the furnace, would cost about thirty thousand dollars. It is, of course, intended to use charcoal for fuel, and this can, no doubt, be obtained in the required quantities from the settlers in the vicinity. The total production of the furnace may be estimated at between 3,000 and 4,000 tons of pig iron per annum, and it is calculated that it could be delivered on a lake port on Ontario for $20 per ton, the market value at present prices being about $35. The transport of iron is one of the difficulties, but it is not as we understand the matter, proposed to take any action in this direction at present. The Port Perry Railway Company, we are informed, have undertaken to carry either iron or ore from Bobcaygeon to Whitby for $1 per ton, and the Nipissing Railway Company have intimated that they could carry it from the mine to Toronto for $2 per ton upon their line being extended from Coboconk to Snowdon. Until other means of transport are available the produce of the furnace will be conveyed by teams either to Coboconk or Bobcaygeon, but it is obvious that immediately the fact is established that the furnace can be worked at a remunerative profit, a railway to the mine will soon be constructed.

A comparison of the ore with that from other places is exceedingly gratifying, showing that the ore is probably the richest and the most free from deleterious substances of any yet discovered in Canada. The advantages of the locality are also great, the situation of the mine being such that the ore can be ran on trucks to the mouth of the furnace without any elevating power being required.

It is noticeable that the ores of Marquette, on Lake Superior though not so good as that from the Campbell mine, resemble it in some particulars, and those ores are conveyed in large quantities to the smelting establishments on Lake Ontario and Erie, a distance of 1,500 miles, and even then give a fair profit. Considerable quantities of iron ore are smelted at Marquette by charcoal, and wood in the locality is comparatively scarce, one acre in Snowdon yielding as much as six acres at Marquette.

It is probable that there will be a large export of ore to the States from the Snowdon mine, quite independent of what may be smelted on the spot, the ore being valuable to mix with the poorer American ores, and improving the quality of the iron produced.

The Joint Stock Company that it is proposed to form will probably be brought out with a capital of $200,000, of which $110,000 will be put on the market in shares. Calls will be made to a sufficient extent to build the necessary furnaces and works, and to give the capital required to carry on the business. On the operations proving successful, their extent will be increased to such a point as may be deemed desirable. We hear that a directory is now being formed, and we hope and believe that the shares will be taken up, in a liberal spirit by all those who are really anxious to see the mineral wealth of Canada developed and the country itself progress in its prosperity.—*Bobcaygeon Independent.*

A "UNIVERSAL" ELEVATOR.

One of the machines which attracted considerable attention at the show of the Smithfield Club, was the "Universal" adjustable grain elevator exhibited by Messrs. J. N. Sears and Co. The elevator itself is of the common form; the peculiar advantages of Messrs. Sears' arrangement are in the fittings, which enable the elevator to be adjusted to the varying positions of the substance to be raised. The principle of this contrivance will be easily understood from our illustrations. Fig. 1 shows the elevator affixed to the wall of a waterside warehouse, as it would be employed in raising grain from the hold of a vessel. D is the "Jacob's ladder," shown partly in section, G being a telescopic tube, forming the shoot through which the grain is emptied into the warehouse. The remainder of the figure gives the mechanical appliances for raising and lowering the elevator, and moving it from side to side, so as to reach various parts of the hold. The central column, A, is the main support of the apparatus, being itself held in position by two strong cast-iron brackets. It is turned perfectly cylindrical, so that the carriage, B, may slide and revolve accurately upon it. An enlarged view of this carriage, with its immediate appendages, is given in fig. 2. The carriage bears the driving wheels of the elevator, and is furnished with two gudgeons, which support the jib, C, at the end of which the trunk, D, is affixed. This jib, C, can be varied in length or form, so as to suit the premises to which it may be fitted, and the colmmn, A, and lift, D, may be similarly modified. The shaft, E, working parallel to the central column, A, communicates the driving power. In our illustration bevel wheels, at its lower end, supply means of motion, but manifestly these wheels can be fitted on the upper end or in any other position that may be advisable. The train of wheels shown in fig. 2 is, as will be seen, sufficiant to communicate any required motion to the elevator. The carriage is raised and lowered upon the central shaft by means of chains and pulleys, and the balance-weight, F. A similar chain and balance-weight is attached to the end of the jib, C. Each chain has a safety link as a protection against sudden strains.

FIG. 1

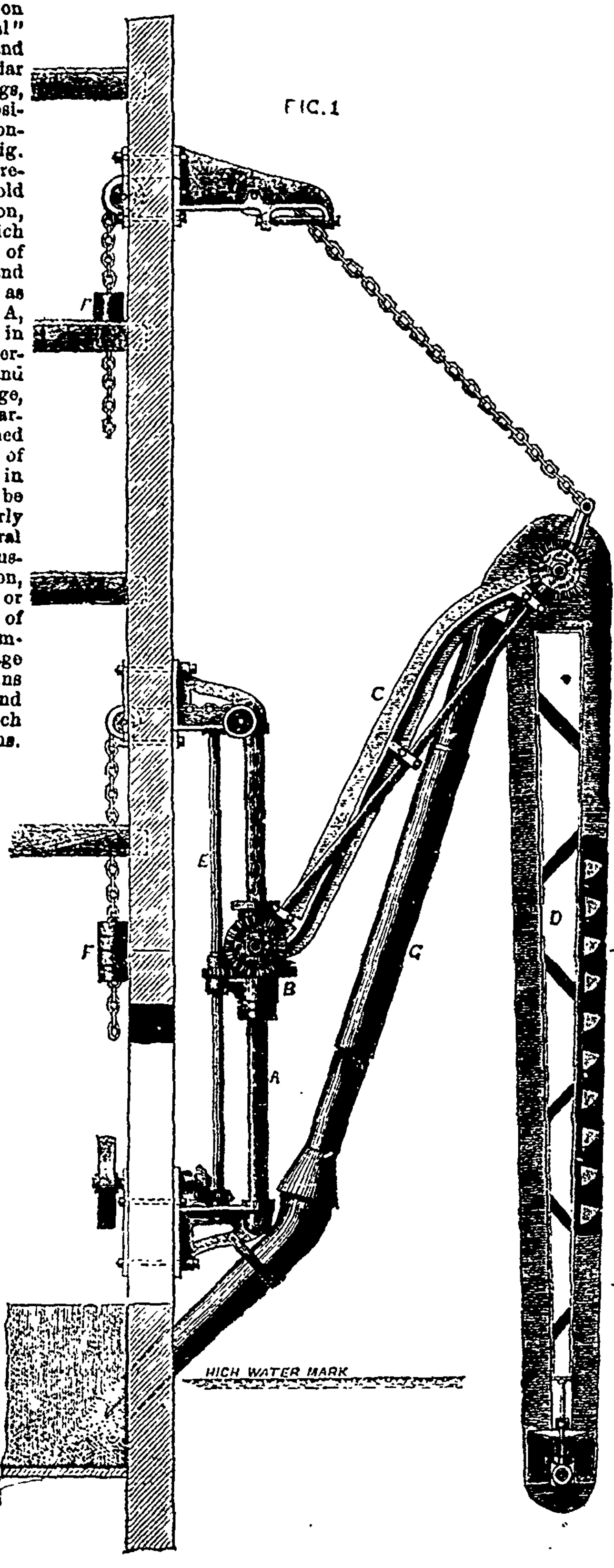
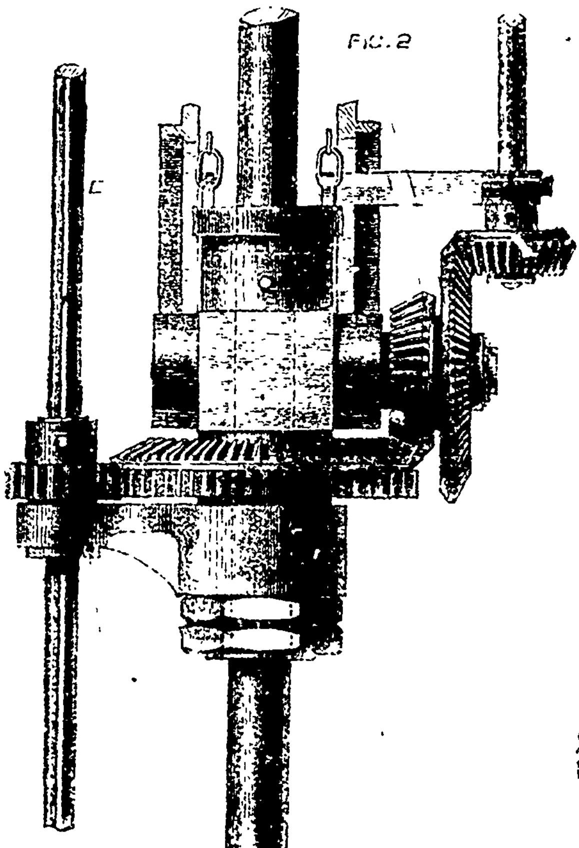


FIG. 2



The machine can thus reach to any part of a vessel's hold, and is capable of adaptation to any motion of the vessel from which grain or other material is being discharged, without, as is claimed, damaging either the elevator or the craft, interruption to the work, or any necessity for shifting the vessel or trimming the grain in the hold.

It is also claimed on behalf of this machine that it is easily applicable to pumping and dredging. It may be worked in various ways by steam, water, or compressed air; and, as necessity may dictate, an engine may be fixed upon the jibs, on the elevator, or elsewhere. Its use seems well calculated to promote economy and prevent loss of time in unlading vessels or lighters, by reducing the expense involved in manual labour hire, wear and tear of sacks and demurrage. Though the elevator is, in the form illustrated, specially adapted for waterside use, it is equally capable of employment elsewhere. —*Iron.*

TOOLS OF ACCURACY.

By Prof. J. E. Sweet, Master Mechanic, Sibley College of Mechanic Arts, Cornell University.

(From the *American Artisan.*)

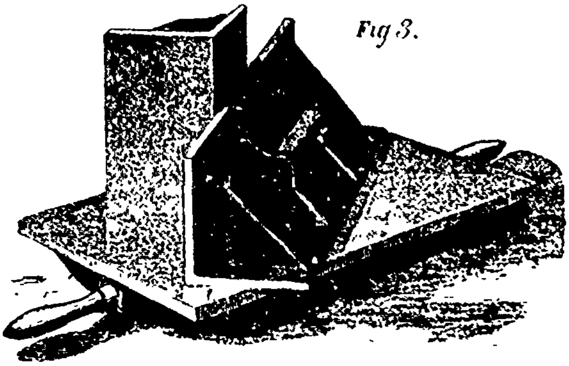
It is a matter of no small surprise to one willing to look upon both sides of a question, to note the many convenient tools in common use in this country, yet unused and mostly unknown in England; while at the same time there are quite as many English productions—none the less meritorious—which we, cute as we think ourselves, are prone to ridicule rather than adopt, or investigated their merits even.

Nearly thirty years ago, Whitworth, the English engineer, devised the method of making, made, and introduced, absolutely true plane surfaces—to-day we are making, trying to introduce, and show the use of the same thing, and yet so little is known of what the word "flat" means, and its value in the construction of tools and machinery, that it is quite safe to assume there is not one in fifty of even the good mechanics of the country, that has even seen a flat surface plate, or have any conception of the freedom with which one can be made to glide upon another.

Theron Skeel, in his first article on "The proportions of crank-pins"—as published in the Artisan of Oct. 11, 1873—makes the statement that "the force required to move one mass of metal upon another, varies from one-twentieth, where *the surfaces are polished and oiled, to one-third,* where they are also polished but only wet with water, of the force with which they are pressed together." This statement I do not question, but would add that I find by experiment, a perfectly flat plate when well oiled will move upon another flat plate by one-fortieth of its own weight, when the weight is not greater than a few ounces to the square inch of bearing surface, and will continue to move if set in motion with as little as one-fifty-fourth of its own weight, when loaded to a few pounds to the square inch. With water as a lubricator on two new plates which had never been oiled, the light load did not require one-half the power to move it as when oil is used, but with the heavy weight the resistance was about equal; these to be sure, were very light loads for the surfaces in contact, but it is only by exaggerated examples that we can make apparent such facts as this—*truth in a wearing surface is of far more consequence than polish*—or to apply the fact to practice. If the guides of an engine are to be finished, if a lathe or planer ways are to be worked up, or, in fact, if any machine slides are to be fitted, it is better for the workman to spend his time—let it be much or little—in "making the crooked straight," rather than in any amount of draw filing or polish. Better, not only because of the infinitely better work the machine, if it be a machine, will itself turn out, but because the machine will run with less friction (which means a saving of power and repairs); as a pretty rough slide, if it only be straight, runs easier than a draw filled one, which is always crooked, will, if ever so highly polished.

True ways and slides can only be made by working them up to the standards or by machines which were themselves made by standards; and even in the latter case the sources of error, that is, the strain in the castings, the spring either on or after it has left the machine, the wear in the machines themselves, etc., are so numerous, that it is not safe to assume any machine work to be true, till tested by that which can itself be proven.

Fig 3.



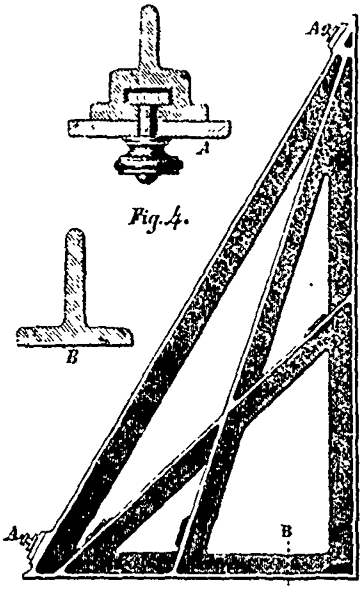


Fig. 4.

