THE MODERN FLOUR MILL.

It may surprise some of our readers to learn that there is as much capital sunk in the flour milling business as in any other of the great British industries. Messrs. Macdougall Bros., of London, Liverpool, and Manchester, estimate the consumption of flour in the United Kingdom as 36,000,000 sacks per annum, of 280 lb. per sack. To manufacture this quantity there are about 7000 flour mills scattered over the country, varying in capacity from 100 sacks to 7000 sacks per week. The cost of the machinery in the smallest sizes will amount to about £2000, and in the largest to about £80,000; while the capital necessary to work the former cannot be less than £4000, and in the latter something like £300,000. A large percentage of this capital has been laid out within the past five years in equipping the mills with the new roller system; and in a future article we propose showing how the money thus spent has been distributed among the British and foreign engineers. Our object at present is to explain fully by the accompanying "flow sheet" the *modus operandi* followed in roller milling, by reference to a mill doing 1200 sacks per week.

From the flow sheet it will be seen that the wheat, as it comes from the farmer or from the ship, is first passed into an ordinary scalping reel, about 8ft. in length by 3ft. in diameter, covered with No. 16 tinned iron wire, which dresses out the dirt and small seeds. The tailings of this scalping reel are passed to the zigzag separator, which is an upright machine containing a number of sieves. The first sieve removes the rubbish, such as sticks, stones, and nails; the second and third remove the oats, maize, barley, and short straws; the fourth sieve removes the cockles, seeds, and sand. The wheat next passes to the smutter, where it is first operated on by a strong separator, which removes light grain, seeds, and dust; then it is scoured of any impurities adhering to the grain. From the smutter the wheat passes to the brush machine, which brushes and polishes it. It then drops to the magnetic separator, which removes small nails and pieces of wire. The wheat is now cleaned, and is spouted, or elevated, to the wheat grader. The grader is an ordinary cylinder machine, fitted with an adjustable reel. The wires of the reel are set so as to let the small grains pass through it, while the larger ones pass over the tail. The object of this is to treat the smaller grains on a pair of rolls with twelve corrugations to the inch, and the larger ones on a pair with eight corrugations. The wheat in passing through the first break rolls is only slightly touched, to open it up along the crease of the berry, to liberate the dirt lodged there. Following the lines of our flow sheet, it will be seen that the wheat in this slightly broken condition is spouted from the first break roll to the first break scalper, where the crease dirt is dressed out through a No. 10 silk. The first break middlings pass through a No. 16 wire machine, and are spouted to No. 4 purifier. The tailings of the *inner reel* of the first break scalper, which is still 99 per cent. of the cleaned wheat, are elevated to the second break rolls, which have sixteen grooves to the inch, and the wheat is broken down further; and the part of the kernel liberated is dressed out on the second scalping reel, while the tailings are elevated to the third break rolls, which have twenty grooves to the inch. The wheat is gradually broken down on the remaining breaks, and the inner part of the wheat berry dressed out from the husk or bran in the same manner as described in the second break. About 8 per cent. of the kernel of the berry is liberated in the second break, 35 per cent. in the third break, 30 per cent. in the fourth break, 15 per cent. in the fifth break, and about 12 per cent. in the sixth break. This is about 86 per cent. of the entire wheat, and the remaining 14 per cent., which, it will be seen, comes over the tail of the bran duster, is the husk or bran. The kernel, in the broken condition in which it comes from the scalping reels, is a mixture of semolina, middlings, and break flour, and part of the fibrous husk rasped off by the corrugations of the rolls. The entire product, as mixed, is called "break meal" or "chop;" and in order to separate these different ingredients the "break meal" is spouted to the chop reel—see No. 7. This machine is simply the old-fashioned hexagon reel, formerly used in the millstones mills to dress out all the flour. In pass-

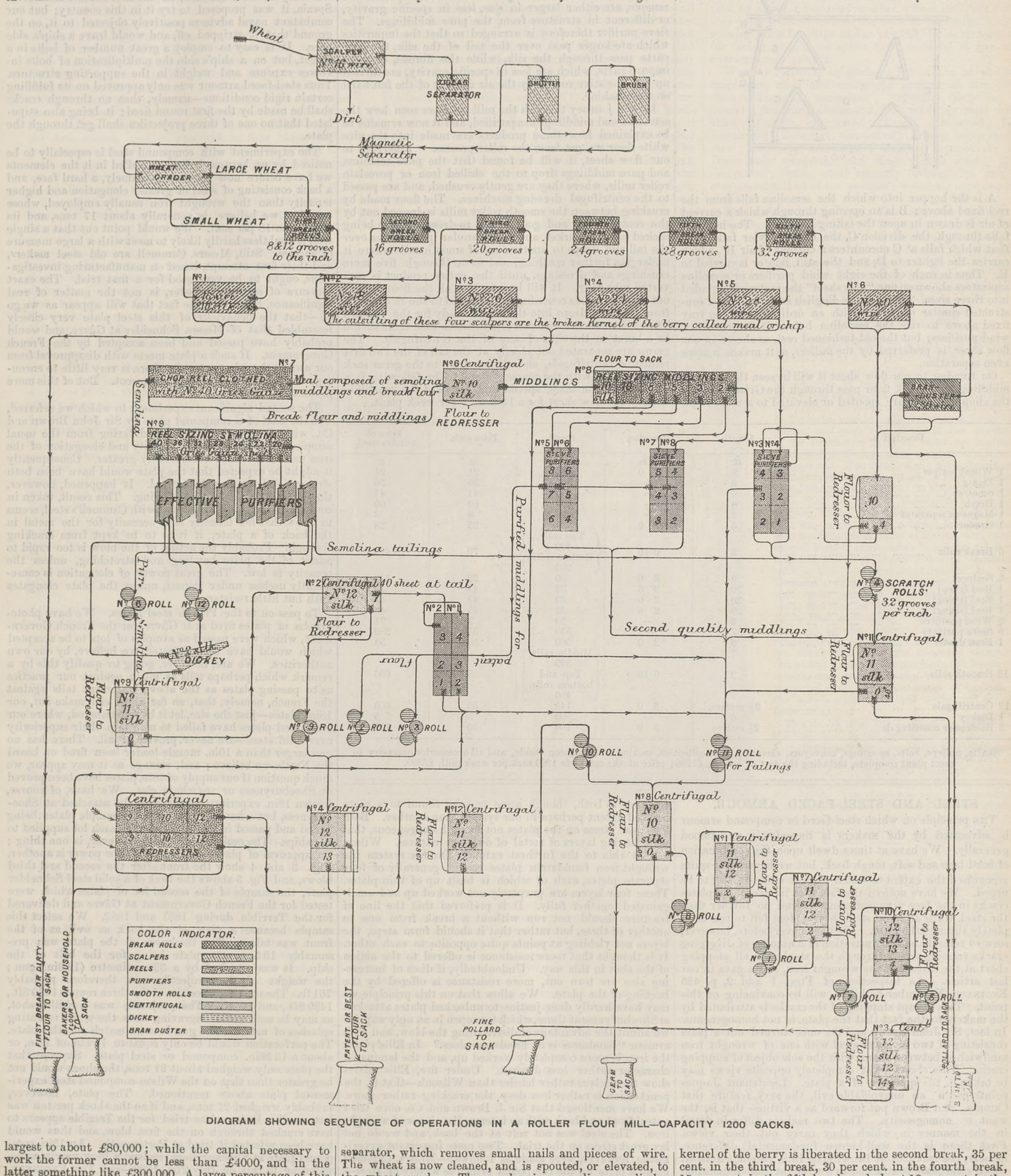
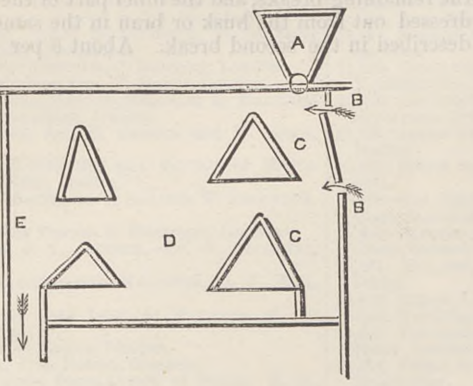


DIAGRAM SHOWING SEQUENCE OF OPERATIONS IN A ROLLER FLOUR MILL—CAPACITY 1200 SACKS.

ing this reel, the middlings and break flour pass through the No. 40 Gries gauze, while the semolina, which consists of the largest parts of the reduced kernel, comes over the tail, and drops to the effective or wind purifiers.

The wind purifier has only been introduced into England within the last five years, although it was invented by Ignaz Parr, of Tattendorf, half a century ago. The following is a section of Parr's machine, and the English engineers have not been able to improve on it:—



A is the hopper into which the semolina falls from the reel fixed above; B is an opening through which a current of air is drawn in upon the falling material. The heaviest falls through the division C, the next heavier falls at D, that which falls at C encounters a current of air B', which carries the lighter to D, and the still lighter is carried to E. Thus in each of the eight wind purifiers or semolina aspirators shown on our "flow sheet" the material is graded into three sizes. Some of the English engineers have constructed similar machines, with an ordinary shaking tray fixed above to size the semolina before it drops to the wind purifiers; but the old-fashioned reel, as shown in our flow sheet, is preferred by the millers, as it makes a more even separation.

On turning to our flow sheet it will be seen that the fine middlings and break flour pass through the Gries gauze on the chop reel, and are spouted or elevated to a centrifugal dressing machine—No. 6—where the break flour is dressed out and sent to the re-dresser, while the middlings, which come over the tail of No. 6 centrifugal, drop to the sizing reel, where the two head sheets of No. 10 silk dust out any flour, and the remaining four sheets of 8, 5, 3, and 2 silk grade the fine middlings on to the sieve purifiers. The sieve, or fine middlings purifier, has been constructed in many different styles, and the designs are very numerous. The machine, however, is simply an ordinary sieve covered with silk, with a fan exhausting a current of air through it. The impurities in the middlings, which it is the object of the sieve purifier to remove, are either larger in size, less in specific gravity, or different in structure from the pure middlings. The sieve purifier therefore is arranged so that the impurities which are larger pass over the tail of the silk, the pure parts pass through the silk, while the fibrous, or most impure parts, which are less in specific gravity, are carried up into the stive rooms by the air current of the fan fixed on the machine.

In our journey through the mill we have seen how the semolina and middlings are purified, and it now remains to be explained how these products are made into the nice white flour we get from the roller process. Referring to our flow sheet, it will be found that the pure semolina and pure middlings drop to the chilled iron or porcelain roller mills, where they are gently crushed, and are passed to the centrifugal dressing machines. The flour made by crushing between the smooth roller mills is dressed out by the centrifugals, and goes to the re-dresser before being sacked for the market, and the granular part comes over the tail and drops to another set of smooth rolls where it undergoes further crushing, and so on through five more crushings and dressings, until the entire product is converted into flour. It will be seen that all the flour dressed out by the various centrifugals is spouted to the re-dressers, from which it drops into the sacks ready for the market. The re-dressers are used as a precaution in case there should be a burst on the silks of any of the centrifugals. The germs are separated out chiefly at the tail of the two first reduction centrifugals, and thence pass to the germ sack or are mixed with the coarse pollard. The following is a summary of the sizes, speeds, and prices of the machines used in one flow sheet for a 1200 sack per week plant.

Descripti n.	Length.	Diameter.	Speed.	Price each.	Price of number used.
	ft.	ft. in.		£	£
1 Wheat scalper	8	3 0	33	21	21
1 Zigzag	6	—	500	36	36
1 Smutter	6	—	550	44	44
1 Brush	6	—	650	60	60
1 Magnetic separator	2	—	20	8	8
1 Grader	5	2 0	35	28	28
6 Break rolls	2	0 10	Top rolls, 400; Bottom rolls, 290	70	420
6 Scalpers	9	3 0	30	22	132
1 Reel (chop)	20	2 6	32	45	45
1 Reel (sizing)	20	2 6	32	45	45
1 Reel (sizing)	20	2 6	32	45	45
8 Wind purifiers	2	—	20	3	24
8 Sieve purifiers	7	—	550	35	280
1 Bran duster	6	2 0	500	50	50
12 Smooth rolls	2	0 10	Middle rolls, 340; Top and bottom rolls, 400	58	696
12 Centrifugals	2½ metres	3 0	145	50	600
1 Dickey	6	—	500	5	5
2 Re-dresser centrifugals	2½ metres	3 0	160	50	100

Shafts, pulleys, belts, spoutings, conveyors, elevators, dust collectors, sacking and weighing tackle, and all accessories necessary to erect plant complete, including the cost of labour, £1260; price of the complete 1200 sack per week mill, £3899.

STEEL AND STEEL-FACED ARMOUR.

THE principle on which steel-faced or compound armour is advocated by the makers is imperfectly understood generally. We have at times dwelt upon the combination of hard face and soft, tough back, but we have never quite recognised the extent to which we now understand it to be urged. We have noticed the fact that in steel-faced plates cracks in the face very commonly extend no further than the steel, while in solid steel they seldom fail to run completely through the mass. We have never before, however, seen so remarkable an illustration of a number of diverging cracks running freely through the steel, and all stopping short at the surface of the wrought iron, as we gave in our last article. An inspection of Figs. 1 and 2, p. 425 ENGINEER, November 26th last, will be convincing on this point. This abrupt stopping of the cracks is attributed by the makers to the fact that the plate is not homogeneous. In fact, Sir John Brown and Co. once turned out a plate consisting of two layers of steel with one of wrought iron sandwiched between them, with the sole object of stopping cracks. This shows what completely opposite views may be taken o. the qualities of a plate. Lieutenant Jaques points out a. an unavoidable evil, the very feature that Camme and Brown put forward as a virtue—that is, the want o nomogeneity. The two makers differ in detail in the manner in which they carry out their views. First there is the well-known fundamental difference, namely, the fact that at Brown's, on Ellis' patent, a finished rolled steel plate is attached to a wrought iron foundation plate by running in molten steel between them; while at Cammell's, on Wilson's patent, the wrought iron foundation plate is brought straight from the furnace, and after having had the scale removed, immediately receives on it, in a mould, the molten steel which forms the face plate. There are advantages urged in support of each of these systems. Wilson's plan is preferred on the ground that one reheating is saved, and that the plate is able to be freed from scale and a sounder body of steel put on it; while Ellis claims that he secures a more perfect face. We may observe, however, that our object is not here to discuss the differences between the systems, but rather to put forward the features common to both, though some may be found to a more marked extent perhaps in one system than another. Both lay great stress on the plates not being homogeneous, that is, in having layers of metal of different natures. Wilson carries this to the furthest extent. On his system the wrought iron foundation plates consist generally of four separate plates, each of which is built up of thin plates. These four layers are purposely not worked up and amalgamated together fully. It is preferred that the line of fracture should not run without a break from one to another of these, but rather that it should form steps, the layers not yielding at points quite opposite to each other. It is thought that more resistance is offered to the action of the shot in this way. Undoubtedly, if discs of increasing size are torn out, more resistance is offered by the backing of the plate. We allow that on this principle we may have hardly done justice to unbacked plates attacked at Shoeburyness at times, which tore open in an ugly way, for we admit the advantage of distributing the blow, and with armour "handsome is as handsome does." In Ellis' plates the iron is more completely worked up, and the laminated character rather less distinct. Under fire, Ellis' plates show themselves rather harder than Wilson's—that is, the penetration is rather less deep, the cracking rather more. We have mentioned that Sir J. Brown and Co. once tried a steel front and back with an intermediate layer of wrought iron. The steel was not soft at the back, and we do not lay great stress on the trial. Two more important experiments, however, were made as follows:—Messrs. Cammell made a plate on the compound principle wholly of steel—that is to say, with hard steel in front and soft steel behind. The steel face had a breaking strain of about 47 tons per square inch, and an elongation of about 1·5 per cent.; whereas the back had about 23·0 tons tenacity, and 25 per cent. elongation. This plate was fired at on board the Nettle, at Portsmouth, on March 14th, 1884, under an experimental title. Its dimensions were 8ft. by 6ft. by 10½in. thick. It was attacked by a 10in. muzzle-loading gun, with a chilled iron projectile weighing 400 lb., and a striking velocity of 1364ft. This would give a total striking energy of 5160 foot-tons, or about 573 foot-tons per ton of plate, supposing the plate to weigh about 9 tons. The calculated perforation would be about 13in. of iron, or 9·8in. of compound armour or steel. Three blows were delivered on it. The plate stopped the shot well, the projectiles only entering to a depth of about 5in. Nevertheless, it did not behave in a way that would meet with approval with English authorities, seeing that it cracked all over in through cracks—*vide* Figs. 1 and 2. It remained held up by its bolts, but was divided into pieces, and was not considered sufficiently satisfactory to encourage further trials in the same direction at the time.