Fig 1

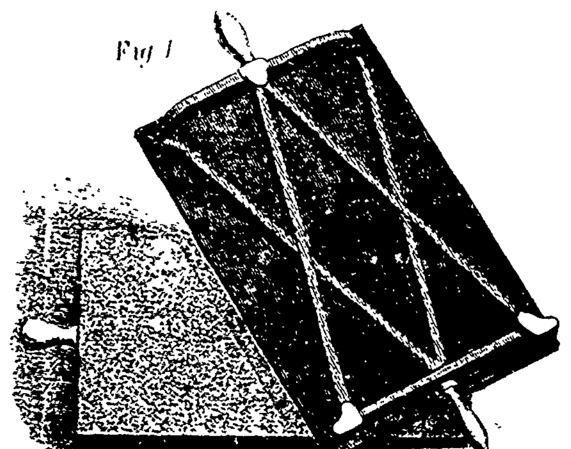


Fig. 2.

The form of Surface Plate we are making, shown in Fig. 1, though somewhat different in design, is the same in proportion and principle as the Whitworth plates. A description of the whole process of working them up on first principles, is rather too long to insert here, but some points which are applicable to work of other kinds may be valuable.

First, it will be seen that the plate is so formed as to rest on three points when placed on the bench. Without that precaution, perfect ones cannot well be made, because the weight of the plate itself is enough to spring it; and with four points of support, it might rest on alternate corners, and stand winding in opposite directions at different times; with the three points, that difficulty is overcome. The back is ribbed, so as to best resist springing; and the castings are good only when free from strain, and this is best secured by that mixture of iron which shrinks the least, or not at all, in cooling. To thoroughly well scale and clean the castings, is not all that is necessary, but they must be painted then, or at least before commencing the finishing process, as sand is no good thing to have scattering on a scraped surface; and so far as that goes, all machinery castings should be painted before they are worked, as they are by some firms, for the same reason. In securing the plates to the planer-bed, what seems to me to be the true way to secure all work liable to be sprung, is adopted. Holes are drilled in the ribs, exactly over the centre of each foot, and the plate held by the reduced ends of the binding straps entering these holes. After the three feet are planed off, the plate is reversed, and with pieces of paper under the feet, the plate is secured by the three straps only. However firm the straps may be tightened down, no strain is put upon the casting, and if it has a tendency to spring, by the removal of the scale from the face, it is free to do so without loosening the bolts. In finishing up we use the scraper wholly, for that which would be removed by using a file is readily removed with a broad ended scraper, with less danger of scratches than from a file, in the hands of workmen of limited experience. The plates are made in triplets, of course, or at least, in the first instance—the guide being to make the plate A fit B and C in all positions—which might be done and yet A be concave or convex, but then B and C would both be either convex or concave, and the two would not coincide; when either two of the three fit throughout their entire surfaces, in all positions, then all must be perfect planes.

While I believe the English workmen use a hook scraper, sharpened quite rounding on its cutting edge—and cutting by the push of the shoke—we use the square ended scraper, very nearly straight on the cut While there is no question, that work done by the rounded tool has the finest appearance, I question if the same amount of work done with the flat scraper will not produce a more nearly flat surface, than if done by the rounded tool; or, in other words, if two otherwise equal plates were worn together, whether the one made with the flat tool would not come to a dead surface or the scraper marks be obliterated, the sooner of the two. Whatever kind of scraper be used it may be as acute, or even more acute, than a right angle at the commencement of the work, but must be considerably more obtuse than a right angle, to finish with. We find a black diamond scraper to a certain degree serviceable, but not smooth enough for finishing. While we have the tools on our benches, as tools, rather than put away like toys, a certain degree of care is necessary; for a piece of iron bends as easy as a piece of wood, only that it does not go quite so far. Tapping the holes for the handles is liable to bend the plates, and even screwing the handles in when a tight fit, will do the same; so we find it necessary, as they are removable, to make them a loose fit.

Fig 2 shows the style of straight edge we have adopted; varying in size from one foot six inches for "Jones kit boxes," to four or five feet in length. They are not only straight and out of cross wind, but parallel also; besides the smaller sizes have their edges at right angles to the flat side, so that when placed upon the surface plate the edges are vertical. This makes them, for practical use, infinitely better than the ordinary steel ones, for besides greater perfection in straightness and parallelism, they will stand on the wide face, and red paint can be used to indicate the imperfections in a piece of work whether straight or square.

Fig 3 shows different lengths of angle plates, perfectly square at angle and ends, so that when placed on a surface plate, external angles of work may be tested.

Fig. 4 shows a new tool specially designed for a machine-shop square, made of cast-iron with wide faces, thoroughly square. While, as a rule, I should not choose a compound tool for any ordinary purpose, unless, perhaps, we except a claw hammer, in extraordinary tools, or those only used occasionally, it will do to make a tool answer a secondary purpose, when its construction or use does not involve complication. Believing this to be an admissible case, two of the braces are put in the square, at the convenient angles of sixty degrees and forty-five degrees, and the thread brace at such an angle, that while the short side of the triangle represents the diameter of a circle, the long arm represents its circumference, with which the circumference of circles may be determined very readily.

The stops, A A, which are narrower and longer than the width of the face, can be set on either angle, so as to serve the same purpose as the projecting stock of a try square, or they may be turned out of the way, leaving the side of the square flat. The heads of the bolt enter recesses in the casting, so they may be changed by simply slacking the screw nuts.

With the tools I have been describing at hand, which embrace three out of five of the hardest words to be found in the machinist's dictionary—*flat*, *straight*, and *square*, the other two being *round* and *size*—a workman will find it as easy to do good straight work as poor, or at least to know whether that which pretends to be straight, is really so, and to apply what time he bestows on a piece of work, to reducing the projections.

A NEW IMPROVEMENT IN GAS MANUFACTURE

The recent increase in the price of fuel and various other causes seem to have turned the attention of inventors to the subject of reducing the expense of making gas. In England Wright's Air Gas and other inventions are attracting much attention and our American cousins are also working in the same direction. We illustrate from the *Scientific American* herewith apparatus which the Citizens' Gas Light Company, of Brooklyn, N. Y., have recently introduced, in their works, for the manufacture of hydrogen, by the decomposition of steam under the Gwynne-Harris or American hydrocarbon process, and also for the preparation of naphtha gas, both of which products are mingled with that obtained in the ordinary way from coal. As a result, we are told that as against 28 benches or 140 retorts in use in October, 1872, at present but 14 benches are employed, two of which generate hydrogen, two naphtha gas, and the rest coal gas, supplying the full amount required, and yet working only from 14 to 15 hours per day. The process, briefly stated, is three-fold first, coal which produces the ordinary quantity of gas, but of inferior quality, is carbonized in separate retorts; second, hydrogen, generated in the manner about to described, is mingled with the coal gas, giving it high incandescent power, and, hydrocarbon vapours which otherwise would be lost; third and last, naphtha gas, or any of the petroleum products, which may be made of almost any richness that it is possible to burn, is led into this mixture, in sufficient proportion to produce the requisite degree of illuminating power. In other words, coal gives coke for fuel to run the works, and common gas; hydrogen takes up the carbon vapours, and adds heat to the flame, thus creating more perfect combustion, and naphtha increases the lighting power to any desired standard.

Using coal alone, we are told that 9,026 feet of gas per ton was about the yield with the full complement of benches Now, 13,000 feet of coal gas and hydrogen mixed is produced, or an average of about 6 feet per pound of coal, which may be increased by increasing the hydrogen.

As the hydrogen and naphtha processes are quite distinct, we shall refer to each in detail, separately. In our large engraving (Fig. 4) the artist has shown the exterior of the hydrogen bench, and in the smaller engraving (Fig. 2) is represented one of the retorts here used The latter, though of the general shape and of the same material as the ordinary gas clay retort, differs from it in that it has a diaphragm extending horizontally across the centre, forming a double retort, and is, besides, covered at the bottom with tiles, one of which is represented separately. The diaphragm is perforated with medium sized openings. The tiles have smaller holes in their upper surfaces, communicating with other apertures which, when several tiles are laid side by side, form two longitudinal passages through them. Thus arranged, these retorts are placed in each bench, in the usual manner, and when in use, are filled with anthracite coal. Once in a day, the coal is raked, and about a bushel of anthracite is thrown in, and once in each week the retorts are refilled.

From an ordinary cylindrical boiler, steam is led to a superheater, and thence to the vertical pipe marked A, in our large engraving (Fig. 4). Following its course for the retort on the right the steam escapes from tube A, into two pipes which lead to the dryers, the ends of which are represented at B. Near the junction of the pipes with tube A, are placed suitable valves to regulate the supply. The dryers B, are made double; that is, the steam enters an inside metal tube by which it is carried back five feet into the bench, and then passes to and through an enclosing metal tube back to its starting point. This is intended to prevent any wet steam from reaching the clay superheaters or retorts in the bench; and, finally, the steam passes out by two upwardly leading pipes, which terminate each just above a retort, at C. At the latter point, each pipe connects with a short tube which joins it with clay superheaters placed just above the retorts, so that the steam, entering at C, travels to the rear of the superheater, which is five feet in length, and then returns, highly heated, in an opening parallel to the front, making its exit by the tubes D. In the latter it is conducted down under the lower portion of the retort into the longitudinal passages formed through the tiles Hence, it escapes up through the perforations and through the incandescent coal, and is decomposed, forming hydrogen and carbonic oxide gas.

The gas thus generated by this American process passes into the hydraulic main, and thence is conducted to mingle with the gas generated by the bituminous coal retorts. The product of the two hydrogen benches is in the neighbourhood of 100,000 feet per day, and its estimated cost is, at outside figures, 30 cents per 1,000 feet.

The naphtha employed is deposited in a suitable reservoir at some distance from the works, whence it is pumped as desired into a tank, marked A, in Fig. 1 This receptacle receives its supply in order to deliver it by the pipes B, into the two huge cylindrical stills. Within the latter is a worm pipe which is filled with steam from the boiler by the pipes C. By means of a fan blower in the engine room, a current of air is driven into the stills by the pipes D, which mingles with the vapour of the naphtha given off through its heating by the interior steam coil. The gas then passes from the stills by tubes E, into the works, where it enters peculiarly arranged retorts, one of which is shown in Fig. 3. It will be noticed that the vapour is conducted to the back of the receptacle by a pipe, whence it escapes.

After heating, the gas is conducted to a condenser, where it passes through a series of pipes surrounded by cold water and from which it is drawn by an exhauster and carried to the station meter, whence it goes to the main to mix with the coal and hydrogen gases. About 300 feet of gas per minute are thus made, a gallon of naphtha giving some 135 feet. This is of a uniform quality of 22 candle power.

The mixture of the three gases, as supplied to consumers, averages about 18 candles; and by carefully observing proper proportions in combining them, we learn that a very fine silver white light is obtained.

The process is unquestionably one of considerable economy to the gas company, as is evident from the large saving in the number of hands employed, due to the decreased number of benches used. Moreover, the raw material for the hydrogen, or anthracite gas, costs almost nothing. And a portion of the anthracite coal used is available for re-employment as fuel under the steam boiler. Naphtha is not costly; no cannel coal is required, and the gas coal, as we have already observed, is of the type only serviceable in its production of the usual quantity of inferior gas. The main object of the bituminous coal benches, where hydrogen and naphtha are used, is to make coke for fuel to run the works.

The rush for the Stickeen mines continues. A numerously signed petition to the Governor in Council, has been sent down from Cowichan and Nanaimo, praying for an appropriation of money for the purpose of opening the Cowichan and Nanaimo road.

One fifteenth of the length of the St. Godard tunnel has already been excavated.

DOMINION.

Liverpool is to have a storm drum.

Halifax, N. S., is making arrangements for holding a Provincial Exhibition on an extensive scale

The Vancouver Coal Company sent away last year 45,728 tons of coal, showing a decrease of 420 tons. The flooding of Douglas pit at the beginning of 1873 very much interrupted the Company's mining operations.

A few days ago a schooner left Georgetown, P. E. Island, for St. John's, N F., with 1,130 carcasses mutton, 50 do beef, 25 do pork, 20 bbls. tallow, and 2,000 geese and turkeys. This is the largest cargo of fresh meat ever shipped at one time from the Island

A recent geological survey reveals the important fact that on the line of the Northern Pacific Railroad, in the Rocky Mountain district, there exists a coal-bearing region of 250,000 square miles in extent, the strata of available fuel buried there varying in thickness from 5 ft. to 35 ft.

The Cobourg *Sentinel* is pleased to learn that Mr. Burnet commenced operations at the Beet Root Sugar Manufactory on Tuesday last. It has been supplied with a new retort and the best machinery procurable, and no doubt is entertained that sugar of the best description can be manufactured at the Factory.

Iron Ore in Prince E. Island —Mr. John Young, Mining Engineer, and some assistants, have been mining for iron ore, for some days past, on the farm of Mr. John Tweedy, Gallas Point Mr. Young purposes bringing a ton of the ore to this city and getting it smelted at Morrissey's foundry. The indications are that a large quantity of the best quality of iron ore exists in the vicinity at which Mr. Young and his men are mining.—*Charlottetown Examiner.*

Sir Alexander Murray has made the important discovery of an extensive coal-field at St. George's Bay, Newfoundland. He has ascertained, beyond all question, the existence of several workable seams of coal of a superior description, the extent of which can only be determined by boring. Much of it appears to be cannel coal, so valuable for the manufacture of gas. One seam is 3 ft. in thickness, and only a few miles from the coast.

The Culbute Canal.—Mr. Johnston, of the Engineering Department of Ottawa, accompanied by a staff of five, started lately by instruction of the Dominion Government to examine and take soundings of the channel on the south side of the Allumette, and test the feasibility of the route for the construction of a canal in lieu of the one now being built on the northern shore of the Ottawa. The company started for the scene of their operations on Tuesday last. We believe it is the intention of Mr. Johnston to begin at the bottom of Pacquetts Rapids and move upward. The task to be accomplished is at the present time both a difficult and dangerous one, owing to the insecurity of the ice in the neighbourhood of the many rapids that occur in the line of their explorations.