It may be here said that, on the first success of steel at Spezia, it was proposed to try it in this country; but our combatant naval advisers positively objected to it, on the ground that it stripped off, and would leave a ship's side bare. It is easy to employ a great number of bolts in a target, but on a ship's side the multiplication of bolts involves expense and weight in the supporting structure. Thus steel-faced armour was only approved on its fulfilling certain rigid conditions—namely, that no through cracks shall be made by the first round fired; it being also stipulated that no one of three projectiles shall get through the plate.

The experiment with compound steel is especially to be noticed by us, because it had embodied in it the elements we have before now suggested—namely, a hard face, and a back consisting of steel of greater elongation and higher tenacity than the wrought iron usually employed, whose tenacity, we believe, is generally about 17 tons, and its elongation 18 per cent. We would point out that a single trial is doubtless hardly likely to meet with a large measure of success. Still, Messrs. Cammell are old steel makers, and their first attempt, based on manufacturing investigations, ought to be very good for a first trial. The exact measure of success, however, is not the matter of real significance, but rather the fact that will appear as we go on—that the behaviour of this steel plate very closely resembled that of Messrs. Schneider at Gâvre, and would probably have passed and been accepted by the French Government. If such a plate meets with disapproval from our own authorities, naturally there is very little to encourage the further trial of steel at present. But of this more presently.

The second significant experiment to which we referred, was the trial of a compound plate by Sir John Brown and Co., with a wrought iron back differing from the usual sample, in the fact that the tenacity and elongation of the iron used were both considerably greater. Consequently it might be expected that the plate would have been both stronger and tougher than usual. It happened, however, that it cracked instead of bulging. This result, taken in conjunction with that obtained with Cammell's steel, seems to show that *low* tenacity is a necessity for the metal in the back of a plate, if it is to be kept from cracking through. Probably the action of the blow is too rapid to admit of the plate bending and stretching, unless the tenacity is low. The great power of elongation is consequently useless under impact, unless the plate elongates with but little resistance.

To pass on to the French steel plates. We have photographs of plates fired at at Gâvre for the French Government, which were passed as samples of lots to be accepted which would have been rejected, we believe, by our own authorities. We are, however, going to qualify this by a remark which perhaps tells as much against our practice as to passing plates as the above statement tells against the French, namely, that, so far as we can make out, our 18in. plates—just the size, let it be remembered, where our compound plates have failed to maintain their superiority over solid steel—are never proved at all. There has no gun larger than a 10in. muzzle-loader been fired on board the Nettle we believe; and, strange as it may appear, we much question if our supply of 18in. plates have been proved at Shoeburyness or anywhere else. We have, of course, known 18in. experimental plates to be attacked at Shoeburyness, but what we question is the sample plates being tested and passed in the usual way for each lot supplied to our ships. The omission of a test, however, is one thing; the approval of plates of proved inferior power is another. Figs. 3 and 4 show the front after the second and third blows, and Fig. 5 shows the back of a solid steel Schneider plate, the sample of the second lot of plates which were tested for the French Government at Gâvre and delivered for the Terrible during 1881 and 1882. We select this sample because a view of the back as well as of the front was taken. The thickness of the plate was presumably 19·5in., the plate being for the belt of the ship. It was attacked by a 32-centimetre (12·6in.) gun; the weight of the projectile was therefore probably 761 lb. The striking velocities of the three rounds 1430·8ft., 1430·8ft., and 1504ft. The projectile was a chilled shot, as may be seen in the engraving from the white radiating splashes of metal. The gun is not a match for the plate. The perforation would be only equal to 17·8in. of iron, or about a 13·36in. compound or steel plate. Suppose that the plate only weighed about 21 tons, the shock would not be greater than that on the Wilson compound steel experimental plate above mentioned. The plate, however, probably weighed 27 tons, and if so the shock per ton was but small. Every plate tried for the Terrible appears to have cracked through on the first blow, and thus would have been rejected if tried at Portsmouth. An 18in. compound plate at Shoeburyness received a blow nearly corresponding to this on July 21st, 1880—*vide* THE ENGINEER, August, 1880—with insignificant effect from the 12·5in. gun, with a chilled iron projectile striking with a velocity of 1504ft., the weight being 828 lb., and an energy per ton of 541 foot-tons.

Both Brown and Cammell's plates, when below 12in. thick, have borne an amount of work out of all comparison with this. An 11in. plate of Brown's, 10ft. by 5½ft. in area, at Shoeburyness received three blows from 9in. chilled shot, one blow from a 9in. steel projectile, and two blows from 12·5in.—38-ton gun—steel projectiles weighing 840 lb. and 845 lb. with 1425ft. and 1413ft. velocity and 19·8in. perforation, and about 11,820 foot-tons and 11,690 foot-tons. In all 38,471 foot-tons, or, taking the plate at 11 tons weight, 3497·4 foot-tons per ton of plate. Discs of metal were nearly or quite separated by the two last blows; but the backing was sufficient to stop them, and the plate held fairly together except one corner. This, of course, was a result beyond all comparison with what we have given above, for here an 11in. compound plate held together and stopped blows which were probably as severe as those which broke up the French steel 19·5in. Terrible plate, the energies being 11,820 foot-tons 11,930 foot-tons respectively. Moreover, the English plate was attacked by cast steel and the French one only by chilled iron projectiles. It is fair to remember, however, that we have only a limited number of results from Gâvre, and we have reason to think that these are worse than would now be obtained; although as we have nearly the whole of the samples tested for the Terrible, they probably represent fairly the quality of the supply at that time. It is quite possible that some very excellent samples might be produced from Gâvre, although hardly likely to be better than one which we shall give presently. We regard the Schneider plate tested at Spezia in 1882 as enormously better than the Terrible samples. This plate had no visible crack on the first round, and it received in four blows 3882·2 foot-tons per ton of plate. It was, however, by that time broken up, the upper portion of the plate hanging loosely out of its place, and large fragments detached altogether —*vide* ENGINEER, December, 1882.

The 1884 Schneider plate allowed the shot to pass clean through it, so that excellent as the plate appeared, it is impossible to argue definitely on it. We shall, however, probably do Schneider full justice if we take a case specially selected and put forward by that able writer, Lieutenant Jacques, as the crowning success in the shape of steel plates fired at at Gâvre, viz., that tested for the Admiral Baudin, on March 7th, 1884. Here three rounds were fired at a plate 12ft. 9in. long, 8ft. 2in. wide, and from 18in. to 20in. thick, weighing 35·45 tons. The 32 centimetre—12·6in.—gun attacked it with three chilled iron projectiles, the two first striking it with velocities of 1518, 1518ft., and on places 18·5in. thick, and the third one with 1593ft. on a place 19·8in. thick. The last gives a perforation of 19·44in. of iron, or 14·58in. of compound on steel. The plate looks well in the drawing, but the test is not a severe one; chilled projectiles were employed, the heaviest blow being only about 378 foot-tons per ton of plate, and the whole three only making up 1064 foot-tons per ton of plate. The shield, moreover, is apparently broken entirely through into two pieces, and only preserves its fine appearance from being well bolted up; and this may bring us to the great distinguishing characteristic of solid steel as compared with compound armour, when both behave fairly well. This appears to be as follows.

Steel armour stands up rigidly, breaking up in through cracks, but if well bolted remains in its place. Steel-faced armour bends more under the blow, face cracks being formed, but much less through cracks than in steel; the back, when it yields, tears rather than cracks.

The habit of cracking through of steel has led the French makers to provide against the stripping of the plate by many well placed bolts. How successful this is, may be seen by an inspection of the back of the steel plate given on page 488, in which it may be observed that the cracks seldom run through the bolts. With this experience it is no wonder that Schneider insisted on having twenty bolts in the 1882 trial, when the Cammell and Brown competed with only six bolts each. Schneider was undoubtedly right, only Cammell and Brown should have had the same; but their encouraging experience with smaller plates and the limited firing trial of 18in. plates rendered them more liable to be caught in this way than Schneider. We have now to consider another point—namely, the element of certainty in behaviour. We have spoken of the variation in the quality of steel being always, so far as we know, greater than in iron; but there is another shape in which the caprice of steel is shown—namely, in spontaneous fracture. We have the extraordinary statement made to us, on authority which ought to be good, that out of the steel plates supplied for the Terrible—about ninety in number, we believe—eighteen actually cracked spontaneously. Of these, fourteen broke at Creusôt, either after tempering or after annealing; one cracked at the time of dispatch to the port, and three broke while in the port of Brest, but before they were placed on the vessel. If this is true, the Terrible is clad in very capricious armour, armour which would break and crack wholesale under fire, and possibly would develope cracks in severe changes of temperature. We may add, if it is bolted on the ship as well as Messrs. Schneider generally bolt it on, it would protect the ship well under heavy blows in spite of its cracking. On the other hand, the continued fire of comparatively light guns ought to produce an effect on it disproportionate to their power. We have seen a steel 18·9in. plate used for proof of 5·9in. projectiles at Spezia which received a great many blows without a great loss in resisting power. It cracked through in broad lines, but if well bolted it would resist any fire of 6in. guns likely to fall on it. Still, 5·9in. guns are very insignificant pieces to attack an 18·9in. plate. After considering all the facts we have discussed, what are we to conclude as to the relative positions of steel and steel-faced armour? It would be safer and pleasanter not to sum up at all, but we think we are bound to say, to the best of our judgment, what are our impressions at the present time.

In spite of a natural preference for English manufacture generally, we were inclined some time since to expect to see compound armour displaced by steel—steel on the compound principle perhaps, but steel in some form, sooner or later. Not so much on account of actual results, perhaps, as because of the great possibilities of steel generally. Just as steel had displaced iron in boiler plates, guns, and projectiles, so it seemed likely to do so in armour. We have strongly advocated the introduction of steel in guns and projectiles long before they were adopted in England, and when English interests were rather on the opposite side. We were much less confident in pronouncing in favour of steel armour, and could not do so in an unqualified way, because, although we had been disappointed in some larger compound plates, and thought that better steel plates had been made on a larger scale, compound plates of 12in. or below had repeatedly beat steel in competitions. We have now brought facts to our readers' notice that make us question whether compound plates may not finally prove to be the best, and certainly forbid our admitting that steel has shown itself superior up to the present time.

The facts that influence us are: (1) The cracking of our own steel experimental plates, made with soft steel backing, and still more the cracking of iron backing when it possessed the very qualities we supposed desirable—that is, high tenacity coupled with great elongation. (2) The records of the Terrible plates, and the conviction that, even in the selected specimen of the Baudin sample, the plate is broken entirely asunder by comparatively light blows, and those with chilled iron shot, which have long since, even in England, been pronounced inefficient for the attack of steel or steel-faced armour. If it be denied

Fig 7.

VIEW OF WOOD BACKING OF PLATE, FIG. 2

that the plates are cracked through, why is not the back exhibited? and if the plates will bear really severe tests well, why are guns of such disproportionate power used to prove them and those with chilled projectiles? (3) The strange account of the spontaneous cracking of steel plates. (4) The last victory of the compound plate over the steel at Pola, showing that on the scale where compound plates have been continually tested and best worked, steel has never been able to compete with them. These facts ought to be met with *actual* facts and figures before we are justified in passing them over.

Happily we are not greatly concerned as a country which kind of armour is eventually adopted. Cammell and Brown have the plant for making steel plates to-morrow, if desired.

At Brown's a gigantic press is in course of erection, capable, in their judgment, of turning out sounder steel plates than could be obtained by hammering. A great deal, however, would have to be done before steel could be allowed to displace steel-faced plates, and it may be well questioned whether the reverse process may not take place.

We should be very glad to see steel tried in this country. The question of superiority is quite an open one yet. The prospects of success for solid steel would, we think, under present circumstances, much depend on the power to give it a harder face than has hitherto been given to it, coupled with a softer back. It must also, we think, be shown to be free from the liability to spontaneous fracture or brittleness from atmospheric conditions. There is something pitiful in the thermometer being consulted and in the circumstance of a steel plate having to be warmed before firing at it, as we are informed took place at Amager in the winter of 1883-1884. Should the Admiralty change their minds, and conclude that the fact of plates breaking through does not signify so long as they are held in the place by bolts, the prospects of steel in this country will be much improved; but compound steel would, we think, in the long run, have a better chance than solid steel. So long as we expect to take down our plates intact and look at their backs after impact; and further, if we test them under oblique fire where a hard surface tells most, and if we back them well, we think solid steel is a long way from competing successfully with compound plates.

At some future time steel may probably become more trustworthy, it may possibly eventually attain the property of elongating instead of cracking under the blows of shot; but this is almost saying what we all know, that steel is daily made more and more like wrought iron in a pure form. At present those who employ them on their ships must take a practical view of the matter and choose between the properties possessed by the two kinds of armour as they are now presented to us, or are likely to be presented for some time to come. *Compound armour*, with *a steel face and soft iron back*, is likely to hold its own as the safest and most reliable plate for ships under present circumstances, while for facing granite or other hard material it has shown extraordinary powers.

We may conclude by giving a list of the naval Powers employing steel and compound armour at the present time:—England, compound; Argentine Republic, compound; America, compound, but we fancy steel will be tried; Austria, compound; Brazil, compound; China, compound; Denmark, compound; France, compound and steel; Germany, compound; Holland, compound; Italy, Italia only compound, the other vessels steel; Russia, compound; Spain, steel recently ordered for one ship, compound talked of for another; Sweden, compound and steel.

The makers are for *steel:* Schneider, at Creusôt. For *compound* (on Ellis' patent): Brown, at Sheffield (and on Wilson's patent), Cammell, at Sheffield; Marrel, at Rive de Gier, Loire; La Compagnie Anonyme des Forges, at Paris; La Compagnie des Hauts Fourneaux, St. Chamond; the Dillinger Works, in Germany; and Tjora Ironworks, Kolpino, St. Petersburg.

TRIAL OF THE SPANISH TWIN-SCREW TORPEDO CRUISER "DESTRUCTOR."

THE development of high-speed vessels is one of the features of naval architecture of the present day. This development is due to improvements in the system of construction of hull, improvements in forms of vessels, improvements in forms of propellers, and more than these, in the development of the locomotive type of boiler for marine purposes, and in the increased speed at which engines are now run. The most recent development of this combination has been made in the Destructor, a vessel which we described in a former issue at the time that the Spanish Government gave her designers, Messrs. Thomson, the order to build her. She was projected by Admiral Pezuela, who was then the Spanish Minister of Marine, who requested several British shipbuilders to submit a design of a seagoing vessel of about 350 tons displacement, with as high a speed as could be obtained. Messrs. Thomson's design was accepted on account of the high speed promised. The vessel has since been built, and was on Monday put through her first official trial successfully. The conditions of trial proposed by the builders, and accepted by the Spanish Government, were that she was first to be run three times upon the measured mile, then to run at full speed for three consecutive hours; after this she was again to be run three times upon the measured mile. From the results of the mile runs the speeds upon the three hours' run were to be determined.

This severe trial was successfully carried out on the 13th inst., in the presence of a Commission of Spanish naval officers, appointed by the Minister of Marine. The following were the members of the Commission: Commodore Casariego, Commodore Montojo, Captains Villaamil, Romero, Elduayen, and Goitia. The vessel was tried at the Admiralty knot at Wemyss Bay, Firth of Clyde, and afterwards ran out to sea about thirty-five knots. The results of the whole day's running show that the Destructor attained a mean speed of 22·65 knots per hour continuously for four hours, including the time occupied in running the mile. The weights carried on this trial were equivalent to having the vessel's armament of one 9 centimetre gun, four 6-pounders rapid firing, and two 47 millimetre Hotchkiss revolving cannon, with all ammunition complete, five torpedo tubes, and ten torpedoes; the crew and their provisions and effects, all spare gear, tools, and fresh-water for machinery; the vessel complete in all respects for sea, and with sufficient coal on board to carry her at 11½ knots for 1800 knots.

The machinery of this vessel is of the high-speed torpedo boat type, but is very much larger. There are two sets, each developing 2000 indicated horse-power. They are triple expansion, and have been designed to run at 350 revolutions per minute. The engine-room is divided into two separate water-tight compartments, each side being protected by a ¾in. bulkhead and coal bunkers. The boilers are of the locomotive type, but have several important improvements introduced by the builders. They are four in number, each in a separate water-tight compartment. The advantage of this minute subdivision is obvious, not only for purposes of buoyancy, but for subdivision of effects of accident of any kind. These boilers are protected by coal bunkers in the same way as the engines. There is a transverse bunker before the boilers, and before this is a bulkhead 1¼in. thick, which protects the machinery from raking fire. Abaft of the engines is a cross bunker, which affords similar protection from aft. The machinery worked very successfully, the boilers showing no sign of priming or leakage. The forced draught was very moderate, being only 2in. The results of these trials will be particularly interesting to warship engineers at the present time, as attempts have been made by the Admiralty to introduce this type of machinery more generally into warships, but they have not yet been very successful. It is only by great care and fortunate experience that it is possible to avoid disaster in this type of boiler and engine when worked in groups in large ships.

The vessel had a run of 135 knots in order to determine her consumption at about 11 knots, and it was determined that with the amount of coal she can carry in her bunkers she can steam 5100 knots at 11½ knots per hour. This same quantity of coal will carry her 700 knots at full speed. In addition to the members of the Spanish Commission, there were present at the trials Mr. Bakewell and Mr. Bennett, of the Admiralty, Mr. J. R.

Thomson, Mr. G. P. Thomson, Mr. Parker, Mr. C. D. Haynes, Mr. Biles, Captain Celies.

This vessel is interesting in many respects. She is not the first high-speed twin-screw vessel built in this country, but she is the second, the first being the Russian torpedo-boat Wiborg, of 168 tons displacement, which also was built by Messrs. Thomson. The Destructor's value consists not only in her high speed, but in the fact that she is able to maintain this speed in a seaway. Last week she was taken to sea with the Spanish Commission on board, and in a heavy sea she maintained a speed of 22 knots for four hours. The duplication of her machinery is an enormous advantage to her, compared with a single-screw ship. Her turning powers are good, as she has a very large after-rudder, and also an auxiliary bow rudder. She turns a complete circle in about one and three-quarter minutes and of less than three times her length. The protection by thick plates of the vital parts of the ship will be of value to her if she is ever attacked by machine guns. As it seems to be almost certain that high speed cannot be maintained in a seaway in a vessel of smaller size than this, we may confidently look to the Destructor as the forerunner of a large number of other similar vessels, whose chief characteristic will be their speeds at sea. It is to be regretted that this vessel is not the property of our own Admiralty, but we have no doubt that the Grasshopper type, though slower, will, if their machinery is successful, be useful ships of the same type.

LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our Correspondents.*]

AMENDMENT OF SPECIFICATIONS.

Sir,—I am very glad that you have considered the above a matter of sufficient importance to publish an article upon it in your last issue.

In my opinion, the greatest care and strictness ought to be observed in allowing amendments of specifications, in order to prevent abuse, which may very soon be practically encouraged by any laxity of administration. There are, I have no doubt, many cases in which it may be quite fair to allow of amendment "by way of disclaimer, correction, or explanation, stating the nature of such amendment, and his—the applicant's—reasons for the same."

It is, I think, quite legitimate to allow a patentee to enter a disclaimer, when believing his invention to be new at the time of filing his specification, he has since found that some part of it has been legally anticipated. I also think it right to allow him to correct an error that he is able to show, to the satisfaction of an authorised officer, has arisen through inadvertence, and to explain a statement in a part of a document in such a manner as to avoid ambiguity, when it is plain from a fair interpretation of the whole document that such statement could not have been made intentionally ambiguous in order to cover different interpretations to be used according to convenience.

But looking at the great number of applications for amendment, and the many allowances of very extensive alterations in specifications, I very much doubt whether sub-section 8 of section 18 of the Act is in all cases fully complied with, the terms of which are:—"No amendment shall be allowed that would make the specification, as amended, claim an invention substantially larger than, or substantially different from, the invention claimed by the specification as it stood before amendment." Unless this provision be strictly adhered to, there may be great injustice to patentees who, relying on the obviously defective specifications, may have subsequently taken out patents for inventions in which the defects are obviated. Also, unless there is strictness observed in requiring accurate statements of the reasons for seeking amendment, abuses may arise. Such reasons should be not merely formal and colourable, but real and logical; and no amendment should be allowed that is not clearly included in such reasons.

It is no matter for surprise that there should be many appeals to the law officers, when we consider the nice discretion that is required in many cases in order to determine whether or not it is right to allow all or any of the amendments applied for. I think it advisable also to remind patentees that a court of law goes behind everything, and may in some cases reverse the order to amend. William Spence.

8, Quality-court, Chancery-lane, December 7th.

TRADE WITH CHINA.

Sir,—The following paragraphs, taken from a letter from a gentleman who has been living in south China and knows its people well, may not be found uninteresting:—

"It is a most difficult matter to persuade Chinamen to improve anything. So long as matters go along smoothly they are quite content, and it would require ocular proof to demonstrate to these people successfully. Your catalogue of machinery has also come to hand, but I fear it will be of no use in South China. Foot-power machinery would be more in place down here, for coal is very bad and expensive in the southern provinces, and steam power finds little favour. Even the steam-filature—silk-winding—establishments introduced by foreigners some years ago are gradually being replaced by similar machinery worked by foot power. On the river, too, instead of the passenger boats taking to steam power, the natives have exercised their ingenuity in introducing side-wheel and stern-wheel—chiefly the latter—boats, worked by eight to twelve coolies, treadmill fashion. It appears it is cheaper to feed coolies with rice than boilers with coal, and there is no danger of explosion with the former. Rice mills, sugar-crushing mills, marine engines, pumps, lathes, spinning machines, all to work by foot power or buffalo power, would be more likely to meet with a demand in the South of China, and they must be of the simplest and most inexpensive construction, and as light as possible. There is an immense business done in nets and lines for fishing, cordage, home-spun cloth—both cotton and rough and fine silk—straw matting—for sails and ornamental purposes—nails, needles, and any cheap, easily-managed machines that would help in the manufacture of such articles, would be more likely to meet a demand from the natives than anything I can think of in that line of business. I have been out here close on eleven years, and have been about the country a good deal, so I have a little confidence in speaking on these matters. I expect my remarks will hold good for the whole of China, but I have only had experience of the southern provinces. I do not intend you to imagine that this is an exhaustive list of the articles for which machinery might be introduced into China; far from it. But it is my intention to put you more in the track of what the natives might go in for. Small and cheap time-saving machinery, worked without the aid of steam is, I am sure, much more likely to find a market than steam ploughs, steam hammers, locomotives, cranes, and the like, to which so much space is given up in catalogues from England. Do you think it would be worth my while to make a collection of the iron and wooden tools, &c., to take home when I go, or should I be out of pocket in so doing, and dubbed a fool for my pains? Chinese are very conservative, and think their own things far better than any other, and it has often astonished me that instead of trying to force the home-fashioned articles down their throats, our manufacturers have not more consulted the requirements of the natives, and made them articles of their own much-respected shapes and sizes. It has struck me that perhaps our manufacturers do not know what these shapes and sizes are."

I have but lately returned myself from a visit to China and Japan, when I formed the conclusion that the adaptation of machinery on any large scale—except where the Governments are sometimes concerned—is somewhat remote; but in small agricultural tools and machinery there may be perhaps room for development by European enterprise. Wherever, however, wood is so cheap as in many parts of the East, and labour still more so, it will not be found easy to produce implements the economical result of which will justify their outlay.

For instance, it might not unnaturally be thought that the circular saw would beat hand labour out of the field; but I was assured that where it had been tried this had not been proved to be the case; and, moreover, the thrifty oriental compared unfavourably the waste caused by the wide-set teeth in their broad path through the wood with the minimum loss caused by the use of their own fine-toothed and bladed saws.

Again, in the burning heats of a Japanese summer I saw on the wide plains of Osaka tens of thousands of small farmers occupied in pumping water into the irrigation ditches; and though it at once occurred that here was a field for the European pump, examination seemed to prove that for simplicity, volume of water delivered, low cost, and portability—this last and most important point—the treadmill wheel pump actuated by one or two coolies would be extremely difficult to beat. At Canton I saw, too, the stern-wheelers propelled by coolies, spoken of by my correspondent, stemming the rapid current of the Canton river. Should the foregoing remarks, however, present to any manufacturing firm the thought of possibilities in the lines suggested, I shall have pleasure in affording any further information in my power, or in disseminating in the East any designs of articles considered as likely to be suitable.

Buxton-buildings, Chapel-street, Liverpool, December 8th. J. J. Birch.

RAILWAY BRIDGE OVER THE RIACHUELO.

Sir,—I have to thank Mr. Woodcock for his letter in your last issue, and am personally obliged for his kind offer of further explanation at his office; but as I am of opinion that the matter is of wider interest than our two selves, I will venture once more upon your and his indulgence with another letter.

The Clerk-Maxwell system is of very great value, but depends upon premises which must first be ascertained by calculation. It does not follow because a polygon of forces is obtainable at any node of a truss that therefore all the stresses acting on the members have been recorded. There may be transverse strain of great magnitude occurring in the same member for which the polygon records correctly a direct stress either positive or negative—*e.g.*, a trussed rafter under transverse strain from purlins placed between the nodes. There is an assumption in Mr. Woodcock's diagram that there is no compression in the end vertical; consequently it is all tension. But is not this a *petitio principii?* The reaction of the abutment would be the same, supposing there were no end vertical A I, and the bottom chord H K carrying its own load by virtue of its own transverse strength, passing to the abutment after the fashion of a plate girder, not as a truss. Again, if there were no king brace H A, and the truss ended as per Fig. 2, the whole of the reaction at H would have to pass down A I to H, producing transverse strain of an enormous amount upon H K, but the reaction of the abutment would be precisely the same. Coming nearer to the point, if the construction were as in Fig. 3—that is to say, the vertical meeting the king brace at a point X a little down the king brace from the node A—all the strains would be defined as by the link of a cantilever truss, all the stress from A K passing down A H. On the other hand, if the construction were as in Fig. 4—that is to say, the king brace meeting the vertical at a point X a little down the vertical from the node A—all the strains would be similarly defined, but H X would become a superfluous member, for it is evident that stress reaching A from K would pass continuously through A I without affecting X H at all, until, of course, deformation of H K threw strain on X H. Now, supposing the stress at A in the actual bridge to be axial, *i.e.*, distributed symmetrically over the rivets, that portion of the stress below the axis of H A would, according to above theory, appear to tend to pass down A I as compression, whilst that which is above would pass down H A.

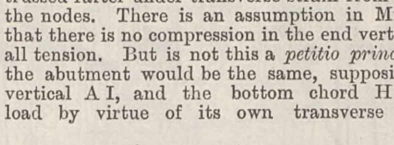


FIG 1

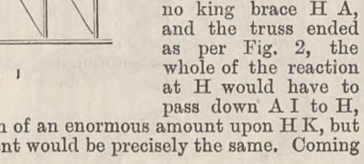


FIG 2

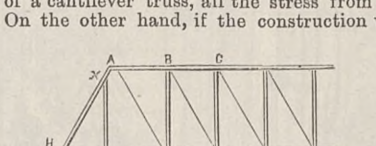


FIG. 3

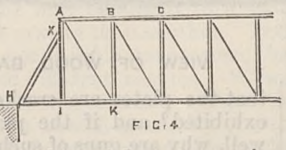


FIG. 4

I cannot see with Mr. Woodcock that if a compressive stress occurred in A I it would be of small importance, but I hope that the deflection tests will prove that, owing to some things which I may have overlooked in the construction, no such action has taken place. It would be most interesting and valuable to have a minute record of the tests at that point when the line is opened.

December 13th. T. G. Gribble.

A NOVEL COMPETITION.

Sir,—Can you authenticate the rumour that the Royal Agricultural Society of England are about to offer £200 *for the "best" Suffolk cart horse and* £100 *for the best Lincolnshire ditto*, the prize to be awarded in each case to the horse which drags a ton of coal in the shortest time from the entrance gate to the cattle ring of the Newcastle show grounds, and eats the least corn afterwards, no restriction being made as to the use of whips or other means of stimulation, it being left to the honour and discretion of the drivers to do all they know in this respect? Suffolk Punch.

December 15th.

[We cannot authenticate the rumour. Has not our correspondent mixed up horses with something else?—Ed. E.]

ENGINE TRIALS AT MELBOURNE.

Sir,—In the face of the mysterious figures you quote from the report on the above, in last week's Engineer, any hypothesis for solving the riddle seems worth trying, and I may be permitted therefore to suggest that possibly "water in cubic inches" means "water in cubic inches consumed per revolution," and the fuel to correspond. Taking the figures of the trial of engine No. 1459, since a cubic inch of water weighs 1·27·7th of a lb. we have the weight of water per revolution = 1·27·7 × 1·31 = 0·05 nearly. The revolutions appear to have been 180—or 120—but as the horse-power seems to have been calculated on the former hypothesis, I shall take 180—which gives weight of water consumed per minute = 0·05 × 180 = 9 lb., or 540 lb. per hour; and as the horse-power was 32·57, this gives weight of steam per horse-power per hour = 16¼ lb. nearly. This, I suppose, might have been got if the weight of steam had been calculated from the volume at cut-off in the high-pressure cylinder, or if the feed-water had been measured, and the real horse-power had been, as appears to be contended by some, about two-thirds of that reported. The relative weight of fuel to water, given as 0·172 to 0·05, however, disagrees with any supposition I can make as to the fuel and water being measured in reference to the same time. The ratio of 0·172 to 1·31 is 7·7 nearly; but this would require 1·31, stated to be cubic inches, being taken as pounds, and the report would then mean that 7·7 lb. of water were evaporated per lb. of coal. The whole affair, as you say, is most mysterious.

Queen's College, Belfast, December 11th. Maurice F. Fitzgerald.

THE PROBLEM OF FLIGHT.

Sir,—An attentive perusal of the letters of Mr. Lancaster and other correspondents of yours, and an observation of sailing birds and boats, has led me to offer the following solution of the problem of flight, which seems to me to be perfectly complete, and to comply with all conceivable conditions.

First, let me take the case of a boat sailing very close hauled, with flat sails, as shown in the accompanying sketch. This boat is, as far as all that part of her which is out of water is concerned, immersed in a sea of moving air. Her sails are in precisely the same condition as a bird's would be floating in the same breeze. But the boat advances, just as a sailing bird advances against a breeze. *The bird is nothing more or less than a close-hauled craft.*

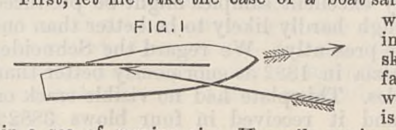


FIG. I

It is found convenient for various reasons to set canvas in vertical planes; but a moment's reflection will show that there is no charm in vertical planes, and that our boat would advance just as fast if her mainsail were set horizontally instead of vertically—this—if only we could get the wind to blow at angles upwards from the sea, or a similar result if we could get it to blow downwards. Blowing horizontally it must blow dead ahead, and we cannot make one ship combine lee way with progress ahead if her sails are set in horizontal planes, because then she could have no lee way. As this cannot be done with a ship we are obliged to use vertical sails, because we can get what horizontal angles we like, because we are not confined to one straight course in a vertical plane.

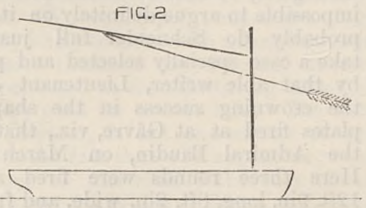


FIG. 2

Now a bird is simply a boat with horizontal sails set close-hauled.

If we examine the conditions in Fig 1, it will be found that the boat would be carried away dead to leeward if there was not some counteracting force brought to bear. This counterbalancing force is the resistance offered by the water, by which the boat is kept up to the wind, but still she will make some leeway.

In the case of a bird, we have the wind blowing in a straight line parallel with the horizon. The bird would be carried bodily upwards by the wind—that is to say, it would have leeway vertical in this case, horizontal in the case of the boat, were it not for gravity; in other words, the bird's weight, which holds it down on the wind, thus playing the same part that water does with a sailing boat, or the sharp runners on the ice do to an ice boat. In fact, gravity, instead of being a foe to flight, is absolutely essential to it.

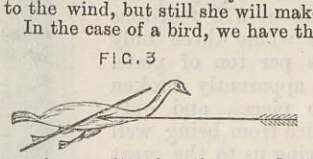


FIG. 3

Sailing or soaring flight appears to me to be as impossible without a wind as would the sailing of a boat without a wind. In a calm the bird uses its wings, just as the crew of a boat would under the same circumstances use their oars.

It may be said that, if this is all, an air boat can be made which will solve the whole problem of flight at once. Nothing of the kind; flight is a very delicate operation, requiring great personal skill in balancing, and, lacking this skill, no man can fly. On the other hand, in attempting to acquire this skill, the would-be aeronauts may probably get killed. The position is like that of a man who wants to learn to swim, yet cannot learn save in deep water, where he is sure to be drowned.

I recently had occasion to make two voyages at very slow speeds. In both cases the vessels I was in—large ships—were in the hands of tugs, and made not more than four or five miles an hour. We were followed by scores of gulls, the wind tolerably strong very dead ahead. As a passenger I had nothing to do, and lying on the deck at the stern, I could watch these gulls, which did not hesitate to come within 20ft. of me. They seldom or never flapped a wing, sailing against a wind blowing some twenty miles an hour, at the rate of say five miles an hour. I very soon found out that some of these gulls flew much better than others. The ease and grace of their attitudes was charming. They never seemed to lose their balance. They resembled a perfect artist on the tight rope; others, on the contrary, were never still two minutes together. They were always losing their balance and recovering it again—stumbling, so to speak. Now and then one would get the equivalent of a fall, and be carried away shrieking with vexation down the wind, and then be compelled to fly hard to get back again.

Some birds never can sail. Sparrows, for example, and rooks. Pigeons possess the power in a limited degree. Such birds are the row boats of the air. Cranes, vultures, the albatross, &c., are the sailing clippers of the skies.