The St. John *News* says:—"The Municipal Council of Potton have under consideration a proposition to grant aid to the extent of $10,000 to the Missisquoi and Black River Railway. The proposed railway is 55 miles in length. If built, it will open up a country of great wealth and vast resources Starting at Richmond, an important junction on the Grand Trunk, it will run through Melbourne, Brompton Gore, Ely, Stukely, Bolton, and Potton, and intersect with the South Eastern near Mansonville. It will pass by inexhaustible slate quarries in Melbourne; the valuable copper, soap stone, and chrome mines in Bolton; and will skirt the banks of a stream with immense water-power at present not utilized. It would also penetrate dense forests of valuable wood, which would open new sources of industry and bring fresh capital into the country. In the more settled portions of the route there are many fine farms; and the lands yet to be cleared would prove unexceptionable for grazing and dairy purposes. Among other grants to the road, Bolton has subscribed $20,000 North Stukely and Ely each a like sum, and South Stukely $10,000.

Fig. 1

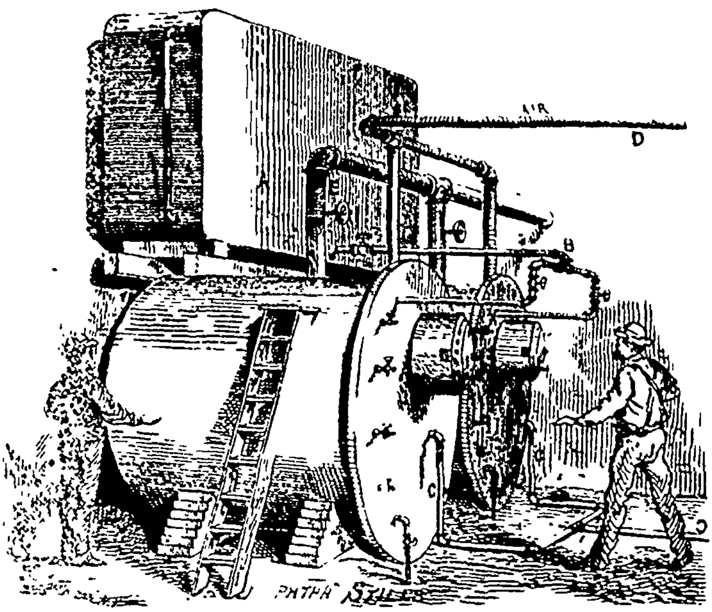


Fig. 2

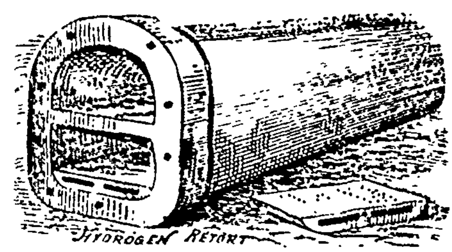


Fig. 3

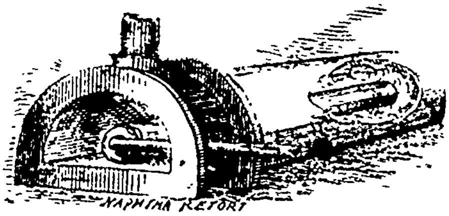
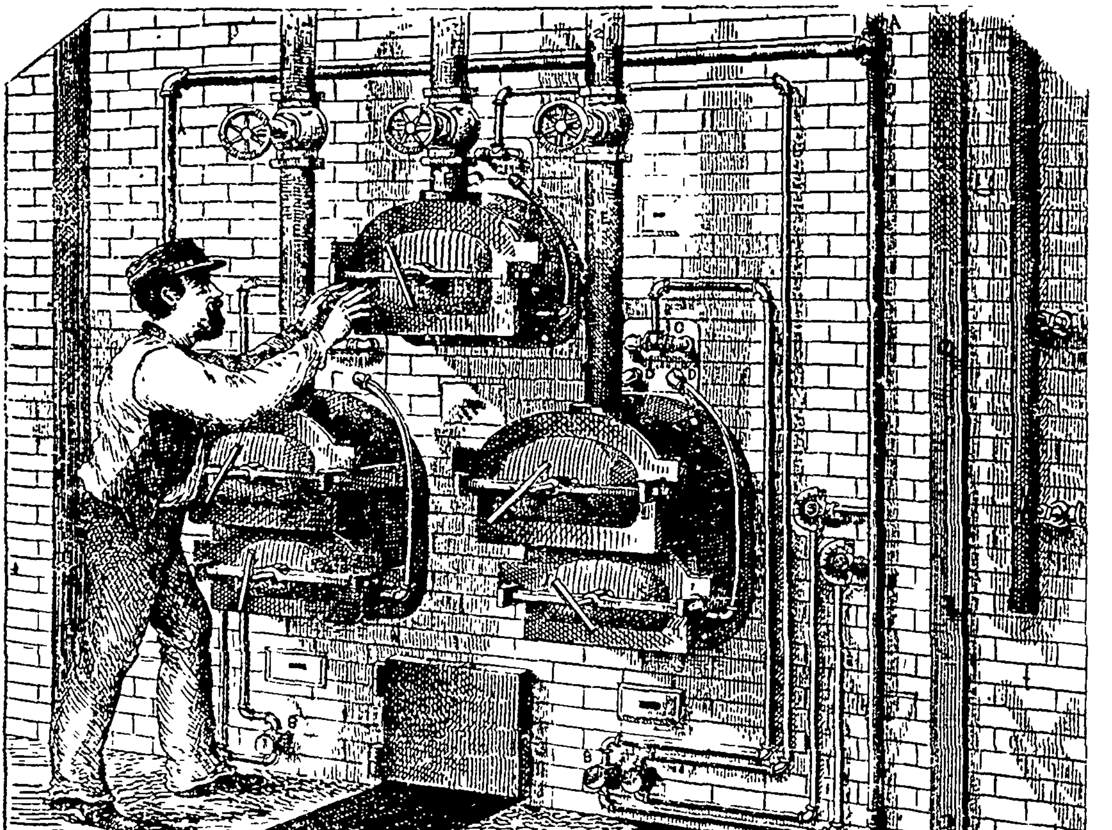


Fig. 4.



NEW IMPROVEMENT IN GAS MANUFACTURE. (See page 245.)

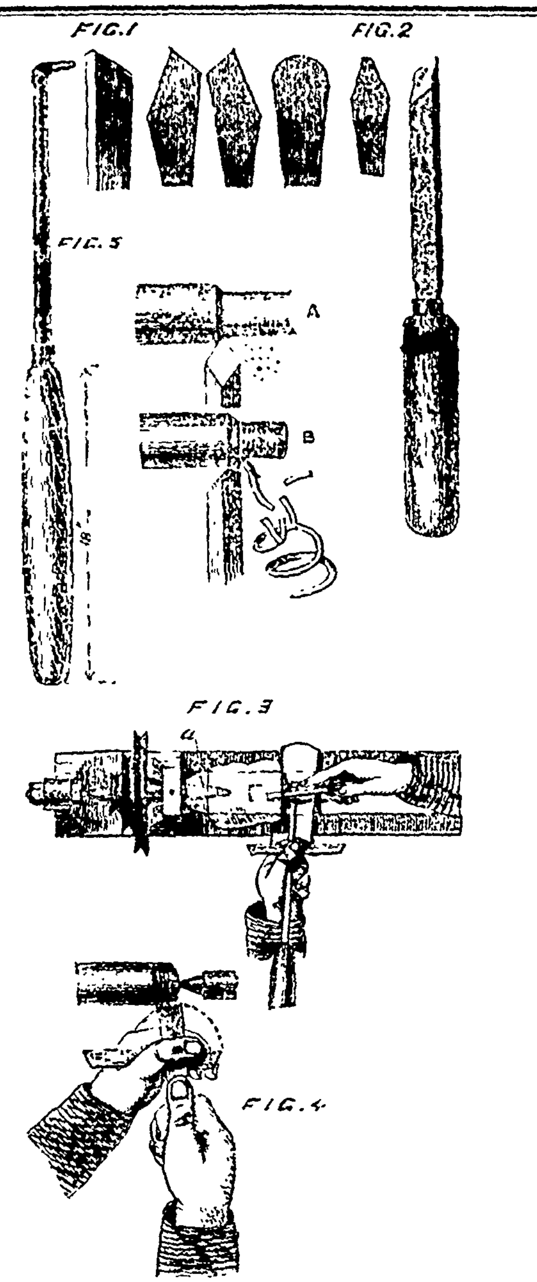
ON INSTRUMENT MAKING.

By "Expertus."

Albeit much has been written upon the various branches of mechanical manipulation, the subject of Instrument Making has hitherto been left comparatively unhandled. It is in the hope of supplying this deficiency that the following series of articles is put forward. The prevalent supposition, that a knowledge of natural philosophy and the use of tools is sufficient, with experience, to perfect one in this intricate study, will bear no test; and so badly, it will be found, do theory and practice go hand in hand, that the practical man will execute his task while the theoretical one is making his calculations. Considering that there is so much literature extant descriptive of tool-construction, and that most of the instruments used may be seen in almost any tool-dealer's shop-window or catalogue, it would be an unnecessary and tedious division of this subject to detail their forms, other than those peculiarly adapted to this pursuit alone. Reluctant to bore my readers with any uninteresting enumeration of these accessories, I have chosen to treat upon each as its description becomes imperative, and to classify the various departments under this head as they are successively employed in the manufacture of an instrument.

As the branch called Turning applies chiefly to the production of telescopes and various other optical contrivances, I shall confine myself for the first to the framing or fitting together of instruments, mentioning only such uses of the lathe as become expedient in that part.

Having selected castings of as sound a nature as can be procured, it is, firstly, requisite to remove all superfluous prominences, called "burr," with an old file, and to harden them thoroughly and evenly with repeated blows from a light hammer, observing at the termination of this process that they are left as nearly as possible to the desired shape; for this purpose, a square and straight-edge must be used, and very often a true surface-plate, or a sheet of the patent plate-glass, which in its manufacture, is rendered surprisingly flat. Should the hammer show upon its face any indentations from its improper use upon hardened steel chisels or drifts, they must be ground away upon the stone, especially for the treatment of sheet metal—the most difficult of all. Remembering that compression of soft metal causes a distension, it must be seen that equality over the whole surface is an important desideratum, and that a sheet, if stretched by this means too much in the centre, will buckle up like the bottom of an oil-can. The same rule applies to the setting of long strips of metal, in which case the piece will curve over in the operation towards that side which has not received a sufficient number of blows. Carefully avoid contact from the hammer edge for obvious reasons,* and never strike a part which has not been previously cleaned slightly, as any prominent places which are thus forced in will fall out in flakes when the piece comes to be turned or filed. It frequently becomes requisite, in the first place, to turn perfectly flat, by means of the slide-rest, those surfaces which necessitate or admit of that process. Taking as a well-known specimen the uprights of a microscope or theodolite, render one side true carefully with the file, using a surface-plate upon which has been smeared a little dirty oil or pasty accumulation from the bore. When laid firmly upon this and gently rubbed backwards and forwards, the surface in process will show on removal its highest points, which may then be filed away, and this process repeated will eventually enable the manipulator to gain a tolerable plane. But if time admits, the work may with advantage be "slide-rested" upon both its sides. In this case set one side in such a manner as to prevent its rocking upon the surface-plate; upon the mandril-nose of lathe, screw a chuck of as great a diameter as possible, having for its surface a circular disc of wood (beech preferable), which has been fixed with bolts to the face-chuck or has had a mandril-screw cut in its rear. Now turn the entire surface perfectly flat with slide-rest, and ascertain its accuracy by means of a straight-edge. The prepared side of the work is now to be heated and then covered with cement. * The purpose of this is to fix the piece or pieces of metal to be operated upon firmly to the chuck, so as to resist the concussions consequent upon contact with the cutting edge of the tool. Now let the lathe revolve, and take off the metal in light steady cuts, until your castings are brought down to the thickness desired, leaving them a little thicker if to be reversed upon the chuck and surfaced upon the other side. The motion should be about 150 revolutions to the minute, and sometimes even less, or the cutting point will materially suffer. The best tools for the purpose may be made from worn-out square files, and the most effective shape for surfacing is an acute-angled V. The best period for commencing, i.e. when the pieces of metal are nearly cold; but the requisite motion of slide-rest handles experience alone will teach. Should the wooden surface chuck prove, upon examination with the straight-edge, to be imperfect, the slide-rest can only be adjusted by the insertion of small scraps of metal or card between one side of the V groove underneath the slide-rest and the corresponding V upon the lathe-bed. Having once turned the wooden chuck, do not alter the position of slide-rest preparatory to turning the casting, or the work may not be parallel. There are many awkward shaped pieces which necessitate portions of the chuck being chiselled out to receive their prominences, and others which require extra blocks of wood to be



* Coppersmiths and Planishers are very skilful in flatting. They may also be advantageously engaged for difficult cases of brazing and soldering.

glued upon the original chuck. It is also advisable sometimes to run a quantity of the hot cement all round the sides of the piece or pieces as the consequences of a dislodgement are serious, often resulting in a deep score from the tool or an incurable bending up of an important part.

We now come to the more difficult portion of what may be called the fitter's province in turning—that which necessitates the employment of box-wood and clamp-chucks, &c., but it is expedient, prior to entering this department, to briefly describe the tools which will be called for.

Right-side, left-side, round-nosed, roughing, parting, and planishing tools may all be forged from cast steel, 3-8ths by 3-16ths of an inch, or from worn-out files of the right size. These are so generally known that it would be superfluous to describe them at any length, but the reader should be cautioned against any obtuse-angled side-tools, and assured that the semi-elliptical form of round-nosed tool is incorrect, the proper shape being a curved extremity, of radius equal to that of the hollow to be produced. Planishing tools are best made long and sufficiently thin to exhibit some slight amount of elasticity; the cutting-edge should be a right-angle, so that either side may be used; each surface should be rendered fine upon an oilstone, and the cutting-end not more than 1-32nd of an inch in thickness. These and the parting-tool alone require mention, a very acute angled extremity is preferred by some for these, but this is objectionable on account of the wide breach which it makes, and by the far the best shape is that similar to one of the non-cutting edges of a planisher, thinned gradually from the point to prevent wedging (Fig. 1) This is a dangerous tool in the hands of an amateur, and requires firm handling. No reference is needed to the remaining ones on cut. For economical motives, triangular files are often employed, but are extremely clumsy and difficult to use. Milling-tools should be mounted so as to work freely upon their axis, and should be firmly fixed into a large handle. They may also be used in the slide-rest in some cases.