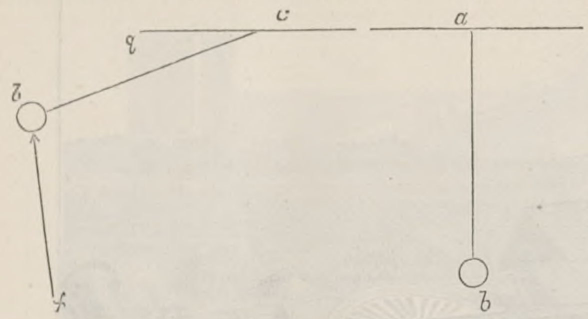
To sum up, we do every day in boats with vertical sails just what the birds do with horizontal sails. We employ the water to hold our boats up to the wind; birds use gravity to hold them down to it. If a man could be taught to use horizontal planes properly without being killed, the problem of flight would be solved. Until a man is so taught there will be no flight. A man knowing nothing of the handling of boats certainly cannot manage one close-hauled. He will probably be drowned.

This seems all quite clear to me; whether I have made it as clear to your readers I do not know. I hope you will publish this letter, and another if I am asked for explanations concerning obscurities. Close-Hauled.

London, December 8th, 1886.

Sir,—The Buffalo scientists went sight-seeing to Niagara Falls, and the following conversation took place at the foot of that torrent. It strikes the centre of the soaring problem:—

Professor: Your attempt to make water run up would play havoc with this cataract, if successful. Student: No; the only water that "runs up," that I know of, is inside of a bird in the act of soaring. These Falls are safe.—P. But the same laws govern both, and gravity brings everything down. S. That would play havoc with the soaring birds. They stay up; this water comes down; and the laws must include both facts to be worth considering.—P. At least you must modify the laws of gravity to suit the birds. S. Attraction can be ignored. Do you presume there were no soaring birds before Newton? A statement of fact settles the case, and the only difficulty that I experience is to make it in the best way.—P. Have you at length succeeded? S. Very much to my satisfaction.—P. I would like you to explain it to my satisfaction. S. Willingly; and if I fail it will be a pity, on your account. Suppose we fasten a 32 oz. weight to the ceiling by a string. The weight pulls along *a b* with a tension of 32 oz., and if left free will hang in a straight line from the point of suspension to the centre of the earth. But suppose it is not left free, but pushed with a stick to one side until its supporting string made an angle of, say, 10 deg. with the ceiling. The weight now both pushes the stick and pulls the string. The string tension on $c\,d$ is 4 oz., and the push on $e\,f$ is $31\frac{1}{2}$ oz., omitting small fractions. This is the vital principle of the soaring problem. The plain fact that weight acts against resistances which are not in the direction of the earth's centre makes soaring possible. The weight is the extended wings



and body of the bird; the pushing stick is the air pressure beneath the wings; the inclination is the effect of automatic adjustments between surface and pressure, aided, doubtless, by the bird's volition. The pressures derived from the large weight on $e\,f$ neutralise as they escape the small weight on $c\,d$, and cause motion on the upward slant which gives a horizontal resultant, as I have persistently pointed out. Pressure on $e\,f$ and tension on $c\,d$ are at right-angles to each other, and either may be increased or diminished, or, in fact, blotted out, without influencing the other in the slightest degree. When the diagram is turned into a soaring bird the only change made is the addition of motion and the substitution of other resistances. There is the same $31\frac{1}{2}$ oz. pressure on $e\,f$, but it is against air and not a stick; the same tension on $c\,d$, but against escaping pressures and not a string. Velocity on $e\,f$ will be determined by the shape and extent of the wing surface; velocity on $c\,d$ by the excess of escaping pressure over the small weight. When these two velocities are adjusted to each other so as to give a horizontal resultant, we have soaring flight, in which the large weight on $e\,f$ is the sole motive-power.—P. That seems plausible, but I have no authority for setting a heavy body to work in that way. S. The matter is clear enough until we introduce the idea of force as embodied in the Newtonian laws, and the amount of fog that comes in with the force is fearful.—P. I do not understand you. S. A single question, I think, will show it. While $31\frac{1}{2}$ oz. is acting on $e\,f$ and 4 oz. on $c\,d$, is there any force acting vertically?—P. Yes, it is because gravity is acting vertically that you get the pull and push. S. I thought so. The fog is on us now.—P. We are too near the Falls, let us get out of it. S. We cannot escape it. It is everywhere that a scientist can go. They have it in London.—P. In London? S. Yes. Then as gravity is acting vertically, motion towards c lifts weight?—P. Yes. S. And yet Newton is not responsible for one atom of this fog. We adjourned. The obscurity had become so great as to preclude further progress. The delusion which prevents the case from being at once seen is the seeming necessity for lifting weight by motion on $c\,d$ towards c after the 4 oz. acting in that line is neutralised. A little thought ought to make it clear that $e\,f$ is a vertical and $c\,d$ a horizontal line, so far as this particular activity is concerned. But there is no law of this universe so strong as habit, and bad habits are unfortunately the strongest of these.

November 23rd. I. LANCASTER.

PILE DRIVING.

SIR,—It is clearly a matter of the highest importance to know the maximum value of the momentum a pile can sustain without permanently injuring the elasticity. In order to be able to do this it is necessary to ascertain the magnitude of the pressure between the head of the pile and the monkey. In endeavouring to calculate this pressure, all the authorities I have met with make the mistake of assuming that the product of the resistance of the earth to penetration, multiplied by the distance the pile is driven, is equal to the work done by the monkey.

This, however, is very far from being the case. In compressing and extending elastic substances, the decrements and extension produced by a suddenly applied load are double those produced by the same load applied gradually. It is clear that the magnitude of a suddenly applied statical load, capable of producing the same effect as the momentum of the monkey, cannot exceed the resistance of the earth, which, for each single blow, when the penetration is small, may be practically assumed to have a constant value equal to its mean value, since the extremes can differ but little from each other. The sinking of the pile will therefore commence as soon as the compression has reached about half its maximum value, and will continue until the monkey has been brought to rest; after this the pressure between the monkey and the pile will be due solely to the reaction caused by the elasticity of the materials of the monkey and the pile and the dead weight of the monkey. This reaction in the most extreme case rarely suffices to raise the monkey more than a few inches. The pressure therefore due to reaction after the monkey has been brought to rest is utterly insufficient to increase the penetration. The monkey will have a downward motion at the instant of maximum pressure equal to that of the pile. If the resistance of the earth is constant, this period would correspond with the period of maximum velocity of the pile; but if the resistance of the earth has increased, the period of maximum pressure may correspond with that at which both pile and monkey are brought to rest. Any penetration of the pile which takes place after the maximum compression has been reached is due solely to the momentum still possessed by the monkey and pile, and must be very slight. In solving the problem therefore, on the assumption that the period at which both pile and monkey come to rest coincides with the period of maximum compression, the results arrived at must be practically correct. Any error that may be involved in the adoption of this assumption will be on the safe side, since the extent of the compression corresponding to a given extent of penetration will be greater than it would be if part of the penetration was caused by reaction. In solving the problem therefore there is no necessity to take any account of the modulus of elasticity of either the monkey or the pile. The whole of the work done by the monkey must be equal to the whole of the space travelled by it after impact, multiplied by the mean pressure on the head of the pile, which will be equal to half the maximum pressure, since the initial pressure is zero. The total distance travelled is equal to the decrement in the length of the pile plus the depth of penetration, because by the assumption no penetration is produced by reaction. Clearly, then, the first step to be taken is to ascertain the extent of the compression of the pile, which may be done in the following manner:—

Let the following symbols be used to denote the various elements of the problem:—

W = weight of monkey in tons.
H = height of fall in feet.
V = velocity of monkey per second at instant of impact.
L_1 = maximum decrement produced in the pile in feet.
L = whole length of pile in feet.
S = distance driven in feet.
P = maximum pressure in tons between pile and monkey.
E = modulus of compression in tons per square foot.
A = area of pile in square feet.

As a first step towards the solution of the problem, we will suppose that the pile is so firmly driven home that the blow does not cause any further penetration.

If l be the decrement at any instant in the length of the pile between the instant of impact and the instant of its being brought to rest, the retarding force on the monkey will be equal to $\frac{l\,A\,E}{L}$ and the equation of motion

$$\frac{W}{g}\frac{d^2 l}{d t^2} = W - \frac{l\,A\,E}{L},$$

from which we get

$$\frac{W}{g}\left(\frac{d\,l}{d\,t}\right)^2 = 2\,W\,l - \frac{l^2 A\,E}{L} + \text{constant}.$$

At the instant of impact $\frac{d\,l}{d\,t} = V$, and we get for the velocity v at any other instant

$$\frac{W v^2}{g} = 2\,W\,l - \frac{l^2 A\,E}{L} + \frac{W\,V^2}{g} = 2\,W\,(l + H) - \frac{l^2 A\,E}{L}.$$

When the monkey is brought to rest, we have therefore the following equation for determining the value of L_1:—

$$L_1^2\,A\,E - 2\,W\,L_1\,L = 2\,W\,L\,H. \quad . \quad . \quad . \quad (1)$$

Whence

$$L_1 = \frac{W\,L}{A\,E}\left(1 + \sqrt{1 + \frac{2\,H \cdot A\,E}{W\,L}}\right), \quad . \quad . \quad (2)$$

and

$$P = \frac{L_1 \cdot A\,E}{L}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

In this case the whole work stored up in the monkey is expended in compressing the pile, and if the value of P and L_1 obtained from equations (2) and (3) are correct, then also

$$\frac{P \cdot L_1}{2} = \frac{L_1^2\,A\,E}{2\,L} = W\,(H + L_1). \quad . \quad . \quad . \quad (4)$$

When the pile penetrates the earth, we shall have the following relation between the work done by the monkey, the maximum pressure, and the distances, viz.:—

$$\frac{P\,(S + L_1)}{2} = W\,(H + S + L_1). \quad . \quad . \quad . \quad . \quad (5)$$

Whence

$$P = \frac{2\,W\,(H + S + L_1)}{(S + L_1)} \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

If, now, we deduct $\frac{P\,S}{2}$, the work done in causing the pile to penetrate the earth, from the whole work done by the monkey, we shall get the work done in compressing the pile. This work will therefore be equal to

$$W\,(H + S + L_1)\left(1 - \frac{S}{S + L_1}\right) = \frac{W\,(H + S + L_1)\,L_1}{S + L_1}. \quad (6)$$

The height, therefore, due to this part of the monkey's whole work will be

$$\frac{(H + S + L_1)\,L_1}{S + L_1}.$$

Substituting this value for $H + L_1$ in equation (1), we have the following equation for finding the value of L_1:—

$$L_1^2 \cdot A\,E = \frac{2\,W\,L\,(H + S + L_1)\,L_1}{S + L_1}.$$

From this we get

$$L_1 = \frac{2\,W\,L - S \cdot A\,E}{2\,A\,E} + \sqrt{\frac{(S \cdot A\,E + 2\,W\,L)^2}{4\,A^2\,E^2} + \frac{2\,W\,L\,H}{A\,E}} \quad (7)$$

which is identical with equation (2) when we put S = O. The maximum pressure will be given by equation (3).

So far as the calculation of the maximum pressure is concerned, there is no necessity to take into account the moduli of elasticity of either pile or monkey. If part of the penetration is produced by the reaction between the pile and the monkey, the work done in compressing the pile will be partly expended in increasing the penetration, and therefore the percentage of useful effect will be greater than the percentage obtained on the assumption that the penetration ceases at the instant the monkey comes to rest.

I have not been able to get the results of any experiments to enable me to calculate the modulus of extension in compression, but as the ultimate compressive strength of fir timber is only half its ultimate tensile strength, we shall be safe in concluding that the modulus of compression is not greater than the modulus of extension. It may, however, be equal to it. The experiments made by Eaton Hodgkinson show that, although the ultimate breaking strength of cast iron is six times the ultimate tensile strength, the modulus of extension is practically equal to the modulus of compression, for small extensions and decrements. The modulus of extension, however, diminishes much more rapidly than the modulus of compression. In my treatise on solid beams I have demonstrated that the extreme stresses exerted at the top and bottom of the beam are to each other always in the ratio of the square root of the modulus of compression to the square root of the modulus in extension. In order to compare the results calculated from my formulæ with the results ascertained experimentally by Eaton Hodgkinson, I assumed that on the eve of fracture the stresses both in extension and compression must have reached their ultimate values. The exact agreement of the calculated with the experimental results proves that both this last assumption and my formula are correct. When the stresses therefore approach their ultimate limits, since the average ultimate compressive stress is about six times the average ultimate tensile stress, the final modulus of compression must be about thirty-six times the final modulus of extension. Since the moduli for working pressures are nearly equal, the working loads calculated from the ordinary formula are practically correct. The breaking loads calculated from these formula are, however, only equal to about one-half the experimental breaking loads, so that beams which have been designed to carry, say, one-fourth of the experimental breaking load are unquestionably exposed to a much greater stress than the designer intended they should be. Solid cast iron beams are, however, of rare occurrence, and the scantlings of timber beams are usually designed to insure rigidity by constants, determined by observation of the extent of bending under loads which would not impair the elasticity of the timber. In the case of flanged beams, however, it is clear that the areas of the top and bottom flanges should not be in the ratio of the ultimate compressive and tensile strengths of the materials, but in that of the extreme compressive stress to the extreme tensile strength, which produce a permanent set in each case. This ratio, as ascertained from Eaton Hodgkinson's experiments, is about 1 : 3.

It follows from this that working loads or cast iron bridges in which the flanges are designed in the ratio of 6 : 1 must subject the material of the top flange to its proof stress. In the case of wrought iron the modulus of extension is to the modulus of compression in about the ratio of 3 : 2 for small stresses within the elastic limits of the materials, whilst the ultimate tensile strength is to the ultimate compressive strength as 5 : 4. For the reason explained in the case of cast iron beams, the ratio of the area of the top flange to that of the bottom flange ought not to be 5 : 4 but as 2 : 3. It is clear therefore that no conclusion can be arrived at *à priori* from a comparison of the compressive and tensile strengths as to the relative value of the moduli of extension and compression; but I think it is evident that the modulus of compression cannot be greater than the modulus of extension if the ultimate compressive breaking stress is not greater than the ultimate breaking tensile stress. In the case of the fir pile therefore the modulus of compression cannot exceed the modulus of extension, which is about 90,000 tons to the square foot.

The following table shows the decrements in the length of a 24ft. pile 12in. square, due to the impact of a monkey weighing 10 cwt., falling through a height of 6ft., for degrees of penetration varying from 4in. to zero, and the corresponding maximum pressures between the pile and the monkey, when the deadening effect of the bruised head of the pile is left out of consideration, and also the decrements in length and the pressure on a 12ft. pile when the penetration is 4in. and zero.

The mere dead weight of the pile can have no appreciable effect in increasing the penetration, and the work expended in overcoming the inertia of the pile is, of course, given back again in causing increased penetration, so that no error is involved in leaving this out of consideration.

As the downward velocity of the monkey at the instant of maximum compression cannot exceed that of the pile at the same instant, it is clear that it must be too small to have any appreciable effect in causing the pile to descend by the subsequent reaction between the pile and the monkey, and that therefore the assumption on which the formula is based must be practically true. If part of the penetration were caused by reaction, the value of the maximum velocity would be greater than that given in the table:—

Length of pile, in feet	× ..	....	24	....	....	....	.. ×	12	....
Penetration, in inches	4	2	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	0	4	0
Compression, in inches	·04	·12	·19	·29	·37	·46	·48	·03	·34
Maximum pressure, in tons ..	16·6	37·5	60	90	116	142	150	21	21·6
Percentage of total work expended in causing penetration	99	94	84	63	40	18	0	98	0

The pressures given in the table are the maximum pressures between the pile and the monkey, and are the same in intensity as those which would be produced by a load applied without initial momentum equal to half the maximum pressure. Although therefore the pressures given in the table represent the actual load which the pile as a pillar has to support, they are exactly double the statical loads which may be applied without causing greater degrees of penetration than those stated in the table.

In Tredgold's work on carpentry, the following formula for the safe-working load on pillars is given—

$$w = \frac{e\,D^4}{L^2}$$

Where w is the safe load in pounds, D the side of the square in inches, and L the length of the pile in feet. The constant e is determined experimentally on the basis that the safe working load ought not in the case of timber to exceed one-tenth of the breaking load. On this basis the value of e for Memel timber, which is the usual materials of piles, is about 2400, and we get for the safe-working load on a pile 24ft. long and 12in. square from Tredgold's formula 86,400 lb., or about 38 tons. So that a monkey weighing 10 cwt. falling through a height of 6ft., when no penetration is caused, subjects a 24ft. pile to half its breaking load, and a pile 12ft. long to one-third its breaking load. Clearly, then, the materials of such piles subjected to blows of this intensity must suffer permanent injury. Although the operation would be somewhat laborious, the formula worked out in this paper will enable us to form a series of tables showing the limiting minimum values of the penetration caused by the momentum of the monkey. For values less than these the material of the pile must suffer permanent injury.