But more generally useful, perhaps, than any of these, is the common graver, as answering most of the requirements of a right-side, left-side, and roughing-tool in one (Fig. 2, A, graver in use as a roughing-tool, B, graver in use as a right-side tool). It is maintained by some—principally engineers—that this should never be used save on iron and steel; but this dictum is ignored by the class who use the tool to its greatest advantage. A few pence will purchase one of as good a quality as can be produced, but they are often found to be improperly tempered, and require some little treatment before being used. In sharpening this, do not be tempted to grind its sides: for it is detrimental to its performance, and time thus saved in preparation is doubly lost in the sequel.

For making chucks, select straight, new, and sound boughs, and the larger number, in reason, the workman possesses, the smaller will be the necessary consumption. For making:—Place upon the mandril-nose of lathe a peg-chuck (Fig. 3, *a*), *i. e.*, one which has upon its surface a conical peg of steel cut with a coarse pitched screw tool, and having sawed up the boxwood into pieces of the desired length, and drilled their centres upon one side to the smallest diameter of screw mentioned, select the first one to be prepared and insert the peg into the hole, then twist it up till the boxwood face and shoulder of chuck are in close contact, to prevent further tightening through the resistance of screw-tool (Fig. 3, internal screw-tool cutting boxwood chuck).

Now ascertain the diameter of mandril-nose and drill up the boxwood chuck, leaving sufficient stuff for cutting the thread, for which directions will be given at the end of this chapter. It is now in a position to be "screwed" and carefully fitted. Some gasfitters and others, prefer to fix their boxwood into cup-chucks to prevent their splitting (a common occurrence), but the same end may be attained by tightly inclosing the circumference with a ring of metal tube.

These chucks are utilized by turning holes in their faces for the reception of the various shaped castings which are to be worked, or by decreasing their external diameter, so as to fit into pieces of shape more suitable to that method. They should always be left slightly tapering in their fittings, so as to wedge firmly in on the application of a hammer, but not sufficiently so as to run the risk of dislodgement through vibration. A little space must always remain in case the casting should require knocking more firmly upon its chuck prior to finishing, as pieces frequently become slightly loosened in the roughing process, but a piece can never be "rechucked" when once commenced upon without being thrown out of truth from its original axis, owing sometimes to the inequalities upon the casting, and often to the variable density and consequent hardness of boxwood; indeed, it is only practicable when the part which fits into the chuck has already been turned, and even then a nick should be made at the edge of casting to correspond with a similar nick in the edge of chuck, that it may be placed the second time in the same relation, and even then it is troublesome to restore truth.

There are certain parts of instruments which require not only to be well fixed upon their chucks but to be also cemented, and sometimes even packed up and supported by small blocks, but this is rarely necessary.

American scroll and iron surface chucks are scarcely ever used by professional instrument makers, their drills, countersinks, &c., being generally fixed in a simple chuck with a small clamping screw, which may be tightened by means of a hand-vice or key made for the purpose; many also use the common die-chuck.*

It is not within our range to include such turning as is effected between the centres of the lathe, but it may not be out of place to caution readers against dependence upon centre-punch marks which have not been drilled, and against using *arbors* which have not been turned true to their ends.

But ere the learner will be able to accomplish the most simple constructive task successfully, he must make himself master of the screw tool; and, though in this he may be assisted by a few directions, one hour's practice will be of more effect than a year's reading. The standard gauge in use is that of Whitworth, and its different varieties are distinguished by size; thus a ¼in. tool is one which has been cut upon a ¼in. "hob," and so on. This system, though, is little known to instrument makers, who, often finding it requisite to cut a fine thread upon a large diameter, ignore for the most part any standard, and keep each firm its own particular pitches It is commonly asserted that a thread should not be cut upon a diameter which is not equal to that of the hob upon which the screw tool was made. The observance of this rule might possibly possess some advantage, but as an appalling number of tools would be required, the manipulator who courts such an insignificant medicum of assistance would do better to spend his money in the purchase of a travelling mandril,† or better still, in receiving lessons.

A hob for *our* purpose may be of any reasonable diameter, the thicker the better, and the tools in use may be classed according to their number of threads to the inch They should be made at a tolerably acute-angled cutting edge. Standing, I think, first in importance for success, is that the work should be true and *smooth;* external pieces should be neatly rounded off, with a tool upon the corner, where the thread is to be commenced, and internal ones—more difficult—should be similarly treated. Considering the external first, it must be remembered that the motion required for striking the first thread is a circular one (see Fig. 4), where the dotted lines represent the motion of tool, and the black spot the central axis A screw tool, in this instance, is nothing more nor less than a lever, of which the operator's thumb forms a fulcrum; and therein should be seen the absurdity of resorting to the angular plate contrivances, which place one's work entirely at the mercy of a, perhaps, much indented hand-rest, and give no room for cutting a screw upon a very small space.

For the purpose of cutting a thread upon an internal part, many prefer to bring the T rest at right angles to the lathe-bed, with its edge a little below the centre; this may be done with advantage where the work is of any size requiring a deep and coarse screw, especially if the work be of iron or steel, but in the lighter branches most commonly required in optical instruments, it is far more workmanlike, expeditious, and safe, to use an arm rest (Fig 5). In using this tool the handle must be tucked well up under the left armpit, the left hand

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* Holtzapfel "On Turning and Mechanical Manipulation," "The Lathe and its Uses," "The Amateur Mechanic's Workshop," &c An excellent contrivance is also published by a contributor to the ENGLISH MECHANIC, No. 316, Vol. XIII.

† It frequently requires as long a time to learn properly the manner of using this arrangement as to become master of doing the work by hand.

grasping the stem of the T rest with its forefinger, and the arm-rest with its thumb. When used for screw-cutting in this case, the axis of motion is upon the T rest, underneath the manipulator's thumb, and the motion of cutting edge is rendered straight by allowing the screw tool to twist slightly in the arm-rest hook—see Fig. 3 showing the correct method of using. This observation applies to the other applications of this accessory in addition to the one mentioned; thus for smoothing the inside of a piece of tube, a reciprocating motion may by that means be given, &c.

The non-acquirement of this much-written-upon and little-taught screw-cutting art is the *Pons Asinorum* of mechanical study, and the bungling tyro commonly expends his very limited amount of patience by trying alternately one contrivance after another, giving none a fair trial, and thus spending considerably more time in the attempt to save trouble than a resolute apprentice or amateur would dream of. I have also to give another hint in concluding this chapter. Do not be in too great a hurry to reduce the size of your casting or work of any kind in the lathe until feeling certain that it is firmly fixed; for cemented pieces will frequently shift when slightly warmed by the friction of cutting tools, and those fixed in box-wood chucks will alter their position by expansion from that cause; so easy is it to make a thing too small, and so difficult and often impossible to repair the mischief done. It may be considered frivolous and out of place to indite these cautions, but I can assure my readers that the non-observance of such seemingly unimportant points, disdained by writers in general, often proves a stumbling block to success, and so imperceptible are the conditions upon which safety depends, that we are affected most by hidden difficulties, gazing only at the port, regardless of the shoals that intervene.—*English Mechanic.*

GLASS SPINNING.

The latest improvements in spinning glass are due to the Vienna manufacturer Brunfaut, who exhibited his talent in this speciality in 1850 at Pesth. After manifold trials, he discovered a composition which may be made at any time into curled or frizzled yarn. The frizzled threads surpass in fineness not only the finest cotton, but even a single cocoon thread, and they appear at the same time almost as soft and elastic as silk lint. The woven glass flock wool has quite recently been used as a substitute for ordinary wool wrappings for patients suffering from gout, and its use for this purpose has been, it is stated, successful. Chemists and apothecaries have found it useful for filtering. The smooth threads are now woven into textile fabrics, which are made into cushions, carpets, tablecloths, shawls, neckties, cuffs, collars, and other garments, &c. They may be used for weaving the figures in brocaded silk or velvet. As a material for fancy dresses, tapestry, for covering furniture, for laces, embroidery, hosiery, &c., the glass tissue will probably at some future time occupy a prominent place. Owing to its brilliancy and the splendour of its colours, it is the most beautiful material for dressing the hair, neck, and head. In softness, the glass yarn almost approaches silk; and to the touch, it is like the finest wool or cotton. It possesses remarkable strength, and it remains unchanged in light and warmth, and it is not altered by moisture or acids. Spots may readily be removed by washing. Being non-inflammable and incombustible, it is especially valuable for making dress materials for ladies. Cloths of glass fabrics are much warmer than those of cotton or wool; at the same time they are of low specific gravity. They are also adapted for veils, as they repel the dust remarkably well. The composition of the materials is still a secret, and the spinning requires extraordinary dexterity and constant attention. This part of the business is said to be very trying to the sight. It is stated that, with a wheel of a diameter of 5 Austrian yards, one operative is able to spin 3,000 yards per minute. The cloth (which is equal to about 11 dr. avoirdupois) is sold for 2 florins—93 cents gold. Some manufactures of glass yarn are sold at the following prices: Bedouin tassels from 2s. to 3s.; eagle feathers from 1s. 6d to 3s. 6d; ostrich feathers from 2s. to 8s; bouquets, 3s.; cuffs, 5s. 6d.; ladies' neckties, 2s. to 18s; gentlemen's neckties from 2s. to 8s. 9d.; watch chains from 1s to 4s, chignons from 2s. to 18s.; trimmings, 1s. 6d. and upwards per yard; ladies' cloths from 6d. to 9d. per yard, ladies' hats from 18s. 6d. to £3.

WHITBY JET AND ITS MANUFACTURE.

From a paper by Mr. JOHN A. BOWER, read at the last meeting of the Society of Arts.

What is jet? This is a question often put, but never satisfactorily answered. Nearly all the jet workers have an opinion on its origin, and most of them, in common with the greater part of the inhabitants of Whitby and its neighbourhood, believe it to be of ligneous origin. Some, however, believe it to be of mineral origin, and others think it combines the two. Taking the opinion of Mr Martin Simpson, the curator of the Whitby Museum, who has studied the geology of this district exceedingly well, and with whom I have talked on this subject, he put his theory as follows:— "Jet is generally considered to have been wood, and in many cases it has undoubtedly been so; for the woody structure often remains, and it is not unlikely that comminuted vegetable matter may have been changed into jet. But it is evident that vegetable matter is not an essential part of jet, for we frequently find that bone and the scales of fishes have also been changed into jet. In the Whitby Museum there is a large mass of bone, which has the exterior converted into jet for about ¼ in. in thickness. The jetty matter appears to have entered first into the pores of the bone, and then to have hardened, and during the mineralising process, the whole bony matter has been gradually displaced and its place occupied by jet so as to preserve its original form."

To this latter opinion I am inclined to agree, for it has the appearance of a substance that has distilled from the rock, and in some cases has impregnated vegetable, and in some other cases animal, substances, while in others it has simply filled up a fissure in the rock, and solidified. In some specimens I have seen the grain, apparently of wood, distinctly; in others, scales and bones of fishes; and in one of the best specimens that have been found here, the mass in form and structure was that of a tree, with bark, knots, and roots, and in the curled portions of the roots, stones and soil conglomerated were imbedded.

Whatever may be the actual formation of jet, that known as the hard jet is most worked, it not being thought worth while working the soft species, since the importation of the Spanish article. The hard jet has a specific gravity of about 1·238, has a conchoidal fracture, a resinous lustre, it gives off a bituminous odour when burnt, is an electric, and a bad conductor of heat. It was formerly obtained in the largest quantity by working in the cliffs, by a process called "dressing" (very dangerous work),—that is, by clearing away and hewing down the cliff-sides till jet ends protruded; the seams were then followed till exhausted. Some seams have realised as much as £1000, and have been discovered in a short time. At other times, however, men have been employed for weeks, occasionally months, and have found nothing; in fact, have been on the point of giving up, when they have unexpectedly come upon a seam that has fully repaid all their labour.

There are somewhat more than twenty mines at work at present; about 200 miners, whose weekly wages vary from 24s. to 26s. Owing to these low wages, many men, who might otherwise be at jet-mining, go to the ironworks in the district where they get paid much better. A short time since there were more than 400 miners, but they have gradually lessened to the number before mentioned. Again, jet-mining seems to be a sort of hazardous undertaking, as far as profits are concerned, for often large areas have been tunnelled, and nothing found; and others have sometimes taken up mines that former workers have given up in disgust, and reaped a fine harvest. Both the jet cliffs and mines are rented by the workers. By far the largest jet-miners are W. Thompson and J Turner, both of Whitby. The former has carried his business on most successfully since the year 1860. Rough hard jet varies in value from 4s. to 21s. per pound, according to its closeness of texture, direction of grain, freedom from flaws, and breadth for working. The soft jet varies from 5s 6d to 30s. per stone, the price of the Spanish is about the same as that of the English soft jet. The Whitby hard jet is the best in the world not only for working, but it will take a fine polish, which it retains for years, and it can be worked up into finer designs on account of a greater tenacity and elasticity that it has over other qualities.