WILLIAM DONALDSON.

2, Westminster-chambers, December 13th.

DRAWING-OFFICE MANAGEMENT.

SIR,—Some time ago—September 18th, 1885—there appeared in your paper a very pertinent article on "Drawing-office Management," in which you pointed out the desirability, if not the absolute necessity, of some sort of check system in our drawing-offices. Your remarks, I believe, had reference only to the taking out of quantities. Still, I think the system could be applied to drawing-office work generally, and is, in fact, indispensable in these "fast" times of ours. Now, as you remarked, "It is all very well to say mistakes should not occur. Of course not, but they do, and a wise man will always reckon on their probable, or at all events, on their possible occurrence, and take his measures accordingly." And more especially are they likely to occur when, as now-a-days, the system of push is so very much in vogue, a man having to get through twice as much work as formerly, the one great aim being to keep down drawing-office expenses. Therefore, if you will allow me, I should like to suggest at least one measure that it seems to me might very properly be employed for the prevention of mistakes in our drawing-offices, which, if it did not keep down drawing-office expenses, would have the effect of considerably diminishing the general expenses of the whole concern. It is, that there should be in every drawing-office a recognised competent examiner—not merely to check quantities and figures, but to go through every draughtsman's work after he has done with it, and pronounce it correct and complete in every respect before passing it on into the shops. This is the only way for it, if we will have such hard working—that is, unless we would make it more expensive in the long run than ever under the old *régime*—for, depend upon it, it will not do to let drawings that have been hurried over go out into the shops without a thorough and complete examination. Why it is the easiest matter in the world for a mistake to occur and entirely to escape the notice of one man; whilst, if there are two, it is by no means such an easy thing for it to escape detection. Of course, this would just about occupy the whole of one person's time. It would not, however, be more than one man could do. At all events, not unless there came to be, say, more than half-a-dozen draughtsmen's work to go through; then it might, but perhaps not then. He would be expected to make up the shop order books, this examiner; to make what alterations were required in standard drawings, to keep them up to latest shop practice, and should a drawing be returned, after it has been sent into the shops, to have any lacking information supplied, he would have it to supply, and to say when a drawing did contain all the information required and when it did not; for the amount sufficient for one man to work to is not always sufficient for another, simply because this other does not know how and where to look for it, but will bring a drawing in to have a dimension supplied when it is there already, though not quite exactly in the place where he expected to find it, but most likely in a better. All, in fact, of the numerous petty interruptions that a draughtsman is subject to would be prevented by the examiner, who would attend to them instead, leaving the draughtsman free to think of nothing but his work. If you think this matter of any importance, I should be much obliged if you could find room for it in your correspondence column.

December 14th. ERBA TAWL.

[What does Erba Tawl suppose the head of a drawing-office does in return for his salary?—ED. E.]

WHITFIELD'S FURNACE BARS.

SIR,—We are obliged for your insertion of a description and sketch of Whitfield's patent furnace bars in last week's issue of THE ENGINEER, but we beg to call your attention to the inaccuracy of the description of the passage of the air through the bars, it being the reverse to what is mentioned. The air passes through the hollow portion of the bars, which becomes heated, and is delivered at the back of the bridge, a surplus quantity of air also passes through the double portion of the bars, at the front end, through the fire; the combination of these two arrangements being the cause of their superiority over the hollow bars, as the advantages of hollow and common bars are combined in one. A correction to this effect in your next issue will oblige.

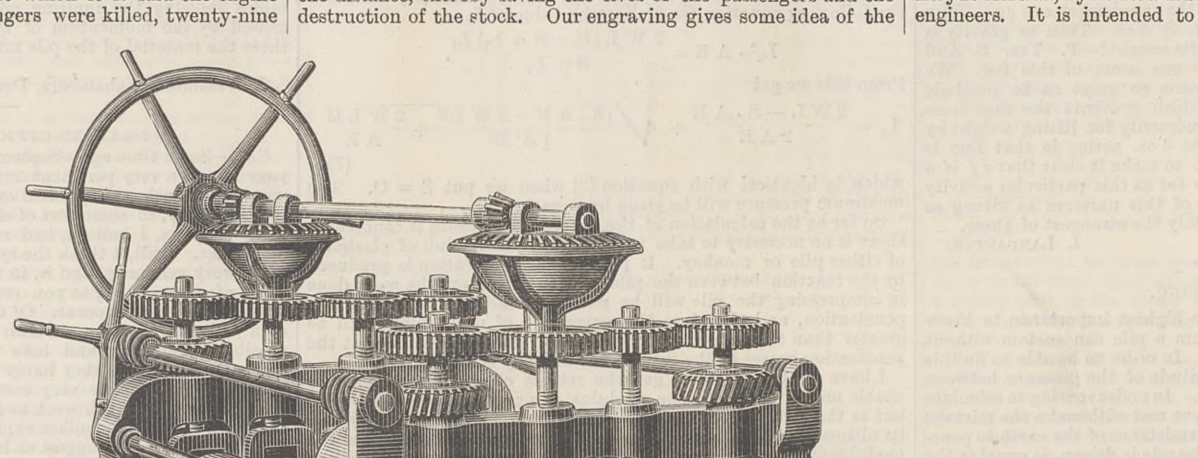
Barrow-in-Furness, J. BEVERIDGE AND BROS.
December 14th.

NAVAL ENGINEER APPOINTMENT.—The following appointment has been made at the Admiralty:—William Onyon, assistant engineer, to the Alexandra, additional.

OFF THE RAILS AT PORTADOWN.

THE PORTADOWN RAILWAY ACCIDENT.

GENERAL HUTCHINSON'S report on this accident has been issued. On June 30th last a passenger train from Belfast for Dublin, consisting of an engine, tender, and six vehicles, when travelling about fifty miles an hour, ran off the line on a 30-chain curve about 2½ miles south of Portadown-station. The engine, tender, and the first two carriages were turned over, stopping about fifty yards from the mark at which it is said the engine probably left the rails. Six passengers were killed, twenty-nine others were more or less seriously injured, and three out of the six carriages were entirely destroyed. The Government inspector reports that, so far as he is able to judge, this accident was due to the combination of three causes, viz.: (1) The distortion of the curve at the spot where the engine left the rails owing to the tense condition of the outer rails from excessive sun heat, and the absence of proper expansion intervals between the rail joints; (2) an insufficiently ballasted road; and (3) a higher speed than was justified by the condition of the road. This conclusion contains but small comfort for travellers. Such emergencies will every now and then continue to arise so long as railways last, and we are more disposed to attribute the serious results to the fact that the train was not adequately equipped and protected by an efficient safety appliance. It seems that the engine, tender, and train, was fitted with a non-automatic brake, and it is, at all events, a singular coincidence that in this, as in nearly all the other great emergencies, when this brake has been in use, the results are just those which might be expected to occur to trains not fitted with any brake at all. General Hutchinson says—"The driver, after applying the brake on feeling his engine leave the rails, accidentally released it when trying to seize the regulator; the same thing might have happened with an automatic brake, and as there was probably no severance of couplings until just before the engine stopped—only about fifty yards from where it left the rails—this was hardly one of those cases in which, had the train been fitted with an automatic brake, the consequences of the accident would have been rendered less serious." We cannot agree entirely with this statement. The mere occurrence of such a calamity illustrates the necessity for the most efficient appliance, and the idea that an automatic brake only comes into play when couplings are severed has been long since exploded. We know, moreover, that under similar circumstances couplings have broken, or the brake work has been injured at the very beginning of an accident, and no one can say exactly what form such an accident may take. All experience goes to show that the only means of mitigating or preventing the consequences, when the front part of a train has left the rails, is to bring instantaneously a powerful retarding force to bear upon the hinder portion. Without this the train is free to crowd down upon the engine and bring the incident to a sudden and disastrous termination—in the present case, in a distance of fifty yards. With it the carriages are held back, and instead of overrunning the engine, tend to support and keep it upright, and thus to prolong the distance in which the whole train may be brought to a stand. The serious results of the Portadown accident were due to the suddenness of the stop, and only an efficient form of automatic brake could have been of service in extending the distance, thereby saving the lives of the passengers and the destruction of the stock. Our engraving gives some idea of the state of things when the train did come to rest. The photograph from which it was taken gave a more complete idea of the state of the road after the accident than can be gathered from the engraving. The engine was not much damaged, but the value of the stock destroyed and injured is given as £1005 in this one accident, to say nothing of the passengers. The report is accompanied by a plan of the site, which we do not give.



SEVEN-ROLLER SHIP PLATE FLATTENING MACHINE.

IT is stated that silver has been recently discovered in large quantities north and south of Caldwell, Kan., where the lead crops out, where it underlies the entire city about 36ft. from the surface, and extends several miles into the territory."

FLATTENING MACHINE—AUSTRIAN LLOYDS.

WE have in another page alluded to the growing necessity for heavy machinery to manipulate the gigantic plates now used in shipbuilding. These plates are often delivered buckled. These plates have to be levelled before being used. The accompanying engraving illustrates a fine seven-roller flattening machine, made for use in the Austro-Hungarian Lloyds Arsenal, by Messrs. Rushworth and Co., Sowerby Bridge, engineers. It is intended to take buckles out of plates cold, and up to ⅞in. thick. The machine weighs 16 tons. Its construction will be understood without further description from our engraving.

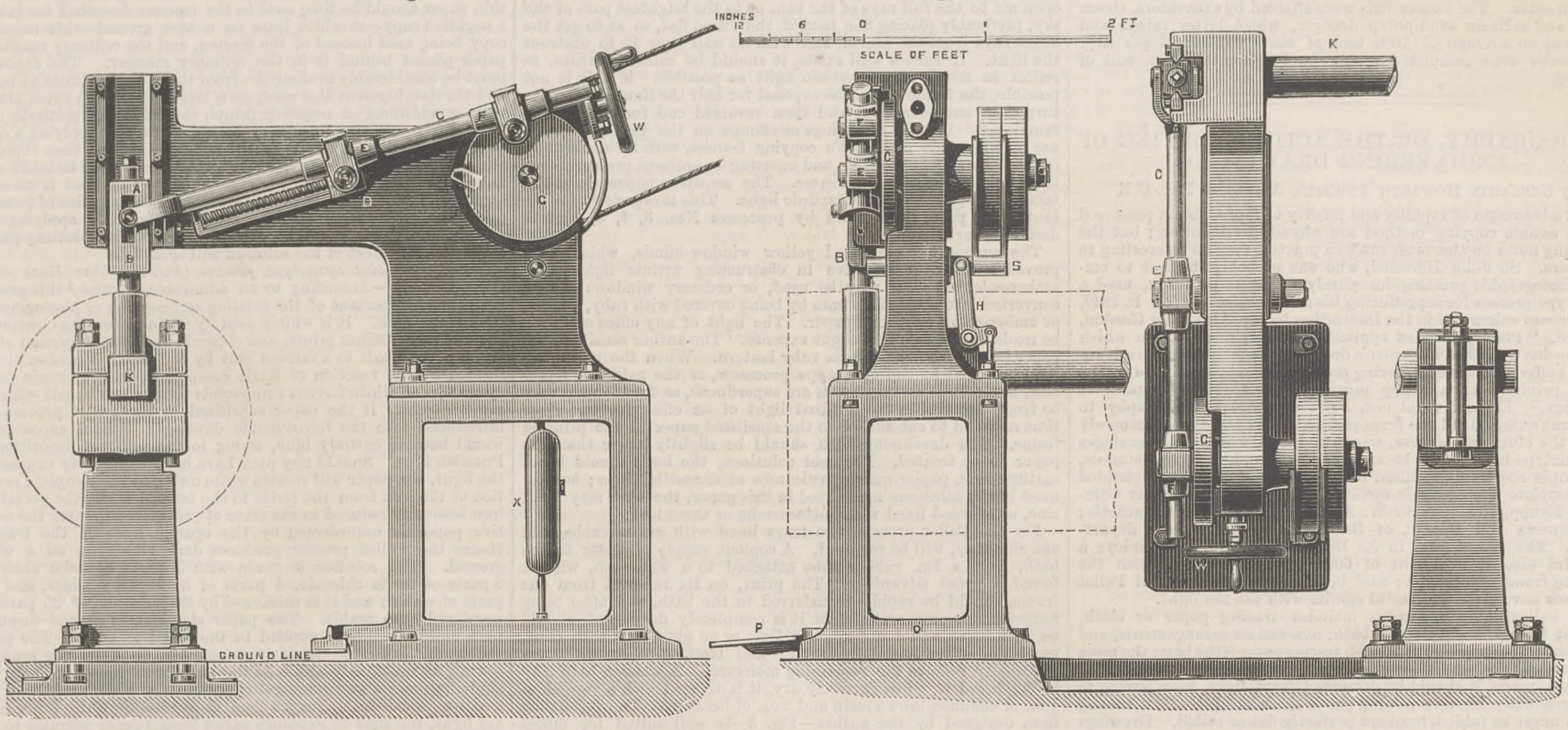
THE PATENT OFFICE COMMITTEE AND THE BOARD OF TRADE.

WE can state on good authority that no report of the Committee of Inquiry into the Patent-office affairs has yet reached the Board of Trade. For some time every one interested in the proper management of patents and Patent-office affairs has been anxiously awaiting this report, and the reforms which must follow any repert resulting from an inquiry such as that which has been held. It appears that the chairman of the committee, Lord Herschell, is responsible for this delay, but whatever the cause it is specially to be regretted, because not only is urgently necessary reform prevented, but because the action of the proper authorities is suspended during an inquiry upon a department by an outside committee. The Board of Trade can thus take no action in the matter until the report has been received. The arrangements made by that Board for the working of the new Act having proved unsatisfactory, the Board ought at the earliest possible opportunity to remedy the serious defects which are abundantly evident to every one, and to no one more than to the two legal members of the committee, Lord Herschell and Sir Richard Webster, whose experiences as law officers must have been in one direction.

WATER SUPPLY IN THE CITY.—At the meeting on Tuesday of the Commissioners of Sewers, Mr. Malthouse drew attention to the reference to the Streets Committee on the subject of sinking artesian wells in the City, with a view to supplying the inhabitants with water, and he moved that instructions should be given to that committee to report without delay. Mr. Deputy Bedford, in seconding the motion, thought they ought at once to test the question of their powers in the matter by sinking an artesian well, and supplying water to the City, as he contended they had a right to do. Wells had been sunk in different parts of the City on private property, but he considered the Court should take definite action, in order to settle the question, as to which he personally had no doubt. Mr. Johnson said inquiries had been made as to whether a well could not be sunk to supply the artisans' dwellings, but it was found the cost of sinking would be £2000, and £180 a year afterwards for maintenance. The present water rate on the building was about £60. After some further discussion, the motion was carried.

PLAYER'S POWER HAMMER.

Fig. Fig. 2 Fig. 3.



PLAYER'S POWER HAMMER.

AT the recent Exhibition in Birmingham Messrs. W. and J. Player, of that town, exhibited some of their power hammers for planishing, wire plate battering, and other work, with some improvements. We illustrate one of these hammers by the accompanying engraving. The working of the hammer is so easily gathered from these that little explanation is necessary. The figures 1, 2, and 3 give side and end elevations and plan, and the detail section and plan, Fig. 4, are of the hammer head or tup. It will be seen from the elevation, Fig. 1, that the forked hammer rod which embraces the plunger piece J—see detail section and plan—is pivotted in a bush E. This bush pivots upon a pin I, Fig. 4, held by a block D, Fig. 1, which is adjustable as to position in the slot shown by the screw and hand wheel W. Thus, although the stroke of the crank pin in the disc C remains constant, the stroke of the hammer head may be varied through a large range. A dead blow and a cushioned up stroke is given to the hammer by the method of connecting it to the lever C. This lever at its forked end takes hold, as in Fig. 4, of a piece J, which is free to move within the hammer head, its range being limited by the pressure necessary to compress the air which gets enclosed in the ends K K[1]. The higher the speed of the hammer the greater the compression of the air, and thus the heavy wear which would otherwise accompany the working of the hammer, particularly at the joints, is reduced to a minimum. Messrs. J. and W. Player exhibited other very useful forms of hammer for various purposes.

THE INSTITUTION OF CIVIL ENGINEERS.