The skin has first to be removed, which is done by the workmen chipping the surface with a large iron chisel; the stripped portions are then taken to the sawing bench, where the jet is sawn up, with the keenest eye to economy, into the various shapes and thicknesses, according to the articles for which they are required. The pieces are then given out to the carvers or turners, as the case may be. In the case of the former, if he requires to make it into a brooch, locket, or chain-link, he takes it to a grindstone, which he works by a treadle, and brings the edge, which he keeps turning round, on to the face of the stone; it soon then becomes oval, round, square, or any geometrical shape required. The surfaces are next both ground smooth; it is then fit for carving. Very often—I might say rarely is it otherwise—the artist in jet who undertakes this is no draughtsman whatever, yet he can cut the most beautiful and truthful faces in high relief, the most delightful floral designs,—the latter often without any pattern at all; the most tasteful monograms, and other designs equally good, without being able to sketch the simplest object on paper, and often not being able to write his own name. It was only last week a striking instance of this kind came under my own notice I saw a workman, one of tde best hands in a large shop in Whitby, able to cut the most elaborate monograms, the most accurate portraits, the most elaborate foliage, but quite unable to sign his name. Is it not important, then, when we have many such instances, that we in Whitby should have not only elementary classes, but also a School of Art? I remarked on the economy with which the jet was cut up. I am informed that some masters, by care, get one-fifth more work out of the same amount of material by strictly observing this.

The most complete workshops we have in the town are those of Mr. Bryan, who has lately gone to considerable expense in rearing not only a large structure, but has added every possible convenience conducive to the health and comfort of the men.

I have heard Mr. C. Bryan, whom I named just now, say that he was willing to take fifty London street Arabs as apprentices, and able, too, to guarantee that more than half should turn out first-rate jet workers; and from frequently visiting these workshops I have every reason to believe this is no exaggeration.

According to the classes of work so do the wages of the workmen vary; some idle and careless hands getting from 16s. to £1 1s. per week; others earning from 30s. to 50s. weekly; and the average wages for boys, from twelve to fourteen years, being 8s. to 10s.

In conversations with the masters on an improvement in the patterns, or the introduction of something new, I am told that if customers improved in taste, and there were any demand for articles of a better design, they would be ready to do them; but when they made a fresh effort by bringing out a good and new design, it frequently was on their hands for a long time, or, to use their own expression, "it would not sell"; so that much improvement in this class of goods depends on the public taste.

MACHINES FOR PATTERN MAKING.

Granting the difficulties that stand in the way of employing machinery in pattern making, it must, notwithstanding, be conceded that among the various branches of woodwork, none has received so little attention in machine adaptation; and that in proportion to the work that may be performed on machines in our pattern shops, they have, as a rule, less labour-saving expedients than the cruder branches of wood manufacture.

We must therefore lend our hearty endorsement to the attempt to introduce a set of special machines for pattern making, such as we publish above, and hope that the future may bring a continued effort at special adaptation in machines to cheapen the burden of patterns as an element of machine cost.

It is especially hoped that an efficient core box machine, one that will make cylindrical boxes, chambered, tapered, or parallel, may be devised. Such core boxes present the nearest approach to uniformity and regularity of shape that can be found in pattern making, if we except the preparation of lumber, by such processes as sawing, planing, and so on. The engravings published are drawn to scale, and show very clearly, on this page and the next, the arrangement and objects of the several machines.

The traverse planing machine Fig. 1, with a hand feed, strikes us as a machine that will answer for a variety of purposes, where larger machines are too inconvenient to be used, especially in planing up small pieces, which is now almost exclusively done by hand.

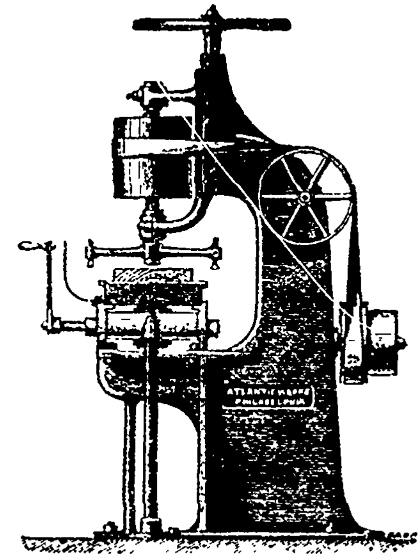


FIG. 1. TRAVERSE PLANING MACHINE

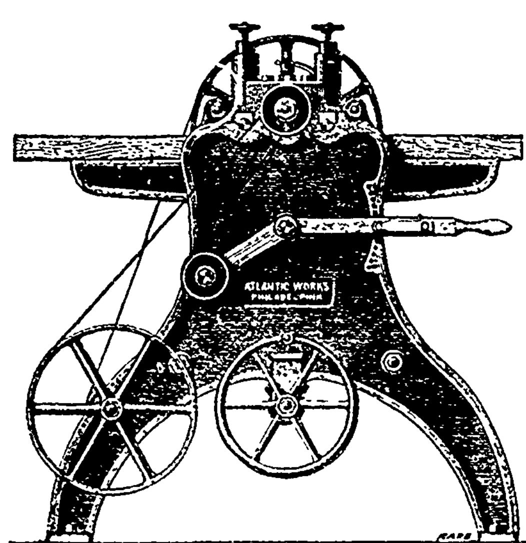


FIG. 2. ROLLER-FEEDING PLANING MACHINE

The glue heater, Fig. 6, if it avoids the objections that have hitherto existed in such devices, will find favour. The heating surface is small, and the steam chamber arranged with double walls to prevent the possibility of leaks. The glue pots are heavy, zinc-lined, and have turned fits where they rest on the steam chamber to prevent the escape of heat.

Aside from a want of machinery, the construction of patterns is one of the most thoroughly developed among the departments of our engineering establishments. Either because of the superior skill of English moulders, the ingenuity of our pattern makers, or from both combined, the cost of wood patterns is at this time very much less in England than in America. Taking the engineering establishments of Philadelphia and Manchester as examples, the cost of machine patterns will show a difference of 50 per cent. or more in favour of Manchester, while the quality of the castings are at least as good, if not better, in Manchester, than in Philadelphia.—*Engineering.*

THE HOOSAC TUNNEL.

An opening has been effected between the opposite workings of the Hoosac Tunnel, an engineering work which is exceeded in magnitude, in its class, only by the Mont Cenis Tunnel.

The mountain to be pierced has two summits, with a wide valley between. The exact distance between the two portals is 25,031 ft. The eastern summit is 6,300 ft. from the eastern portal, and 1,415 ft. above the grade of the railway. The western summit is 6,200 ft. from the western portal, and is 1,704 ft. above grade. The two summits are somewhat more than two miles and one-third apart. The lowest point of the intervening valley is 801 ft. above grade. A geological examination of the mountain by Professor Hitchcock, then one of the best American authorities, seemed to establish it as a fact that the formation was mica slate throughout, "mixed up however, with a little quartz of an imperfect kind, which does not differ materially from the mica slate in hardness." This did not prove to be true, as a vein, several thousand feet thick, of very hard rock was struck some years ago, and caused a material delay in the completion of the work.

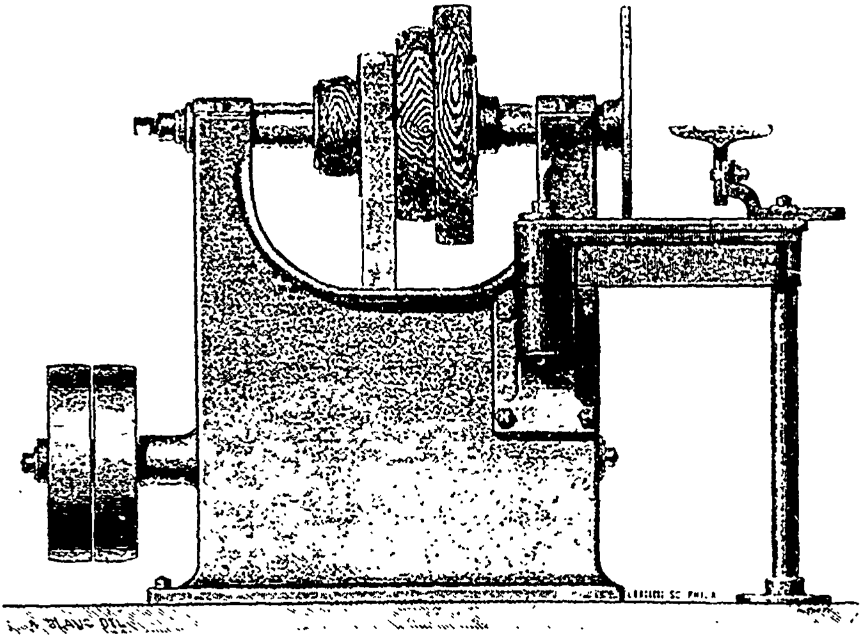


Fig. 3. LARGE FACE LATHE.

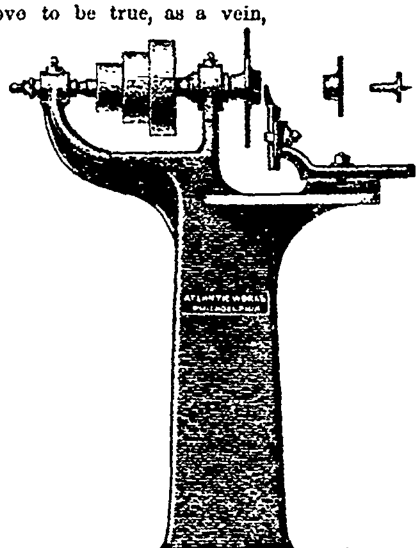


Fig. 4. SMALL FACE LATHE.

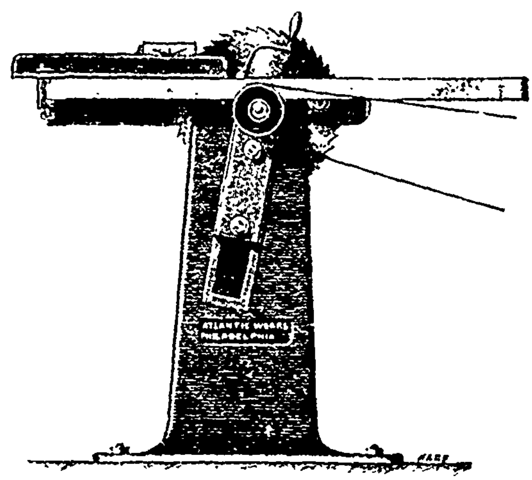


Fig. 5. BLOCKING AND CROPPING MACHINE.

All sorts of inventions have been tested in the Hoosac Tunnel. There was one boring-machine that was to cut its way into the rock at the rate of 2 ft. an hour. It failed utterly. A great dam was constructed across the Deerfield River, which flows by the eastern portal, to furnish power for compressing air. The dam cost nearly 300,000 dollars, and yet it was necessary to supplement it with steam-engines. Thousands of dollars were wasted on experiments with power drills, and there is perhaps no known explosive which has not been tested in the Tunnel. Since the Messrs. Shanly took the contract, all the drilling, except on the central shaft, has been done by means of compressed air-driving power drills, which are an American improvement on those that were used at Mont Cenis. At all the points of working except one the usual explosive has been nitro-glycerine. As a total result of the ten years' desultory working, up to the making of the contract, only 9,338 ft., or somewhat less than two-fifths of the

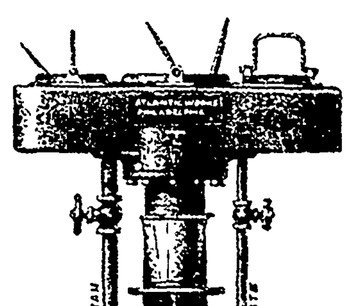


Fig. 6. STEAM GLUE HEATER.

entire distance, had been pierced. The progress in 1869 was 1,688 ft.; in 1870 it was 2,864 ft.; in 1871 it was 3,553 ft.; in 1872 it was 4,456 ft.; in 1873 it has been 3,132 ft., completing the entire distance of 25,031 ft. The tunnel is completed from the east end to a point 750 ft. west of the shaft; that is, about 12 600 ft., and from the west end about 9,600 ft., leaving between about 1,850 ft., where the opening is of full width, but only 8 ft. high The dimensions of the full-sized tunnel are 24 ft. in width, and 20 ft. in height, and its shape is nearly semi-circular, the variation being such as to give nearly the full height of each of the two tracks which will be laid through it.

The advantages of the tunnel are not so much a shortening of distance as a diminution of gradients If Albany were the objective point of a railway, the "tunnel route" would be six miles the shorter. But on the Boston and Albany road there is an ascent of 85 ft. to the mile, as against 60 ft. on the tunnel line. Of course, as the tunnel is twenty miles to the north of the nearest point on the Albany road the distance also would be shortened if the idea be to seek a lake port where the produce of the West may be transhipped This is, in fact, a part of the plan.

The tunnel will be completed in July. Unfortunately, the railway east of the Hoosac is in a bad condition. It has but one track, its location is as bad as it could well be, and the road-bed is utterly unfit for the transaction of a large amount of business The same remarks apply, modified slightly, to the middle section, about fifty miles in length The Fitchburg-road, the Boston end, has a double track, but it is unprovided with freight-rooms, wharfs, docks, and elevators, such as a great through line should possess. The strange circumstance, therefore, of a great work that has cost 10,000,000 dolls. or 12,000,000 dolls., being, nevertheless, practically useless, seems likely to be presented.

The object of the central shaft, which was begun under the State Commissioners about ten years ago, was to supply four faces to work upon. When it had been sunk to grade in 1870, operations were begun in both directions; but large "pockets" of water were struck going westward, and only three faces could be worked. Water made so fast that immense pumps were put down the shaft, which rais d it in three lifts 1,030 ft. at the rate of more than 200 gallons a minute. In 1872 the headings eastward from the shaft and westward from the east end, met in December. Soon afterwards the removal of the "bench" between the two points of working gave the water an opportunity of running harmlessly out at the east end, and westward work from the shaft was resumed.

More than three months ago Mr Shanly estimated that the two headings would meet on the 1st of December. As a matter of fact he gained three days on his estimate. There are many circumstances of interest in connexion with the opening. The headings met with wonderful accuracy The measurements have not been made; but the two lines cannot possibly vary more than an inch or two, and probably the error is less still. For a great part of this work the State is indebted to Mr. Wederkinch, a young Danish engineer, who has not only run all the lines in the central shaft section, but has invented and made with his own hands the necessary instruments. The amount of nitro-glycerine used at each blast was something enormous. The last quantity used was more than 150 lb., being nearly twice as much as was ever before put into one charge. The effect was in proportion. One great piece of rock, weighing upwards of a ton, was thrown directly outwards with such force that, at 100 yards distance, it demolished the great wooden barrier which had been put up to protect those beyond. Another singular fact is, that the current of air sets steadily outwards. Heretofore the current between the east end and the shaft has depended on atmospheric conditions; now it would seem to be established that there will be a steady current through the entire tunnel from east to west when it shall be opened.

The Central Pacific Company are fitting up a travelling machine shop in their Sacramento shops. The shop is a large car, formerly used as a boarding car, and contains a lathe, small planer, drill press, vice-bench and a small engine which furnishes power. There is also a steam pump. The travelling shop is to be used in repairing breakdowns on the Mountain Division.

SCIENTIFIC NEWS.

The Hoosac tunnel alignment proves to have been very accurately made. The error in vertical alignment was only nine-sixteenths of an inch, and that in the level was one inch and a half. This result is very creditable to the engineers.

Detection of Sewage in Water.—A simple means for this is given in the *Journal* of the Franklin Institute. A half-pint of the water should be placed in a perfectly clean colourless glass bottle; a few grains of the best white sugar should be added to it, and freely exposed to daylight in the window of a warm room. If the water becomes turbid, sewage contamination may be suspected.

A natural method of deepening the bed of rivers is suggested by Prof Shaler, who proposes, to improve the navigation of the Ohio, that willows should be planted on the banks. He finds, he says, that wherever such a plantation has been made the roots not only hold the soil of the banks together but accumulate that brought down by the river. It will be obvious that if the banks are augmented the water will move at a greater pace, and after a time the result will be a deepening of the channel.

The number of stars visible to the naked eye in the entire circuit of the heavens has been usually estimated at about 6,000. An ordinary opera glass will exhibit something like ten times that number. A comparatively small telescope easily shows 200,000, while there are telescopes in existence with which, there is reason to believe, not less than 25,000,000 stars are visible. And yet when all of these are seen and numbered, the eye will have visited but a mere speck in the illimitable bounds of space.

A "new or improved musical instrument" has been recently patented. It consists of a number of diapasons or vibrating forks, somewhat similar in shape to tuning-forks. The treble ones are strung on a spindle by which they are suspended, but the tenor and bass diapasons are suspended by their shanks upon rods of metal and wood, terminating in sound-boxes provided with shutters actuated by pedals so as to intensify or moderate the sound. The diapasons are struck by hammers, and dampers arrest their vibrations.

Plastic Carbon for Filters.—In a paper on the so-called plastic carbon for filters, in the *Polytechnisches Notizblatt*, Prof. V. Kietzinsky recommends two mixtures, the one composed of 60 parts coke, 20 parts animal charcoal, 10 parts wood charcoal, and 10 parts pipeclay; the other is composed of 10 parts coke, 30 parts animal charcoal, 20 parts wood charcoal, and 10 parts short asbestos. The ingredients, except the last, are pulverised, sifted, and mixed dry in proper proportions, then kneaded with an equal weight of molasses to a plastic mass, baked in a muffle, soaked in dilute muriatic acid, washed, dried, and baked again.

A company has been formed in France to attempt the utilisation of the power of the tides. The first experiment will be made in the neighbourhood of St. Malo, where there is a rise of nearly 80 ft., the water overflowing many miles of flats. The idea has often been mentioned, and has now resulted in the flux-motor of M. Tommasi, which is the form the proposed attempt to utilise the rise and fall of the sea will take We shall look for the result of the experiment with some anxiety. In the rise and fall of rivers, as well as of the sea, there is undoubtedly a vast power at present unutilised; but as far as we know the means of successfully utilising it have not yet been invented.

A novel project has been submitted to the United States Transportation Committee by a Mr. Cheesebrough, of New York, who proposes to keep the Erie Canal open during the winter by means of artificial heat. He would run pipes down each side, and also float them in the centre a little below the surface; these pipes would be supplied with steam from boilers placed at intervals of half a mile. Mr. Cheesebrough says that one ton of coal will prevent a canal 70 ft wide, and half a mile long, from being frozen over for twenty-four hours; but what data he has to support this assertion we know not. It is considered, however, in America, that if the coal consumed should amount to eight tons per mile per day, the cost would be as nothing to the benefit obtained.

How to Make Cheap Frames.—Cut strips of stiff paste-board about an inch wide the desired length, clip the ends to a point, and cover with any nice black cloth, like broad-cloth or fine casimere; lap the ends at the corners of the frames and fasten with a white or gilt button. Bind your picture and glass together with strips of gummed paper and glue, on to the frame. Hang against a white wall Bronzed paper, which can be bought for eight cents a sheet, may be used instead of cloth, in which case a short strip across the corners of the frame is a great addition to its comeliness.

The French Academy of Sciences has received an interesting communication from Mr. Gimbert, who has been long engaged in collecting evidence concerning the Australian tree, *Eucalyptus globulus*, the growth of which is surprisingly rapid, attaining besides gigantic dimensions. This tree, it now appears, possesses an extraordinary power of destroying miasmatic influence in fever-stricken districts. It has the singular property of absorbing ten times its weight of water from the soil, and of emitting camphorous effluvia. When sown in marshy ground, it will dry it up in a very short time. The English were the first to try it at the Cape, and within two or three years they completely changed the climatic condition of the unhealthy parts of the colony. A few years later its plantation was undertaken on a large scale in various parts of Algeria, and complete immunity from local fever has been maintained by it. In the island of Cuba, paludean diseases are fast disappearing from all the unhealthy districts where this tree has been introduced.

A simple invention for the preservation of cards, photographs, and, in fact, of anything likely to be injured by moisture or dirt, has just been announced. It consists of a preparation of gutta-percha in solution This liquid is thrown in a very fine spray over the article to be protected by an atomizer. By this process a thin film is produced, and when the liquid part has evaporated, as is very speedily done, the object is coated with a translucent substance, impervious to water. Gutta-percha in its pure state is of a semi-transparent grayish colour. But its transparency as a covering for pictures depends on the thinness of the film. The gum first needs to be purified, and then, if it has not been treated with alcohol, it is soluble in chloroform or ether. The process of dissolving it is in itself a purifying one. The ether, being highly volatile, very soon disappears when the spray is deposited on any object. A drawing or photograph thus protected can be washed, the gum not being permeable by water, and resisting any amount of heat so long as it is wet. It begins to soften, however, at a temperature of 150 deg. Fahrenheit. But this is a temperature to which our climate naturally subjects nothing. This simple invention might come into very practical and general use, and if it did no more than to give additional security to the work of the camara, it would be a highly valuable invention.

Tempering Steel, &c —M Caron made a communication to the Paris Academy of Sciences, on the 20th ult, respecting the method of tempering steel and treating burnt iron. "A piece of steel," he says, "is generally hardened and then tempered down to the requisite condition." He objects to this as an unnecessary trial of the metal, and, moreover, the plunging of red-hot steel into cold water causes cracks, or "shakes, to occur" — to appear would perhaps be the better word, as they probably already existed, but were not apparent; and he declares that after many experiments he found that if the hot steel be plunged into boiling instead of cold water an excellent temper is obtained by a single operation. M. Caron informed the Academy also that the same treatment was applicable to "burnt," that is to say to crystalline and brittle iron, resulting from imperfect forging. It is only necessary to heat the burnt bar to bright redness, plunge it into a boiling solution of sea-salt, and leave it there till the iron and solution are of about the same temperature. A curious phenomenon takes place during this operation: the iron, when plunged into the salt solution, is immediately covered with a coating of white salt, which isolates it from the liquid and greatly retards its cooling. He particularly recommends this treatment for finished forgings. If they have been thoroughly wrought the tempering can do them no harm, while if, on the contrary, they have been submitted to too much or too prolonged heat, the process, as already stated, corrects the faults.

ON THE APPLICATION OF SOLAR HEAT AS A MOTOR FORCE.

(G. A. Bergh in *Poggendorff's Annalen.*)

That the heat of the sun may be transformed into mechanical force no one can doubt; for we see daily what masses of water solar heat raises into the air, to be again precipitated to the earth; and we know what an enormous mechanical force is here represented. Further, we know that solar heat is the cause of motions of the atmosphere, that plants under its influence form out of the carbonic acid of the air, an organic substance richer in carbon; that plants which grew in earlier times, under the influence of sun-heat, were transformed into coal and peat, whose combustion now yields heat to drive our engines, which is simply the solar heat returned.

But while solar heat is the cause of nearly all mechanical force developed on the earth, we have yet hitherto known of no means whereby it may be directly utilised for mechanical work It has been proposed, indeed, to employ solar heat, concentrated by lenses or mirrors, for driving a steam or caloric machine. These machines, however, are not suited for this, as they involve too great a waste of heat. Moreover, in concentration a large quantity of heat must be lost. These circumstances, as also the fact that the concentrating apparatus must always be moved according to the motion of the sun, have rendered such machines impracticable. Sun machines must be so arranged, that the solar heat absorbed by a given surface may, without too great waste of heat, be directly transformed into mechanical work. We propose to inquire how such a machine may be had.

It is known that the arrangement of machines, which serve for the transformation of heat into mechanical work, rests on the principle that a liquid or gaseous substance, acted on by the heat, undergoes a molecular change, through which a certain mechanical force is developed The changes of solid bodies under influence of heat, are too small for transformation of the heat into mechanical work, or to render them means of movement, although through such molecular change, a certain mechanical force is developed. Gaseous bodies have been applied as means of movement in the caloric and gas machines; but with the small differences of temperature which occur in some machines, they cannot be employed as such, with advantage. Thus nothing remains but to employ a liquid; and it must be one whose boiling-point is very low. We know that the great expenditure of heat in steam-engines is due, in great part, to the high boiling-point of water The higher steam-pressure we have in the boiler, the greater is the quantity of heat transformed into mechanical work. Hence, if we had a liquid which, at ordinary temperature, behaved like water at a high temperature, this liquid would be a suitable means of motion for a sun machine. There are several such liquids, *e.g.*, sulphurous acid, methylic chloride, methylic ether, &c. Of all these, sulphurous acid best deserves attention, as it has several useful properties for the end in view. It is not too difficult to condense, and it can be got at a moderate price. The keeping of it presents no difficulties, and it may quite well be put in ordinary steam-boilers. Now we have got the principle on which we must construct our sun-machine. Conceive a vessel, filled with sulphurous acid, exposed to the sun's rays; the tension of the sulphurous acid vapour, if the temperature of this vessel exceeds that of the surrounding air by at least 10° to 20°, must be from 1 to 3 atmospheres higher than that of the sulphurous acid vapour in another vessel B, similarly filled with sulphurous acid, but which has only the temperature of the surrounding air. We can thus arrange an engine which agrees in principle with the steam-engine with merely this difference, that the water is replaced by sulphurous acid, and the fuel by the solar heat; while the vessel exposed to the sun's rays represents the steam-boiler, the vessel kept at ordinary temperature may represent the condenser. The sulphurous acid condensed, after doing work in vessel B, could easily be driven back by a force-pump into the boiler representing vessel A. The capability of work of such a machine must naturally increase with the amount of heat communicated to vessel A, or be proportional to the surface exposed to the solar rays.

If now, we conceive a factory or shop, the roof of which is covered with vessels containing sulphuric acid, and which is furnished with a sun machine, made on the above principle, such a machine might indeed work while there was sun shine;

but in default of this, the establishment would be brought to a standstill. True, the solar heat might be replaced by the heat of the air, if the temperature of the air were pretty high, and one had at hand a cooling substance like ice. But as this is not always the case, the establishment should have, besides the sun-machine, an apparatus which might "store up," some of the work done by this. As such, Natterer's apparatus for condensing carbonic acid might with great advantage be used. If a supply of carbonic acid were kept in a large gasometer, like those in ordinary gasworks, the Natterer apparatus might be fed from this. In a wrought-iron vessel thus filled with liquid carbonic acid, we should thus have an enormous store of mechanical force, which might be made to replace the action of solar heat in the sun-machine, partially or wholly. After work done, the carbonic acid, become gaseous again, might be collected in the gasometer. Or, again, the sun-machine, while in action, might drive an ice-machine, and might, in default of sunshine, profit by the ice it had produced, for maintenance of its working.

We thus see that from the present standpoint of science, it is possible to construct a constantly working sun-machine.

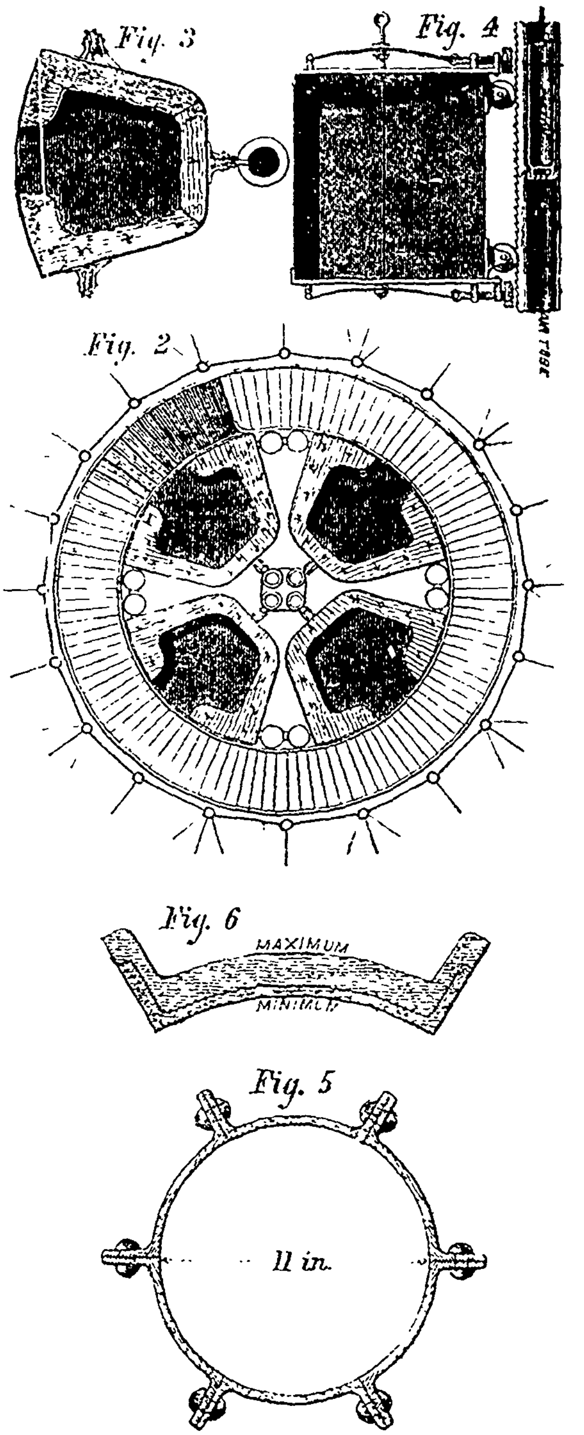
THE CENTENNIAL TOWER, ONE THOUSAND FEET HIGH.