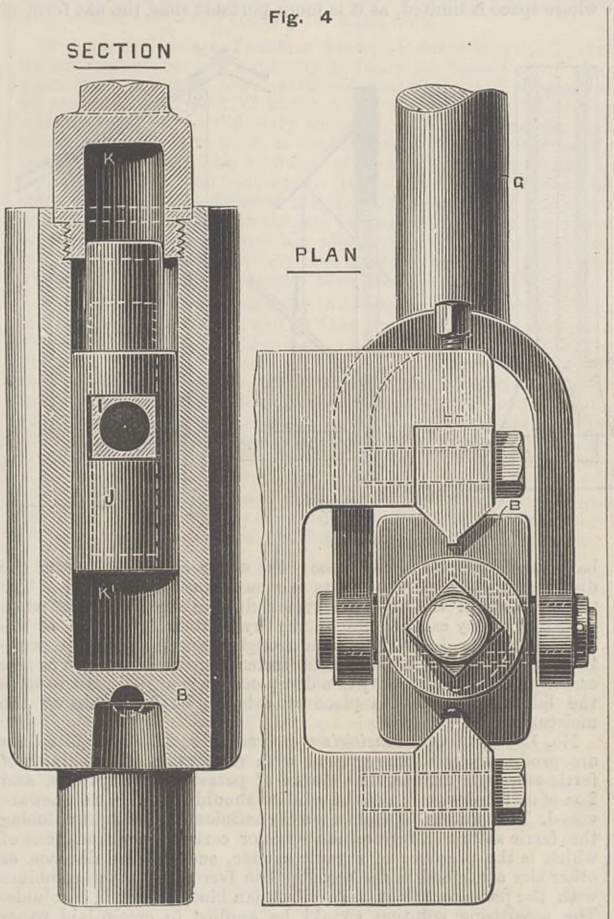
CONCRETE AS APPLIED IN THE CONSTRUCTION OF HARBOURS.

AT the ordinary meeting on Tuesday, November 16th—Mr. Edward Woods, President, in the chair—six papers were read on "Concrete as Applied in the Construction of Harbours," at Greenock, Girvan, and Quebec; Colombo; Newhaven; Wicklow; Fraserburgh, Sandhaven, and Portsoy; and Lowestoft; by Messrs. Kinipple, Kyle, Carey, Strype, Willet, and Langley, MM. Inst. C.E.

Mr. Kinipple, in his paper on "Concrete Work Under Water," described the methods he adopted for depositing partially set or plastic concrete under water at various harbour works, having found that plastic concrete, when sufficiently set to resist the action of a current of water, was capable of uniting into a solid mass under water, though deposited in separate lumps. At Greenock the concrete was deposited behind sheet piling, in depths of from 8ft. to 38ft. At Girvan a pier and quay-wall were constructed of plastic concrete, deposited behind a facing of small dovetailed concrete blocks, grouted together at the joints; and a concrete groyne was formed under the shelter of a movable wrought iron shield. The head of the Wick Pier was rebuilt with blocks of plastic concrete of 60 to 140 tons, formed *in situ* under the protection of sail-cloth. Quay walls were constructed at Quebec Harbour of crib-work filled with plastic concrete, the cribs being floated into position, and sunk on bearing piles. Some experiments showed that cement grout, poured down pipes, could unite shingle 20ft. under water into a solid mass; and this method was successfully adopted for filling up the fissures and open joints in a graving dock at Greenock, which had given great trouble with leakages. The paper concluded with descriptions of novel expedients which the author proposed for the construction of breakwaters in concrete, with little plant, and independently of the state of the weather.

Mr. Kyle, in his paper on the "Colombo Harbour Works, Ceylon," described the various stages by which the western breakwater, 4212ft. in length, was constructed from Custom-house Point, for sheltering a water area of 502 acres at low water. The works were commenced in 1874, and completed in 1885, at a total cost of £705,207. The breakwater was formed by laying sloping courses of large concrete blocks, by means of a travelling Titan, on a rubble mound previously deposited from an 80-ton steam hopper-barge, and levelled by divers. The Titan could carry a load of 40 tons on an overhang of 28ft., and cost £5562. The first 1326ft. of pier, 50ft. wide, consisted of two walls, with an intermediate hearting of rubble; but the rest of the pier was built solid, 34ft. in width, with four or five courses of blocks, weighing from 16½ to 31 tons each. The foundation of the pier increased in depth from 13ft. below low water, near the land, to 23¾ft. at the head. Each row of sloping blocks was connected with the adjacent ones by filling the joggle grooves, left between each row, with concrete in bags, and the pier was capped all along the top with concrete in mass. The pier-head was built of concrete in mass, the lower portion being deposited inside a circular wrought iron tank, and it was surmounted by a concrete lighthouse 36½ft. high. Twenty-five steamers of the largest class could moor in depths of from 26ft. to 40ft. in the harbour; and there was room at low water for a large

Fig. 4



number of vessels drawing from 6ft. to 26ft. The works were designed by Sir John Coode, V.-P. Inst. C.E., and carried out by the author.

Mr. Carey commenced his paper on "Harbour Improvements at Newhaven, Sussex," by a history of the successive improvements effected from 1767 down to the commencement of the new works, begun in 1878. These new works — of which he was resident engineer, and Mr. Banister, M. Inst. C.E., the engineer-in-chief—consisted of a curved breakwater, 2800ft. long, to form an outer harbour, and to protect the entrance to the river, constituting the old harbour; the rebuilding of the entrance piers, and widening the waterway between them; the erection of a new quay on the eastern side of the river; the construction of a sea-wall along the shore; and dredging in the river and the approach channel in the outer harbour. The western sea-wall was commenced first, and was formed of concrete deposited within framing, with a hard skin of cement-charged concrete on the face to withstand the attrition of the shifting shingle beach. The breakwater was begun in 1880, and consisted of a monolithic mass of concrete raised from low water on a foundation of concrete sack blocks, weighing 100 tons each, deposited transversely in layers by a special steam hopper barge. A concrete mixing machine was designed by the author and Mr. Latham, which measured, mixed, and delivered 100 tons of concrete in twenty minutes for filling the bags; and, besides securing a more uniform mixing, it effected a great economy in time and cost. A portable continuous-mixing machine was also designed, capable of delivering 70 cubic yards of concrete per hour into the timber framing, erected on the top of the bag work, for the construction of the portion of the breakwater above low water in lengths of 40ft. By this means 300 lineal feet of superstructure were erected in three months. A gallery, raised above the quay level on the western side of the breakwater, provided protection to the quay and a sheltered access to the extremity of the breakwater; it was mainly built of concrete *in situ*. A lighthouse was built of plastic concrete *in situ*, on a pilework foundation, at the extremity of the west pier. The total expenditure on the whole undertaking, including land, two short railways connecting the works with the London, Brighton, and South Coast Railway, dredging, and various other works, was £463,000, out of which the works described cost £254,000. When the works were suspended in 1885, 1482ft. of the breakwater had been completed, and 300ft. of foundations laid in advance, and a dock of twenty-four acres, which formed part of the scheme, had not been commenced.

Mr. Strype, in his paper on "Wicklow Harbour Improvements," described in detail the methods he adopted in the construction of a breakwater, 750ft. long, for sheltering the mouth of the river Leitrim, and the improvement in depth of the entrance channel to the port. The breakwater was built solid, of concrete deposited *in situ*, and, starting above low water, extended into a depth of 18ft. at low water spring tides, being founded partly on rock and partly on marl. Staging was erected in advance of the work, secured at the bottom with shoes of concrete round the piles, and carrying two lines of railway on the top, along which the Titan and crane for depositing the concrete ran. At first panelling was employed, reaching down to the bottom, for protecting the concrete carried up in layers inside it; but subsequently a large central mound of concrete was deposited under water by means of skips, on which the panelling was erected, which reduced the exposure of the panelling and facilitated the progress of the work. Divisions were left at intervals in the work, increasing in number in the upper part, to prevent irregular cracking. Richer and finer concrete was placed in the face near low-water level; rubble was not used below low water, and it was kept away from the face above, as its projections caused eddies and consequent disturbance of the concrete. The total expenditure on the breakwater, steam-packet pier, and dredging, including cost of land, amounted to £40,000. Ordinary plant sufficed for the work, which consisted of huge masses of concrete, resting uniformly on the most irregular bottom, and secure from the attacks of the sea on account of their size. The author considered that a larger central mound might be adopted with advantage, thus reducing still more the amount of panelling required.

The new works carried out at Fraserburgh, Sandhaven, and Portsoy, as well as the previous condition of these harbours, were described by Mr. Willet in his paper on "The Fishing-boat Harbours on the North-east Coast of Scotland." The works at Fraserburgh consisted of a breakwater, 860ft. in length, for sheltering the entrance to the basins, and the widening of the old Balaclava pier. The breakwater, 30ft. wide, extending into a depth of 19ft. at low water, was built below low water with bags of concrete, of 28 tons to 50 tons, deposited from a hopper barge. Above low water, the concrete was tipped from wagons into a framing up to quay level; and the parapet was formed by filling the framing with concrete from tipping boxes lifted by a derrick crane on an overhead traveller, which was also used in erecting the frames. The Balaclava east pier was widened 16½ft. on the sea side, along its whole length of 1400ft., with solid concrete, which protected the old dry rubble wall from the sea; and as a parapet was raised 9½ft. on its outer side, and 19ft. above high water, like the parapet on the breakwater, an additional protection was afforded to the quay, and an increased shelter to the harbour. The widening of the pier was commenced at the end of 1875 to provide a roadway to the breakwater without interference with the quay space; and the breakwater was begun in 1878, after the completion of the widening, and was finished in 1882. The average yearly rate of deposit of concrete was 8000 cubic yards; and under favourable conditions, 400 cubic yards could be deposited in a day. The concrete in the pier cost 17s. per cubic yard, and in the breakwater, 26s. 5d. in bags, and 19s. 5d. in frames; and the total cost of the works was £69,000. Some damage was done to the breakwater, after its completion, owing to defects in the method of construction; and the pier was somewhat abraded by the shifting shingle along its sea face. These damages were repaired at a cost of £1184. A new pier, 1395ft. long, was erected at Sandhaven to increase the accommodation in the harbour by enclosing a water area of five acres. The pier was mostly built between walls of concrete, deposited from barrows within framing, with intermediate hearting, resting on rock; and where the bottom was clay, a concrete toe was added. An exposed portion of the outer arm was made of solid concrete. The average cost of the concrete was 18s. per cubic yard; and the total expenditure on the works, including deepening the harbour, was £17,500. The piers of dry rubble masonry protecting the east harbour of Portsoy having been damaged by the sea, rendering the harbour useless, their repair was undertaken in 1882. The piers were reconstructed and extended in solid concrete, deposited within framing from an overhanging crane resting on staging, at an average rate of 60 cubic yards in a tide. The works were completed in eighteen months, at a cost of £9000. The author considered that the proportion of 1 part of cement to 9 parts of gravel and sand, adopted for concrete at Fraserburgh, was too weak, and that the proportion of 1 to 6, adopted by him at Sandhaven and Portsoy, formed concrete of more suitable strength for such exposed works. Mr. Langley, in his paper on the "Lowestoft Harbour Works," described the works carried out by him for forming a new basin of ten acres along the foreshore to the north of the harbour, excavated to a depth of 14ft. at low water. The west quay was built, up to low water, by sinking thirty-eight hollow rectangular monoliths of concrete, 18ft. long and 10½ft. wide, to a depth of from 7ft. to 9ft. below the bottom of the basin. The hollow blocks were built up within framing, on a wedge-shaped cast iron shoe. The block was gradually sunk by excavating inside it; and its descent was guided by long hanging bolts at each corner. The blocks were connected together by passing iron rails through two holes left in the adjacent sides of each block, and filling up the intermediate space between the blocks with concrete; the well inside was also filled with concrete. A block, 21ft. to 23ft. high, was sunk in forty-two days; and the block foundation cost 30s. per cubic yard, or £45 per lineal yard. A concrete quay wall was built, from low water, on the top of the blocks, 13¾ft. high, and 8½ft. wide at the base. The eastern and northern sides of the basin were enclosed by embankments surmounted by a wall of concrete-in-mass. The excavations were effected by excavators, steam grabs, and a Bazin sand-pump dredger, which latter raised and delivered an average of 1000 tons of sand and gravel per day. The works were completed within twelve months, at a cost of £60,000.

HELIOGRAPHY, OR THE ACTINIC COPYING OF ENGINEERING DRAWINGS.[1]

By Benjamin Howarth Thwaite, Assoc. M. Inst. C.E.

The advantages of rapidity and fidelity of reproduction possessed by the actinic copying method are already well known; but the following notes on the most modern practice may be interesting to engineers. Sir John Herschel, who was probably the first to employ photographic printing for purely scientific purposes, used a cyanotype process for reproducing his astronomical tables. In 1840, a paper was submitted to the Institution by Mr. Alexander Gordon, entitled, "Photography as applicable to Engineering," in which Mr. Gordon described Daguerre's discovery, pointing out the advantages it offered to the engineering profession, and recommending the silver printing as a ready means of obtaining duplicates of drawings.[2] Engineers did not, however, employ heliography to any great extent until the ferro-prussiate, or cyanotype, commonly called the blue copy process, was introduced, when the advantages of cyanotype heliography became manifest; and, in some instances, the simple apparatus required for this method has been extended into complete photographic *ateliers*. The Midland Railway Company; Krupp, of Essen; Sir W. Armstrong and Co, of Newcastle; and Siemens and Halske, of Berlin, have photographic departments. The latter firm, in its Berlin establishment, employs a powerful electric arc light of 6000 candles, around which the printing frames are placed; and both the platinotype and Pellet processes have given successful results with the arc light.

The heliographic apparatus includes tracing paper or cloth, printing frames, a developing bath, non-actinic arrangements, and cases for storing paper. Thin bluish tracing paper is the best; the more translucent it is, and the stronger, the better. After the tracing has been made, it should be preserved from light, as exposure to light gradually renders tracing paper more opaque. The tracing should never be folded, but kept perfectly flat or rolled. Drawings on ordinary drawing-paper, or from illustrated papers, can be copied

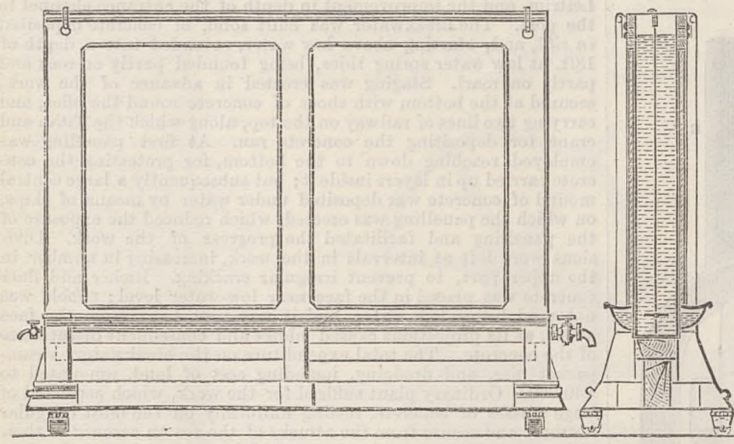


FIG 3

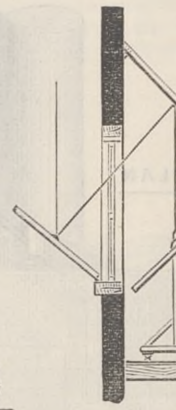


FIG 1

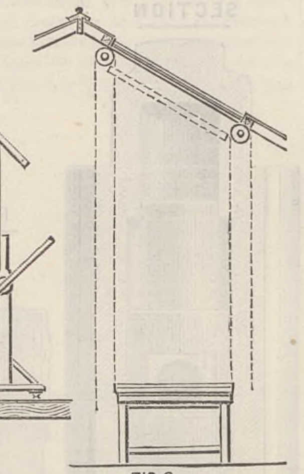


FIG.2

if they are exposed to the light sufficiently long, the duration of exposure depending on the thickness or transparency of the paper. When the drawing only shows half the section of the figure to be traced, the full section can be shown by tracing the other half on the back of the tracing-paper; the sun-copying reproduction is precisely the same as if the tracing had only been made on one side; and all the writing and dimensions should be on the front side. Translucent drawing parchment paper, specially prepared for the sun-copying processes, can now be obtained. The dimension-lines for the ferro-prussiate, or cyanotype negative, should either be dotted or ruled in Indian ink, chrome yellow, or raw sienna; or if in Prussian blue or carmine, the colours should be made more opaque by a slight admixture of flake or Chinese white. In copying by the ferro-prussiate or cyanotype processes, the sectional parts of the figure should be cross-hatched; or the sectional parts can be coloured with shades slightly less opaque than the linear portions, by the addition of an opaque colour, such as Chinese white; and as these sectional parts of the print are reproduced almost white, they can be coloured with the usual conventional colours, which could hardly be done on a blue ground. The Pellet and Shawcross methods allow of the ordinary conventional colours being used without this preliminary preparation. The best Indian ink should be employed, its opacity being increased by the addition of gamboge or chrome yellow.

The printing frame is the most important part of the apparatus, as upon its merits depends much of the success, both as regards accuracy and legibility. If the tracing and the sensitised paper are not brought into close contact with each other, the actinic rays pass under the lines of the drawing, which are thus either obliterated or contorted. The pressure should be uniformly distributed, to bring the sensitive and tracing papers into close contact, as any local pressure produces irregularities and false impressions, causing wrinkles in the tracing paper, the shadows of which are reproduced. In order to test the shrinkage of the paper, the scales should be drawn on the tracing in two directions, at right angles. The shrinkage of strong Pellet or cyanotype paper is equal to 0·005. The form of frame is very simple. The glass should be ¼in. plate, free from blemishes; and the author has used 26oz. glass for small frames. A piece of soft felt, ½in. thick, the full size of the frames, should be used to equalise the pressure, or a piece of folded flannel will serve the purpose admirably; and it is well to use india-rubber sheets, sewn to the edges of the flannel or felt. The most useful sizes for the printing-frame are 12 by 14, 19 by 26 for royal, 22 by 30 for imperial, 30 by 43 for double elephant, and 40 by 56in.