Near the modern village of Hilleh, in Asiatic Turkey, and on the river Euphrates, at about 300 miles above the junction of that famous stream with the Tigris, stands a huge irregular mound, rising abruptly from the desert plain. Masses of vitrified brick are heaped about its base, and its interior, so far as excavations have progressed, proves the whole vast pile to be of similar material. Cuneiform characters, imprinted upon the sun-dried clay, have told to the archæologist the long forgotten history of this ancient ruin, carrying the mind back to the glories of Babylon the Great, back to the reign of Nebuchadnezzar, and, yet still further into the mists of antiquity, to the days when "the whole earth was of one language and of one speech." Equalled in age only by tradition itself, the first monument erected by human hands yet remains, and though its lofty pinnacle is overthrown and prostrate, it fulfils the purpose of its builders: "To make us a name."

It is but natural for the mind to wander back to this earliest attempt of our race to make for itself a written history, and to commemorate a great event by the erection of a colossal structure, in connection with the subject of the present lines. As did the descendants of Noah, so propose we to do. The oldest of ancient nations formed brick and made mortar, and built for themselves a tower to record their existence; we youngest of modern peoples, build us a tower to celebrate the close of the first century of our national life. And to its prototype, Babel, a pile of sun-dried clay which authorities assert, at the hour of confusion of tongues, had not attained an altitude of over one hundred and fifty-six feet, the graceful shaft of metal, rearing its summit a thousand feet above the ground, forms a fitting contrast, typical of the knowledge and skill which intervening ages have taught mankind.

"But how high, comparatively speaking, will this thousand foot structure appear?" doubtless is a question already in the mind of the curious reader. Beside the mighty works of Nature, we answer, infinitely small; beside the works of man colossal. Compared with the vast peaks of the Himalayas, twenty-five thousand feet above the sea, ten hundred feet is but a pigmy elevation; beside the loftiest spires which exist upon the earth, it is as are the giant trees of California to the tallest maples and elms, which join their leafy arches over our streets and doorways.

The reader can draw the contrast for himself, by a glance at the admirable effort of both artist and engraver, to which our final page is devoted. Here are grouped the highest structures in the world; and in the centre and springing far above them all, is the airy network of the great tower. Many, of the edifices depicted will be recognized at a glance. First in point of altitude is the graceful spire of Cologne's far famed cathedral, rising to a height of 501 feet above the marble pavement of the sanctuary below. Next is the Great Pyramid of Cheops, beneath the crest of which lie 480 feet of stone before the vast foundation is reached. And then another fane, spared by the fate of war, though not unscathed, Strasbourg's minster, towers 468 feet from earth to pinnacle. Michael Angelo's grandest work, the dome of St. Peter's, the gilded cross surmounting which, from its



PROPOSED CENTENNIAL TOWER AT PHILADELPHIA

height of 457 feet, seems to watch over the Roman campagna, is closely followed by another pyramid, that of Cephren, brother and successor to Cheops, the summit of which is 454 feet from the desert sands which continually drift about its foot.

Rivaling the glorious vault of the Italian architect, Sir Christopher Wren's masterpiece, St. Paul's, rears its symbol, 365 feet above the crowded streets of the great city at its base, overtopping, by comparison, the dome of our own Capitol at Washington, to which our artist invites the contrast, by fully 78 feet. Representative structures from three of our principal cities complete the picture. Trinity Church steeple, in New York city, 286 feet from the foundation to apex, then Bunker Hill Monument, its granite column towering 221 feet, above the scene of the conflict which it commemorates, and, lastly, St. Mark's church in Philadelphia, an edifice of no small architectural beauty, the spire of which springs to an altitude of 150 feet above the curb.

So much for relative height. And now a word as to who is to build the great fabric, and how they propose to carry out their task. The designers are Messrs. Clarke, Reeves & Co., civil engineers and proprietors of the Phœnixville Bridge Works, of Phœnixville, Pa., a firm represented by its productions throughout the whole country, and regarding whose ability to carry through an enterprise of this kind no corroborative assertions on our part are at all necessary. The material is American wrought iron, made in the form of Phœnix columns, shown in section in Figs. 5 and 6, united by diagonal tie bars and horizontal struts. The section is circular, and is 150 feet in diameter at the base, diminishing to 30 feet at the top. A central tube 30 feet in diameter, shown in section in Fig. 2, extends through the entire length, and carries the four elevators, shown in plan and section in Figs. 3 and 4. The latter are to ascend in three and descend in five minutes, so as to be capable of transporting about 500 persons per hour. There are also spiral staircases winding around the central tube.

The bracing above noted, as will be observed from our large engraving, runs in every direction, so that the tower will be as rigid as if made of stone, and yet will expose very little surface to the wind. The proportioning is such that the maximum pressure resulting from the weight of the structure, with persons upon it, and a side wind force of 50 lbs. per square foot, will not strain the lowest row of columns over 5,000 lbs. per square inch. The four galleries are roofed over and protected with wire netting, in order to prevent accidents. The estimated cost of the fabric is one million dollars, and the necessary time for construction, the designers tell us, need not exceed one year. The site has not been as yet definitely located, but it will probably be in Fairmount Park, Philadelphia, in proximity to the buildings of the Centennial Exposition. By calcium and electric lights from the tower, it is suggested that the latter, with their adjoining grounds, might be brilliantly illuminated at night. The summit of the spire would also form a magnificent observatory, while the view of the surrounding country would be unparalleled.

It is hardly necessary for us to point out the very appropriate character of the design in connection with the object of its erection. That the hundredth anniversary of our national existence should not pass without some more permanent memorial than that of an exposition, which, within a few months from its close, will have disappeared, seems to us eminently proper. It is clear that, within the coming two years, no monument of so imposing a nature, or of so unique and original conception, can be constructed of any other material than iron, nor, indeed, can we hope to erect a fabric more completely national in every feature. Not only then shall we commemorate our birthday by the loftiest structure ever built by man, but by an edifice designed by American engineers, reared by American mechanics, and constructed of material purely the produce of American soil.—*Scientific American.*

HELIOCHROMIC PICTURES.

The following is a translation of a paper by M. de S Florent, in the "Bulletin of the French Photographic Society."

After many unsuccessful attempts, I have at last been fortunate enough to discover a method of producing, with great ease and certainty, heliochromic prints whose colours are closely allied with those of nature. I have obtained by my method reproductions of coloured glass and stamps. I can also obtain landscapes in the camera, but with colours rather weak in nature, the result, no doubt, being capable of improvement by having recourse to a better adapted apparatus. My method of operating, at which I have arrived after numerous trials and experiments, I will now describe :—A sheet of paper, with as fine a grain as possible, is plunged into a silver bath made up as follows : Nitrate of silver and distilled water, 20 parts of each ; as soon as a solution has been made, there is added, alcohol, 100 parts ; nitric acid, 10 parts. When the sheet has been thus treated and dried again, it is further plunged into a solution of

Hydrochloric acid..................	50 parts
Alcohol	50 "
Nitrate of uranium..................	1 "

A little zinc white is dissolved into the hydrochloric acid beforehand.

After this double treatment, the sheet of paper is exposed to sunlight for a short time, until its surface has assumed a violet blue tint. It is then immersed again, after desiccation, in the silver, as also in the hydrochloric bath. These operations are repeated until a most intense blue has been obtained, this being the only way to secure very vigourous images.

Before the paper is altogether dry, it is put into another bath, made up by adding a few drops of a solution of mercury, dissolved in nitric acid, to some distilled water. The sheet is allowed to remain from five to ten minutes in this last named bath, and is then dried by contact with blotting paper.

The sheet thus sensitised is then exposed to light under coloured glass—a coloured magic lantern slide, for instance ; and after a period of twenty to thirty seconds in the sunlight, an impression on a white ground is obtained, with all the colours of the model. The colours are more vivid, and the rapidity quite as great, if there is added to the bath just mentioned :—

Saturated solution of bichromate of potash or ammonia..........................	2 parts.
Sulphuric acid..........................	2 "
Chlorate of potash......................	1 "

To fix the prints in some degree, they are washed in plenty of water, and then immersed in

Ammonia....................	5 parts
Alcohol..........................	100 "

After again washing, the impression is put in a bath saturated with an alkaline chloride. Then, after a final washing, the image will be found to resist for a considerable time the action of diffused light.

ACTION OF COLOURED GLASS.

1. Much greater rapidity is obtained if the chloride of silver paper is darkened under violet or blue glass.

2. If, on its exit from the nitrate of mercury bath, the sheet is exposed under a coloured glass, and there are interspersed, between the sunlight and the glass, screens or glasses of different colours, it will be observed that the colours appear more rapidly under the yellow, green, and red screens, than under the blue and indigo ones.

COMPLEMENTARY COLOURS.

The phenomenon of complementary colours, observed by M Becquerel when plunging the impressions in ammonia, is exceedingly easy to produce with paper. To effect this, it is only necessary to put the print, after it comes out of the frame, into a solution of carbonate of soda, and then plunge it, after washing, in a solution of nitrate of lead, and expose it to sunlight in a bath of an alkaline chloride. The phenomenon may also be produced in several other ways.

To reproduce landscapes in the camera, it is necessary to prevent, as much as possible, the action of diffused light, and to do this a cone of cardboard of sufficient length is fixed in front of the lens. The time of exposure with a Darlot lens of about eight inches focal length is from fifteen minutes to an hour, operating with an open stop and in full sunlight.

IT is said that 400 men were killed in the State of New York in seven months while coupling cars.

AN EPISODE IN THE EARLY ENGLISH GLASS TRADE.

By J. A. Langford, LL.D.

The reign of Elizabeth was one of intense activity in all departments of public life. The mind of England, liberated from the bondage of centuries, displayed the utmost energy, and sought for employment for its newly-awakened powers in all the fields of human enterprise. It was an age of unparalleled greatness, in which men "went about their noblest tasks like children at their play." In poetry, in philosophy, in government, in war, and in adventure, were found fitting and appropriate openings for the exercise of the highest genius and the use of the ablest talents. It is the age of Shakespeare, of Spenser, of Bacon, of Raleigh, of Cecil, and innumerable other mighty souls who have left their impress on all succeeding ages, and whose "memory the world will not willingly let die." And over all these great ones was placed a ruler who knew how to avail herself of their varied powers, who won for her glory, their deepest devotion and self-sacrificing service, and, working together for the common good of their country, they made her reign one to which all Englishmen look back with pride, and still regard as one of the grandest and brightest epochs in the history of this greatly-favoured land.

As was only natural under such circumstances much attention was paid to the industries of the country, and trade and commerce partook of the new energy and new life which had been so widely aroused and developed. In the correspondence of the time which has been preserved, we find many curious and interesting evidences of the great activity displayed in all matters connected with trade, and that the spirit of enterprise and adventure which animated the nobles and the upper classes, was equally active among the middle classes, the great trading companies, and the people. The heart of the whole nation had been stirred to its depths, and the effects of this marvellous awakening were as visible in the enterprise of the people as in the daring deeds of the commanders, the unconquerable bravery of the adventurers, the matchless wisdom of the statesmen, and the unrivalled strains of the poets whose works have immortalised the reign of Elizabeth.

In the Lansdowne MSS. is preserved a very curious letter from George Longe to Lord Burghley desiring a Patent for glass-making, in which he describes how the trade came first to England. This remarkable letter is published in the second series of "Original Letters Illustrative of English History," by Ellis, and is worthy of being reproduced in *Iron*. It is as follows :—

To the right honourable the Lord Burgleighe, Lord Treasurer of England.

Att what tyme that troubles begun in France and the Lowe Countryes, so that glass could not conveniently be brought from Loraine into England, certaine glassmakers did covenantte with Anthony Dollyne & John Carye, merchants, of the said Low Countryes, to come and make glass in England. Wheruppon Dollyne & Carye obtained the Patent for making glass in England in September, the ixth yeare [1566] of the Queene's Majesties raigne for xxj years ensueinge under these conditions, to teache Englishmen & to pay custome, which Patent was fully expired a yeare ago

Carye & Dollyne, having themselves no knowledge, were driven to lease out the benefitt of their Patent to the Frenchmen, who by no means would teach Englishmen, nor at any tyme paide one peny custome. Carye being dead, Dollyne tooke vjd. upon a case of glass.

For not performance of covenants, their Patent being then voide, about vj. yeares after their grant, other men erected and set on worke divers glasshouses in sundry parts of the realme, and having spent the woods in one place, doe duyly so contynue erecting new workes in another place without check or controule.

About vij. yeares past, your honour called them that kept the glasshouses before you, to knowe who should paye the Queene's custome, whose answere generally was, that there was no custome due, but by condicions of a speciall priviledg which no one of them did enjoye, and they not to pay custome for comoditys made within the realme Thus hath Her Majestie beene deceived and still wilbe without reformation.

I most humbly desire your honour to graunt me the like Patent, considering my pretence is not to contynue the making of glass still in England, but that therebye I maye effectually repress them. And wheras ther are now fifteen glashouses in England. Yf it so like your honour (graunting me the like Patent) to enjoyne me at no tyme to keep above ij glashouses in England, but to erect the rest in Ireland, whereof will ensue divers commoditys to the commune wealth, according to the effect of my former petition.

The woods in England wilbe preserved.

The superfluous woods in Ireland wasted, then which in tyme of rebellion Her Majestie hath no greater enemy theare.

The country wilbe much strengthened, for every glashouse wilbe so good as twenty men in garison.

The country wilbe sooner brought to civilitye, for many pore fol .s shalbe sett in worke.

And wheras Her Majestie hath now no peny proffitt, a double custom must of necessity be paide. Glass be transported from Ireland to England.

May it please your honour to be gracious unto me and, God willing, I will put in sufficient securitye not only to performe all things concerning the Patent, but also (thankfully acknowledgeing the good I shall receive by your lordshipp) to repaire your honor's buildings from tyme to tyme with the best glasse, duringe the leave of said Patent ; & allso bestowe one hundred Angels at yovr honor's appointment.

I have spoken to Dollyne as your honor willed me, & may it please your honor to appoint some tyme that we may both attend your honor.

Your honour's poore orator,

George Longe.

We do not know whether George Longe's petition was granted or not. The pretty little bribe offered to keep Lord Burleigh's buildings in repair "with the best glasse," and to give him, in addition, "one hundred Angells," was likely to prove effective, and is in strict accordance with the habits of the time Such bribes or "fees" were the recognised payment for such services, and were looked upon as part of the recognised revenue of all persons holding public offices. George Longe was too shrewd a man of business not to include such offer in his petition. We do not know the petitioner's success, but we do know that he was not able to divert the trade from England, and transplant it into Ireland, notwithstanding the many public advantages which he delares would result from such a transference. Looking at the magnitude of the glass trade in England at the present time, it is curious to note that three hundred years ago there were only fifteen glass-houses in the kingdom, and that George Longe proposed to reduce them to two. It is also illustrative of the time to find the petitioner placing as one of his principal reasons for urging his suit for the granting of the patent, that the trade would destroy the superfluous woods in Ireland, "then which in tyme of rebellion Her Majestie hath no greater enemy there." Such a reason would not fail to have its weight with the astute statesman to whom it was addressed.

A Simple Ornament.—A pretty mantelpiece ornament may be obtained by suspending an acorn, by a piece of thread tied around it, within half an inch of the surface of some water contained in a vase, tumbler, or saucer, and allowing it to remain undisturbed for several weeks. It will soon burst open, and small roots will seek the water; a straight and tapering stem, with beautiful glossy green leaves will shoot upward, and present a very pleasing appearance. Chestnut trees may be grown in the same manner, but their leaves are not so beautiful as those of the oak. The water should be changed once a month, taking care to supply water of the same warmth ; bits of charcoal added to it will prevent the water from souring. If the little leaves turn yellow, add one drop of ammonia into the utensil which holds the water, and they will renew their luxuriance.

The *Telegraph* says. St. John now is the great lumber exporting city of the world. We sent 2,000 tons more of lumber-laden vessels to Liverpool than Quebec, nearly 40,000 tons more than all the other Colonial ports put together. About 70,000 tons more than the pitch pine ports, and over 15,000 tons more than all the Baltic ports. Such an exhibit should be most gratifying to us, as it unmistakably shows how thoroughly we have eclipsed all competitors in the lumber trade. This year, there is little doubt will be even more favorable to St. John than last was, as there is a prospect of a large rise in Baltic wood.

RAILWAY MATTERS.

New Locomotive Bell-ringer.—*There is now in use on two* of the locomotives on the Northern Railway an excellent apparatus for ringing the bell by steam. It was obtained from the United States by one of the Northern engineers, Mr. Robert Pearson, who first saw it when attending the Convention of the Brotherhood of Locomotive Engineers, which met last summer in Philadelphia. It is a great improvement on the arrangement by which the bell is rung on the Great Western locomotives. By the latter the bell is rung faster or slower, according to the speed at which the engine is going. By this apparatus the bell is rung with a certain measured stroke, whatever be the rate of travel. The new bell-ringer consists of a miniature steam cylinder, with the piston of which the bell-cord is connected. The bell may be kept ringing continually or not, at the pleasure of the engine-driver.

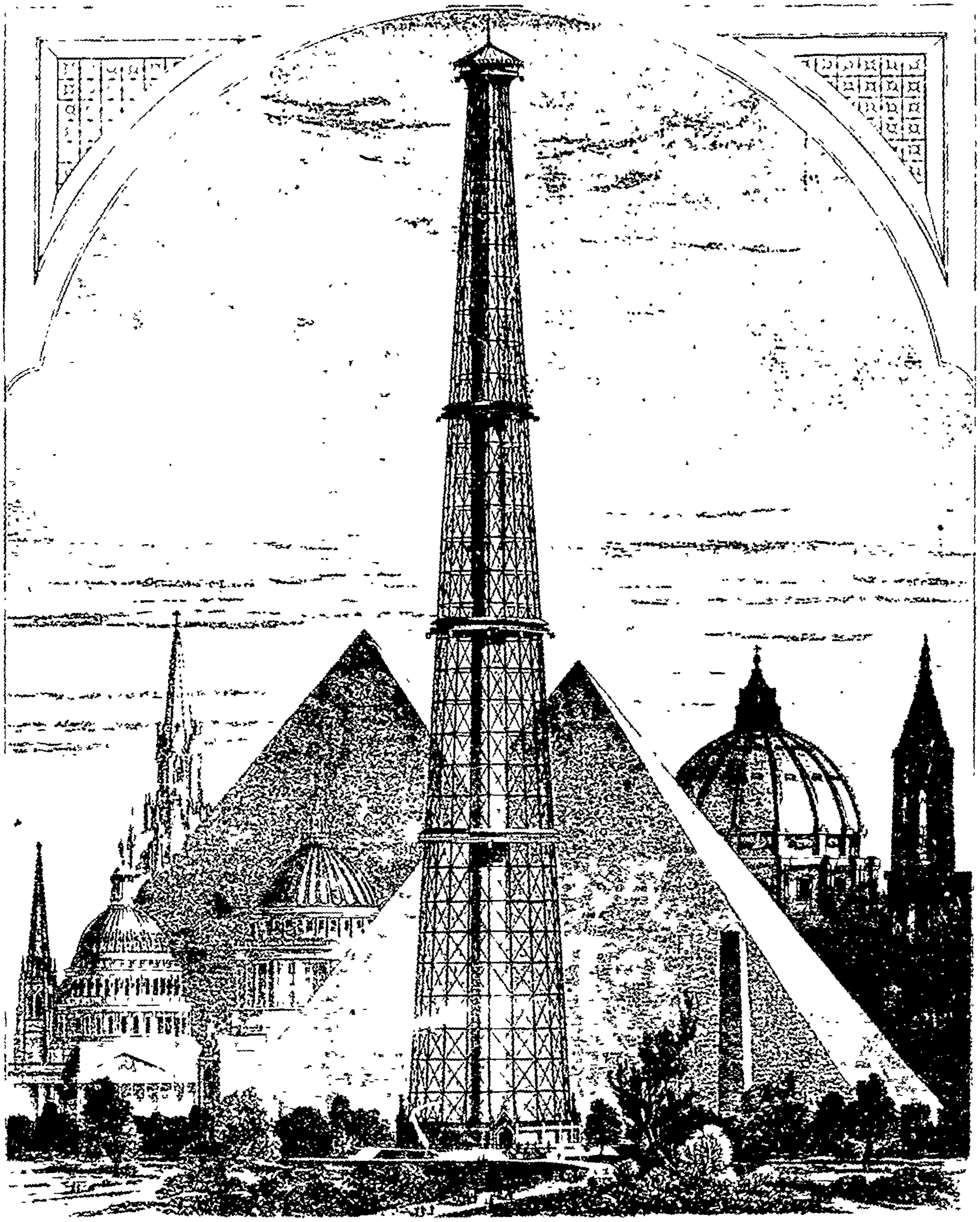
A Novel Railroad.—There has just been completed at the machine shop of Laferty and Brothers, Gloucester City, N. J., a fourton locomotive, designed to run on one rail. It is built for a street railroad company in Georgia. This engine can with propriety be called a steam velocipede, as it rests upon two wheels, one following the other. The rail or track upon which it is to run, a sample of which is laid in the yard of the builders, is styled a "Prismoid, or one track railway," and is composed of several thicknesses of plank, built up in the style of an inverted keel of a vessel, with a flat rail on the apex. Upon a trial a speed of about twelve miles an hour was attained, and the inventor and patentee claims that the speed can be almost doubled on a lengthened track. Mr Crow, of Opelika, Ga., is the inventor and patentee of both tracks and engines, and he claims that his inventions demonstrate a tractive power superior to anything in the locomotive line of equal weight. The capacity for running curves is very much greater than the two rail system The track upon which the trial was made contained 36 feet of lumber and 18 pounds of iron to the lineal foot, proving itself equal to a span of 20 feet, remaining firm and unyielding under the pressure of the engine as it traversed the road. The revolving flanges attached to the engine, and which run on the outsides of each wheel, Mr Crow claims, absolutely lock the rolling stock to the prism, and obviate the necessity of so much heavy rolling stock in light traffic at a high rate of speed. It is also claimed that prismoidal railway built with a base of fourteen inches, angles forty-five degrees, can be built at a cost of $3,000 per mile. The inventor is of opinion that his engine and track is particularly adapted to the propelling of canal-boats, and will compete successfully with horse-power on canals without necessarily interfering with the use of the latter, but he does not state in what way. The engine will shortly be shipped to its destination (Atlanta, Ga.), where it goes into operation on a street railroad built at an elevation of twelve feet above the sidewalk.—*Philadelphia Ledger.*

Some interesting experiments with mosquitoes have lately been made by Professor Mayer in the United States, who, at the session of the Academy of Sciences at the Steven's Institute, Hoboken, the other day, gave an account of his discoveries with regard to these insects. According to the *Pall Mall Gazette*, he said that by placing a male mosquito under the microscope, and sounding various notes of tuning forks in the range of a sound given by the female mosquito, the various fibres of the antennæ of the male mosquito vibrated sympathetically to these various sounds. The longest fibres vibrated sympathetically to the grave notes, and the short fibres vibrated sympathetically to the higher notes; the fact that the nocturnal insects have highly organised antennæ, while the diurnal ones have not, and also the fact that the anatomy of these parts of insects shows a highly developed nervous organisation, leads to the inference that these facts form the first sure basis of reasoning in reference to the nature of the auditory apparatus of insects. The experiments were also extended in a direction which added new facts to the physiology of the senses If a sonorous impulse strike a fibre so that the direction of the impulse is in the direction of the fibre, then the fibre remains stationary. But if the direction of the sound is at right angles to the fibre, the fibre vibrates with its maximum intensity. Thus when a sound strikes the fibrils of an insect, those on one antenna are vibrated more powerfully than the fibrils on the other, and the insect naturally turns in the direction of that antenna which is most strongly shaken. The fibrils on the other antenna are now shaken with more and more intensity, until the insect, having turned his body so that both antennæ vibrate with equal intensity, has placed his body in the direction of the sound. Experiments under the microscope show that the mosquito can thus detect to within five degrees the position of the sonorous centre.

Working the Cable.—But few persons in perusing a cable despatch understand the process whereby it reaches its destination. It may be thus described: An operator sits at a table in a room darkened by a curtain; on his left hand stands a little instrument named the "reflecting galvanometer," the invention of Sir William Thompson, without which Atlantic telegraphy would be a slow process, not exceeding two or three words per minute, instead of eighteen or twenty, the present rate. This delicate instrument consists of a tiny magnet and a small mirror swinging on a silk thread, the two together weighing but a few grains. The electric current, passing along the wire from Valencia, deflects the magnet to and fro. The mirror reflects a spot of light on to a scale, in a box placed at the operator's right hand, where, by its oscillation, the spot of light indicates the slight movements of the magnet, which are too slight to be directly seen. This little swinging magnet follows every change in the received current; and every change, great or small, produces a corresponding oscillation of the spot of light on the scale. A code of signals is so arranged by which the movement of the spot of light is made to indicate the letters of the alphabet. When receiving a message from Valencia, the operator watches the movement of the light speck, which keeps dancing about over the scale on his right. To his practised eye, each movement of the spot of light represents a letter of the alphabet, and its seemingly fantastic motions are spelling out the intelligence which the pulsings of the electric current are transmitting between the two hemispheres.

As india-rubber plates and rings, says the *Journal of the Franklin Institute*, are now used almost exclusively for making connections between steam and other pipes and apparatus, much annoyance is often experienced by the impossibility of effecting an air-tight connection. This is obviated entirely by employing a cement, which holds equally well to rubber and the metal or wood. Such cement is prepared by a solution of shellac in ammonia. This is best made by soaking pulverised gum shellac in ten times its weight of strong ammonia, when a shining mass is obtained, which, in three or four weeks, will become liquid, without the use of hot water. This softens the rubber, and becomes, after volatisation of the ammonia, hard and imperviable to gases and fluids.

We note, says the *Scientific American*, with no small degree of gratification that the project of a colossal telescope, which is to be the largest and most complete instrument that modern scientific knowledge can suggest, ingenuity devise, is actually in progress of elaboration. The scheme of a "million dollar telescope," to which we have so frequently referred, and which has encountered such an earnest support among large numbers of our readers, is in fact to be carried out; though whether it will be found necessary to expend the whole of this large sum of money is not determined. It is known that the cost of the great Washington instrument, which was to be $50,000, has not amounted to a sum greater than $30,000; and hence there is a possibility that that of the mammoth telescope now contemplated may fall below the large aggregate first proposed.



PROPOSED CENTENNIAL TOWER AT PHILADELPHIA. (See page 254.)