The method devised by the author for hanging the printing-frames is shown in Fig. 1, whereby the printing-frame can be inclined at any angle. This frame is adapted for offices in which space is limited, and in combination with the author's arrangement of developing bath, forms all the apparatus necessary for the Herschel, cyanotype, and Shawcross processes. Where diffused light alone reaches the office, owing to the obstruction of neighbouring buildings, reflecting frames can be used —Fig. 1—or the printing-frame may be hoisted to the roof fanlight by pulleys—Fig 2. The tracing is placed with its figured face next the glass, and the sensitised paper, with its prepared face next to the tracing, is carefully and uniformly pressed into contact with it. The felt is next laid upon the paper, in such a way as not to disturb the position of the tracing or the sensitised paper. The back board is then placed on the felt, the clamping bars are fixed in position, and the face of the frame is exposed to the sun at such an angle as to be as nearly as possible at right-angles to the solar rays. There should not be any obstacle, such as window-mullions, &c., intervening between the printing-frame and the source of light, as any partial obstruction of the rays would produce an imperfect copy. Where practicable, the printing-frame should be exposed in the open air to the full rays of the sun, or to the brightest part of the sky, preferably placing the face of the frame flat, so as to get the direct rays from the zenith, and with no wall near it to obstruct the light. If such a wall exists, it should be coloured white, to reflect as much of the actinic light as possible. If this is not possible, the frame should be exposed for half the time of exposure turned in one direction, and then reversed end for end for the remainder. Instead of springs or clamps on the printing-frame, use may be made of Street's copying frames, with an air-cushion inflated by simply blowing, and exerting a uniform pressure over the whole surface of the frame. The sensitive paper should be taken from its case in non-actinic light. This is especially important with papers sensitised by processes Nos. 3, 4, 5, and 6. described further on.

The author has employed yellow window-blinds, which have proved sufficiently effective in obstructing actinic light; and amber-coloured glass may be used, or ordinary windows can be converted into non-actinic ones by being covered with ruby, yellow, or amber-coloured glacial paper. The light of any office can thus be made non-actinic at a slight expense. The author sensitises the paper in the evening, using a ruby lantern. When the paper has been prepared by the cyanotype processes, or the gallic acid process, non-actinic arrangements are superfluous, as these papers may be freely handled in the diffused light of an office for the short time required to cut and place the sensitised paper in the printing frame. The developing bath should be slightly larger than the paper to be treated. For acid solutions, the bath should be of earthenware, papier-maché, vulcanite or enamelled iron; but for most of the solutions mentioned in this paper, the bath may be of zinc, or of wood lined with gutta-percha or sheet lead.

For the Pellet process, two trays lined with gutta-percha, and one zinc tray, will be required. A copious supply of water to the bath, from a 1in. rubber tube attached to a water-tap, will be found a great advantage. The print, on its removal from the frame, should be rapidly transferred to the bath, and after being immersed in pure water until it is completely developed, should be withdrawn and hung up on a line, or on glass rods with clips, until the water has drained off; and blotting-paper will then effectually remove the remaining moisture. A wooden bath may be employed if, when perfectly dry, it is treated with a varnish of ½ lb. of common brown resin and 2 oz. of beeswax. The developing bath designed by the author—Fig. 3—is well suited for offices where space is limited, as it is more portable than the flat form of bath, and occupies little space; the water clears itself from the dissolved salts, and the prints are more easily developed. The prints, when in the bath, are removed from the light, and when withdrawn they can be hung on the drying-rods at the sides of the bath, the water draining into the troughs at each side. The sensitised paper should be preserved from damp and the light in zinc cases. Where the locality is a damp one, it is a good plan to have the lid fitted to hold a piece of calcic chloride to absorb the moisture.

No. 1.—*Cyanotype sensitising process* (*Herschel's*).—White lines are produced on a blue ground with a solution of 140 grains of ferric-ammonic citrate, 120 grains of potassic ferri-cyanide, and 2 oz. of distilled water; and the solution should be kept in a stoneware vessel. This process depends upon the actinic action of light reducing the ferric salts to a ferrous state under certain conditions, one of which is the presence of organic matter, such as the albumen or other size contained in the paper. The ferrous salt then combines with the potassic salt to form Prussian blue, which is insoluble. The sensitising solution should be applied to cream-laid paper rolled and well sized by a flat damping brush, 6in. wide, or a tuft of cotton waste; and the paper should be allowed to dry in the dark. The solution should be applied uniformly, and sufficiently just to cover the surface of the paper. After drying in the dark, the paper should be rolled and stored in special cases. Two or three minutes' exposure to the sun at noon, and thirty minutes in the afternoon, is sufficient when newly-made sensitised paper is used. The exact degree of printing during exposure can be ascertained by the use of a small printing frame, in which sensitised paper should be exposed along with that in the larger frame, and under precisely similar conditions. Another method is to allow a part of the sensitising paper to protrude from behind the tracing. The effect of the degree of exposure can be ascertained by watching the varying colours of the paper, which, with the blue negative cyanotype processes, change from an initial yellowish green to a bluish green, then to bluish grey, and finally to an olive green, when the exposure is complete. A 6000-candle arc-light is equal to half the actinic effect of ordinary sunless noonday light, and equal to one-sixth of the actinic effect of unclouded sunlight. At a distance of 5ft. from the electric arc-light of 6000-candles, an exposure of thirty minutes is required for paper sensitised by the Pellet process, and a little longer for the other cyanotype processes. As the argentic paper is four times more sensitive than the cyanotype paper, about ten minutes' exposure only is needed for paper sensitised by the argentic nitrate process. By arranging several printing frames in a circle of 10ft. around the arc-light, as many as eight large copies can be made at the same time. When it is required to copy during dark days, and where the electric arc-light is not available, actinic light may be produced by a deflagrating mixture of 8 parts of potassic chlorate, 4 parts of antimony sulphide, 2 parts of sulphur, and 2 parts of magnesium dust; but it is only suitable for the highly sensitive argentic nitrate and platinotype processes, and must not be pounded or otherwise mixed in a mortar. The development is effected by thoroughly washing the print in pure water, in a bath, for a few minutes. A little hydric chloride is occasionally added to the water to increase the intensity of the blue ground, which may be converted into black by first immersing it in a bath of caustic potash, and afterwards in one of tannic acid. Development is considerably accelerated by the use of water at 90 to 100 deg. Fah. Only sufficient paper for two months' use should be obtained.

No. 2.—*Cyanotype process* (*Marion's*).—White lines on a blue ground are also produced by a sensitising solution composed of 9⅜oz. of ferric-ammonic citrate, and 6¼oz. of potassic-ferric oxide, dissolved separately in pure water, and then made up to 1 quart. Both processes Nos. 1 and 2 give good results. When positive prints—or blue lines on a white ground—are required, the sensitive paper should be of the thinnest possible description that will permit the solution to be applied without sinking through it. This thin paper should be then used in the manner described for taking a negative copy—or white lines on a blue ground—this negative copy being used instead of the tracing, and the ordinary sensitised paper placed behind it in the ordinary manner. The exposure must be considerably prolonged—from three to four times at least; and the development also occupies a longer time. To effect alterations or additions on negative prints, the following methods may be adopted. White lines may be obliterated by applying a quill pen or brush dipped in the sensitising solution, and then exposing and developing as already described. Additions may be made with flake, or Chinese white; but a more effectual method is to use a quill pen, or brush, dipped into a solution of forty grains of potassic carbonate in 1 oz. of water. Immediately after applying the potash, the paper must be carefully dried with blotting-paper, otherwise the effect of the solution will spread.

No. 3.—*Positive cyanotype process* (*Pellet's, blue lines on a white ground*).—According to an admirable treatise,[3] this process is the most important of the existing sun-copying or photographic-tracing methods. It is widely used by engineers on the Continent; it gives very distinct prints, and depends upon the reduction of an organic ferric salt to a ferrous salt by actinism. Prussian blue is formed by the reaction of ferric compounds with potassic ferrocyanide; and white ferrous compounds form a white salt with the same reagent. If the paper sensitised by the Pellet process was introduced into the ferrocyanide developer without exposure, it would become entirely blue, owing to the uniform deposition of Prussian blue. Should any part have been sufficiently exposed to the light, the paper will remain white owing to the complete reduction of the iron from the ferric to the ferrous state, the persalt of iron becoming reduced to the state of protosalt wherever the sensitive paper is unprotected by the opaque lines of the tracing. Hence the Pellet process produces dark blue lines on a white ground. The solution is made with 3 parts of sodic chloride, 8 parts of ferric chloride, 4 parts of hydrogen tartrate, and 100 parts of water; and it is thickened by the addition of 25 parts of powdered gum arabic. The paper should be fastened down by pins, and the solution applied in the usual manner. The paper should be dried as quickly as possible, to keep the sensitive coating as much as possible on the surface of the paper. In full sunlight one or two minutes' exposure is sufficient; but in dull weather, considerably longer time is required. With the electric arc light, the time of exposure varies from twenty minutes to half an hour. The progress of actinic action on the Pellet paper may be tested by inserting several test slips beneath a similar piece of tracing paper, on which some lines have been drawn, withdrawing these slips at different periods during the exposure, and inserting them in potassic ferrocyanide, until the exposure is found to be sufficient. By adopting this simple actinographic method, much disappointment may be prevented. The paper sensitised by this process will keep for days after exposure before developing, so that when a considerable number of sun-copies are required, it is advisable to expose all of them when the light is good, and to develope them subsequently at leisure. The print should be transferred into a saturated solution of potassic ferrocyanide, not immersed, but floated with the prepared face next the solution. By simply turning up the edges of the print, the developing solution is prevented from reaching the back of the print. The development is rapid, one minute being generally sufficient. A blue coloration of the ground is a proof of insufficient exposure; while weakness of the lines indicates over-exposure. If the exposure has been sufficient, the paper may be left for a considerable time in the developing bath, to increase the definition of the lines. On the contrary, should the exposure have been weak, the print must be submitted for a short time only to the influence of the potassic ferrocyanide, to avoid blue spots caused by unreduced particles of iron. After the completion of the development, the print should be floated face downwards upon clean water, and in about two minutes it should be immersed in an acid bath, composed of eight parts of hydric chloride, three parts of hydric sulphate, and 100 parts of water. From six to eight minutes is sufficient time to allow for the acid reaction on the iron compounds, and for the removal of the redundant iron compounds by the acid. The print should next be thoroughly washed with water, and dried. Any blue discoloration may be remedied by a dilute solution of potassic hydrate, applied with a quill pen, or brush, and blotted. The potash solution is composed of 1 part of potassic hydrate and 28 parts of water. A solution, termed blue solving, is provided for making alterations, or additions, on paper prepared by this process. When the helios produced by the Pellet process are discoloured, they may be effectually bleached by a 4 per cent. solution of hydric sulphate in summer; and in winter this may be increased to 6 per cent. When the cyanotype, the Pellet, or Shawcross prints are intended for the workshop, they should be saturated with white hard varnish. This will prevent the penetration of oily matters, grease, &c., and the adhesion of dirt. For rough work, the prints should be mounted on linen, with fresh, white paste, entirely free from acid and alum, applied to the back of the print. (*To be continued.*)

[1] Minutes of "Proceedings" Inst. C.E. vol. lxxxvi.

[2] Minutes of "Proceedings" Inst. C.E. vol. i. (1840), p. 57.

[3] "Die Modernen Lichtpaus Verfahren, zur Herstellung exacter Copien nach Zeichnungen Stichen," &c.

Draycott Drainage—The Shardlow Rural Sanitary Authority has instructed Mr. W. H. Radford, Assoc. M. Inst. C.E., engineer, Nottingham, to prepare a sewage scheme for the district of Draycott. This hitherto rural village appears likely to increase rapidly in population. A large factory is in course of erection and new streets are being set out; therefore it is urgently necessary to provide some proper method of sewerage disposal for the old and new population. The surrounding country is very flat, being chiefly meadows on the banks of the river Derwent.

New Repeating Rifle.—The Vienna correspondent of the *Times* says:—"Herr Joseph Schulhof, the inventor of a new repeating rifle which was tried recently at Enfield, leaves for England for some final experiments with his rifle, which he believes may be adopted by the British Government. The rifle was introduced to the notice of Mr. W. H. Smith and Lord Randolph Churchill while they were in Vienna, and Herr Schulhof was subsequently invited to go to England. The experiments at Enfield were judged to be most satisfactory, but some modifications were suggested in the calibre of the cartridge, and these have now been effected. It can be used as an ordinary rifle as well as a repeater. The receptacle for the repeating action holds ten cartridges, which can be poured in with one turn of the hand from a cardboard case. The loading of the repeater can be done in four movements, the fourth being the turn of a lever which stops the repeating action. The loading for single-shot firing is done in three movements, and the action for reloading throws out the empty cartridge case. Single shots are fired by a trigger, while the repeating action is worked by a knob handle. All the mechanism of the breech can be taken to pieces without the use of a screw-driver. The cartridges, which are shaped like small claret bottles, are of 7½ millimetres diameter, instead of 11 millimetres, as in the Martini-Henry. The weight of 130 of them equals that of 70 of the Martini-Henry cartridges, which is the charge usually carried by a soldier. The rifle is to cost 60 f. which is about 15s. less than the Martini-Henry. The use of the cardboard cartridge boxes is to be noticed; for in the Mannlicher system metal boxes are used, and if these get bent or dented, as they are liable to do, the cartridges may stick in them at the moment for loading. This is impossible with the Schulhof boxes, which are opened by simply tearing off a piece of paper. Moreover, the Mannlicher boxes only hold five cartridges instead of ten."

RAILWAY MATTERS.

COMPLETE railway communication between Adelaide and Brisbane, except the break—which is to be made good—by the bridge over the Hawkesbury, will be effected on March 31st next.

A TELEGRAM from Merv states that the completion of the Transcaspian Railway as far as Charjui, was yesterday celebrated at that place in presence of the principal Russian and Bokharan authorities.

WE recently illustrated portable sleeper preparing machinery. A portable steel rail saw is now used by Michigan Central Railroad for cutting off the battered ends of some English rails laid on the Canada Division of this road. The machine will cut from 200 to 300 rails at both ends, and re-drill and straighten them, in ten hours.

THE death is announced of Mr. W. Harrison, assistant general manager of the Midland Railway, which took place at his residence at Borrowash, near Derby, on Thursday night. The deceased had been in the company's service for a great number of years, and became assistant general manager in the room of Mr. Richard Speight, who relinquished his connection with the Midland Railway Company to assume his present high position on the Victoria Government Railways.

THE railways in the colony of the Cape of Good Hope are on a 3ft. 6in. gauge, and the greater part of them are in the hands of the Government, who at the commencement of the present year were the owners of 1599 miles then open for traffic. The three systems into which they have been classified—the western, the midland, and the eastern, proceeding from the respective ports of Cape Town, Port Elizabeth, and East London, converge towards the diamond fields. The works have been executed partly by contract and partly departmentally, at a total cost of £14,371,306 sterling. The average cost has thus been £8980 per mile, inclusive of stations, rolling stock, and plant.

AMONGST the steep inclines of important railways worked by locomotives of the "Consolidation" type the following have been enumerated as typical:—The Lima and Oroya Railway, crossing the chain of the Andes, with a summit level of 15,672ft. above the sea, attained in a distance of 100 miles by gradients of 1 in 25, and 1 in 34. The Arequipa and Puno Railway, also crossing the Andes, at a summit level of 14,666ft. above the sea, with maximum gradients of 1 in 25. The Denver and Rio Grande Railway crosses the mountain range at a summit level of 10,850ft. above the sea, with ruling gradients of 1 in 30. The Union Pacific Railway, crossing the range of the Rocky Mountains at a summit level of 8242ft., with ruling gradients of 1 in 88.

OF the 238 axles which failed during the first nine months of this year on our lines, 147 were engine axles, viz., 130 crank or driving, and 17 leading or trailing; 20 were tender axles, 2 were carriage axles, 63 were wagon axles, and 6 were salt-van axles. 29 wagons, including the salt-vans, belonged to owners other than the railway companies. Of the 130 crank or driving axles, 91 were made of iron and 39 of steel. The average mileage of 85 crank or driving axles made of iron was 233,057 miles, and of 39 crank or driving axles made of steel 223,933 miles. Of the 164 rails which broke, 79 were double-headed, 83 were single-headed, 1 was of the bridge pattern, and in one case the pattern was not stated: of the double-headed rails, 49 had been turned; 31 rails were made of iron and 133 of steel.

IN his book on English and foreign railway rates, just published, Mr. Grierson, of the Great Western Railway, says:—"It may be a matter of doubt whether it has been prudent on the part of railway companies to consent to some of the import rates complained of. Indeed, this doubt may be entertained, even if there is no substantial grievance, and it may be desirable that Parliament or the Board of Trade should institute an inquiry into the subject, which affects not only the interests of railway companies, agriculturists, and manufacturers, but also those of consumers, steamboat proprietors, merchants, and seaports." Not a few readers of these sentences may be tempted to conjecture that some railway companies would not be greatly annoyed if outside pressure were brought to bear upon them to remove rates which are maintained probably more with the view of keeping on good terms with powerful interests than for the sake of the traffic which they now yield.

THE *Electric World* says:—"Thanks to the numerous systems of electric railways, which are rapidly being developed in this country, the time cannot be far distant when the employment of electricity in the realm of locomotion will become general. Mr. S. D. Field's electric railway system shows that new forms are being applied—or rather, old forms are being employed to suit present purposes. The method of driving by means of the parallel rod connected directly to the armature shaft, while novel in its application to electric locomotives, is the usual type of driving mechanism in steam locomotives. Mr. Field proposes to operate on the elevated railways of this city, using an electro-motive force of 600 volts and over." The drawings show a powerful motor, with its spindle projecting beyond the road wheels sufficiently to receive a crank by which the armature is coupled direct and can only run the same speed as the rail wheels. This is simplifying things; but can the armature pull enough for this?

OF the 379 persons killed and 664 injured on our lines during the first nine months of this year, from causes other than accidents to trains, rolling-stock, permanent-way, &c., including accidents from their own want of caution or misconduct, accidents to persons passing over level-crossings, trespassers, and others, 63 of the killed and 516 of the injured were passengers. Of the latter, 12 were killed and 32 injured by falling between carriages and platforms, viz., 8 killed and 14 injured when getting into, and 4 killed and 18 injured when alighting from, trains; 7 were killed and 335 were injured by falling on to platforms, ballast, &c., viz., 1 killed and 44 injured when getting into, and 6 killed and 291 injured when alighting from, trains; 18 were killed and 14 injured whilst passing over the line at stations; 57 were injured by the closing of carriage doors; 9 were killed and 17 injured by falling out of carriages during the travelling of trains; and 17 were killed and 61 injured from other causes. 66 persons were killed and 22 injured whilst passing over railways at level-crossings, viz., 42 killed and 16 injured at public level-crossings, 14 killed and 5 injured at occupation crossings, and 10 killed and 1 injured at foot-crossings. 151 persons were killed and 66 injured when trespassing on the railways; 62 persons committed suicide on railways; and of other persons not specifically classed, but mostly private people having business on the companies' premises, 37 were killed and 60 injured.

ON Thursday last, 9th inst., a large party of gentlemen, representing the City of London College Science Society, under the leadership of Prof. Henry Adams, M. Inst. C.E., paid a visit to the locomotive works of the London and South-Western Railway Company at Nine Elms. They were received by Mr. W. Adams, M. Inst. C.E., the locomotive engineer to the railway company, and conducted through the various departments. During the time of the present chief the works have been thoroughly re-organised, and now present a good example of what is possible in the way of economy and dispatch in the operations of large railway workshops. Among the machinery observed were multiple drilling machines for wood and iron, hydraulic flanging presses, circular saws for cutting iron, machines for facing all parts of a cylinder casting without removal, steam hammers for stamping forgings between dies, bolt and rivet making machines, hydraulic rivetters, heavy wheel lathes, &c. During the visit some large blooms were brought out from the furnaces and made into slabs under the steam hammer, and in every department some special feature was arranged to make the visit both instructive and interesting. A vote of thanks was unanimously passed to the engineer for his kindness and courtesy, to which he replied in his usual hearty manner, and said that he hoped the members would show their appreciation of the visit by coming again.

NOTES AND MEMORANDA.

THE whole of the deaths as given in the *Times* of December 13th gave an average age of 72½ years. Some of the ages are not given, and possibly those omitted are of the younger people.

FOR lecture experiments, Herr F. C. G. Müller recommends a thermometer containing sulphuric acid blackened with sugar, as it is readily seen; sulphuric acid expands regularly, and has a coefficient of expansion three and a-half times greater than that of mercury.

IT is stated by M. H. Dunville that if two glasses of water be placed, one upon the north pole of a powerful magnet, and the other upon the south pole, in four or five minutes the former acquires a slight alkaline reaction, while that on the south pole becomes slightly acid.

A NEW fluid for preserving museum specimens, so as to keep their colour, size, form, and consistency for several weeks, has been devised by Professor Grawitz. It consists of 150 grams of sodium chloride, 20 grams of saltpetre to 1 litre of water; to this is added 3 per cent. of boracic acid.

THERE were 2485 births and 1738 deaths registered in London last week. Allowing for the increase of population, the births were 185, and the deaths 45, below the average numbers in the corresponding weeks of the last ten years. The annual death-rate per 1000 from all causes rose to 21·9.

SULPHATE of bismuth, according to M. de Boisbaudran, does not fluoresce in a vacuum when submitted to the action of the electric discharge; but when mixed with sulphate of calcium, it gives out a fine reddish-orange fluorescence. Sulphate of bismuth, with sulphate of strontium, gives a bright orange fluorescence; and with carbonate of strontium, a blue light. With sulphate of magnesia, sulphate of bismuth gives an orange fluorescence. M. de Boisbaudran has applied this method to the discovery of traces of bismuth in a number of chemical products and reagents of the laboratory, several of which were reported to be pure.

A TELEGRAM from New York, in a daily contemporary, says:—"Professor Thomson has demonstrated before the Society of Arts a novel application of electricity. By placing pieces of metal end to end under a forcible pressure, and passing an electrical current through them, perfect weldings are effected, even between metals otherwise incapable of being welded together, or between different metals. To weld steel of 1½in. diameter, a current of 6000 ampères, having an electro-motive force of half volt, was necessary. It is stated that the use of 35-horse power for one minute will weld that thickness of steel without any blows or the application of other heat. Steel also may be welded in this way to brass." The figures seem to require amendment, and welding by electricity has long been in use in this country for small work.

IN a recent lecture Professor Austen Roberts mentioned that the union of copper and antimony by fusion produces a violet alloy when the proportions are so arranged that there is 51 per cent. of copper and 49 per cent. of antimony in the mixture. This alloy was well known to the early chemists, but unfortunately it is brittle and difficult to work, so that its beautiful colour can hardly be utilised in art. The addition of a small quantity of tin to copper hardens it, and converts it, from a physical and mechanical point of view, into a different metal. The addition of zinc and a certain amount of lead to tin and copper confers upon the metal copper the property of receiving, when exposed to the atmosphere, varying shades of deep velvety brown, characteristic of the bronze which has from remote antiquity been used for artistic purposes.

A NOVEL method of measuring the deflection of railroad bridges has been tried in Russia, and is thus described by the American *Engineering and Mining Journal*:—An iron pipe 1½in. in diameter was carried along the outside of one girder. From this pipe, on each abutment of the pier, and at five intermediate points at each span, vertical pipes of the same diameter branched out. Inside, and near the top of each vertical pipe, was fixed a graduated ¾in. glass tube, the iron pipe being cut away on both sides. The zero divisions on the tubes were all the same distances above the flange of the girder. Before the bridge was loaded, the apparatus was filled with water, the tops of the upright pipes covered over, and the water was then drawn off until it stood at zero in each gauge. On the bridge being loaded, the deflection could be read with ease.

PROFESSOR HELMHOLTZ has shown that it follows from Faraday's experiments on electrolysis that while a monovalent atom carries to the electrode one charge of electricity, a divalent atom carries two charges of electricity. For instance, when we electrolyse potassium chloride, we have each potassium atom delivering a charge of electricity at the one electrode, and each chloride atom delivering an equal charge of electricity at the other electrode, all monovalent atoms, carrying with them an equal charge of electricity, which we may call the unit charge. When, however, we electrolyse magnesium chloride, we have two atoms of chlorine set free for one of magnesium, and consequently, while each chlorine atom carries its unit charge with it, the magnesium atom carries two units of electricity to the electrode. In fact, electrolysis proves that differences of valency mean differences in the electrical charge on the atom.

A PAPER was recently published on the specific heat of alloys of lead and tin, by W. Spring (*Bull. Soc. Chem.*). At low temperatures, alloys of lead and tin behave as simple mixtures of their constituents, each element still keeping its specific properties; as the temperature rises, a molecular action takes place, the molecules of each metal being broken down into molecules of simpler construction. This molecular modification increases in rapidity with the rise of temperature, and at a certain point attains its maximum, when the alloy melts, and it is to what the author terms the simplification of the molecules of the metals when heated in intimate contact with one another, that alloys so frequently have a melting point situated below that of either of their component metals. After the alloy is fused, the molecular change becomes less active, and finally, at a certain temperature varying with the composition of the alloy, ceases altogether; the alloy then once more behaves as a mixture of the component metals, each, however, having a more simple molecular structure than that of the separate metals at the same temperature. On cooling a melted alloy, an inverse action takes place.

IN a paper recently read before the Royal Society on "A Theory of Voltaic Action," by Mr. J. Brown, it was stated that the difference of potential near two metals in contact is due to the chemical action of a film of condensed vapour or gas on their surfaces. Such a pair of metals is thus similar to a galvanic cell with its electrolyte divided by a diaphragm of air or other gas, and it is the difference of potential of the films that is measured in "contact" experiments; the metals themselves being at one potential. But it appears that covering the metals with varnish, or immersing them in naphtha, to protect them from atmospheric action, reduced the difference of potential near them considerably, but not to zero. Drying the atmosphere about a copper-zinc pair by means of phosphoric anhydride in one instance reduced the difference of potential in 173 days from ·66 to ·5 Daniell. Then, on opening the instrument, it rose to ·67 Daniell. Experiments with an electrometer having quadrants of the metals under examination were made on the rate of decrease of the difference of potential near two metals in contact, and exposed to the action of the air and of other gases; also where a change in the constituents of the atmosphere surrounding a pair of metals in contact reverses the difference of potential near them in correspondence with the reversal of electro-motive force which takes place after a similar change in the corresponding liquid electrolyte used with the same metals as a voltaic cell. Such reversal takes place with pairs of copper-iron when hydrogen sulphide gas, or ammonia gas, is added to the air surrounding them; with silver-iron, when hydrogen sulphide is added; and with copper-nickel when either ammonia or hydrochloric acid gas is added.

MISCELLANEA.

THE *Figaro* stated on Tuesday that the Danish Government is about to order, probably in France, nine new ironclads and twenty-eight torpedo boats.

DURING the nine months ending September 30th, 12 horses, 1 pony, 38 beasts and cows, 62 sheep, and 7 donkeys, were run over and killed on our railways.

THE fourteenth edition of "Calvert's Mechanics' Almanack"—that for 1887—maintains the character of its predecessors, and is, as usual, instructive, very useful to those for whom it is intended, and amusing.

THE address of the Combination Flask Company, to which we referred in our impression of the 3rd, is 28, Martin's-lane, E.C.; and of the Anglo-American Tin Stamping Company, Stourport, instead of Southport, as we gave it.

NEW docks at Gravesend are proposed; and applications will be made to Parliament during the coming session for powers to construct the docks and tidal basins, and connections with the London, Chatham, and Dover, and South-Eastern Railways.

SPEAKING of lead mining in Swaledale, the *Leeds Mercury* Richmond correspondent states that a large and rich vein of lead has been discovered by workmen at Hurst Mines. This discovery may have an important bearing on the lead mining industry of the district.

THE Chinese Minister, Hsu Chin Cheng, has been to Stettin to inspect the two new Chinese ironclads now building there, one of which will be launched at the end of this month. Next week he goes to Essen to attend the trials of the guns ordered by China from Herr Krupp.

THE American *Engineering News* says:—"Work on the new lake tunnel at Chicago is progressing rapidly. The men work in three shifts, of eight hours each. The first dig the hole about 10ft. in diameter, through clay, at the rate of about 18ft. per day; the second trim it up and wall with planks; and the third lay a circular wall of bricks in cement, 12in. thick. The tunnel is left a shade over 7ft. in diameter, the whole plastered with cement. This will be completed in about five weeks, and the whole work in about three months."

A SIMPLE method by which stockless anchors can be drawn up and stowed in the hawse pipes of vessels, nothing but the flukes remaining outside, lying flat against the side of the bow, has recently been introduced by Mr. Wasteneys Smith, inventor of the Smith's stockless anchor. No alteration is required except that the hawse pipes must be slightly larger than usual, to admit the anchor shank, but the advantages are obvious. No anchor cranes, blocks, falls, &c., are required, "catting and fishing" are entirely dispensed with, and there is nothing on the fore part of the vessel to obstruct the sight. The anchors are securely stowed, and yet always ready to let go at a moment's notice.

HER Majesty's Consul at Stockholm has forwarded to the Secretary of State for Foreign Affairs the following translation of an advertisement in the *Göteborgs Handels och Sjöfarts Tidning* of the 6th December:—"It having been decided to build a bridge across the River Gotha at Trollhättan, for which the Government has granted an allowance, the Committee of Management hereby request intending competitors to send in offers, before the expiration of the month of December, separately for the bridge and separately for the foundation, according to drawings and specifications. Solvent guarantee or other approved security must be given for the completion of the work. Offers are received by, and necessary information given upon application to, the chairman of the Committee of Management, Ernst Stridsberg, civil engineer, Trollhättan."

A DEVICE used by some of our mills and found very beneficial by them, is, the *North-Western Miller* says, an exhaust for rolls, built on a principle very similar to that upon which the Behrn's millstone exhaust is constructed. Woollen cloth is adjusted in a zigzag form to an iron frame, and this is placed in a box over the conveyor connected with the rolls desired to be ventilated. A fan is attached to the box, by the means of which a draught is secured on the rolls through the cloth. This keeps the rolls perfectly cool and free from pasting, and at the same time ventilates the conveyor and connecting spouts. A rod, with one end obtruding from the box, is connected with the framework of the cloth, and when there has been an accumulation of dust on the cloth, an attendant strikes the rod and jars it off. The appliance is simple, and can be used in various ways and for numerous purposes.

ACCIDENTS have been of rare occurrence at the construction of the new Tay Bridge, but one with fatal results happened on Wednesday afternoon. The *Leeds Mercury* says:—While James O'Neil, rivetter, 20, was engaged at work along with his brother on a staging suspended at a giddy height from one of the girders on the south side, a plank on which they were standing canted over, and O'Neil was drowned. His brother escaped by catching hold of the staging. In connection with the bridge it may be mentioned that another of the large girders was floated into position on Saturday. Another of the large girders is nearly completed, and it is likely to be taken out in the course of a few days, the piers meantime being made ready for its reception. After it has been placed there will be only one other girder required to complete the bridge. The work is being pushed vigorously forward, and there is no doubt the bridge will be opened for traffic in the beginning of the summer.

IT is the intention of the Admiralty to make all appointments of inspectors of machinery to the Steam Reserves at Chatham, Devonport, and Portsmouth for a term of three years only. At present the appointments are nominally for five years; but as there is in reality no law on the subject, such as governs the holding of other responsible trusts, the appointments are usually for an indefinite period, several officers having held them until compulsorily retired from the service by the age regulations. With the exception of superintendents of dockyards and inspectors of machinery in connection with the Steam Reserves, all naval appointments on shore terminate at the end of three years. In order to remedy a grievance complained of by officers on half-pay, as well as to introduce definiteness and uniformity in the service, the Lords of the Admiralty have resolved for the future to appoint inspectors of machinery to the Steam Reserves for a fixed term of three years.

A CORRESPONDENT of the Buffalo *Commercial Advertiser* thus speaks of improvements now in progress at the Niagara Suspension Bridge:—"The original anchors were strengthened by sinking deep pits at either end of the bridge, and extra anchors were added to help sustain the heavy structure. The stone towers on which rest the huge cables were watched with great care, and new stone was added to any spot showing the slightest weakness from decay. It was finally decided that not only for symmetry and beauty, but for durability also, it would be better to substitute steel towers for the stone ones. The contract was let some time since and work was commenced. The stone towers were chiselled down to such a point that the steel when put in place would occupy about the same space. There was some delay in concluding the operations, but the work is now fairly under way. The iron is being placed in position, and before many weeks the old suspension bridge will be practically a new bridge throughout. The towers are to be built and secured before any part of the transfer of the cables will take place. Then by means of hydraulic jacks the cables are to be lifted slightly and placed upon the steel towers, after which the old stonework will be torn down. The operation is an interesting one, and is under the charge of Engineer Buck. It will be necessary during the last treatment of this operation for Grand Trunk cars to pass over the cantilever bridge, and it is understood that arrangements have already been made to that effect."

THE EFFECT OF PROJECTILES ON ENGLISH AND FRENCH ARMOUR PLATES.

(For description see page 480.)

FIG 1.

FIG 2.

FIG 3.

FIG 5.

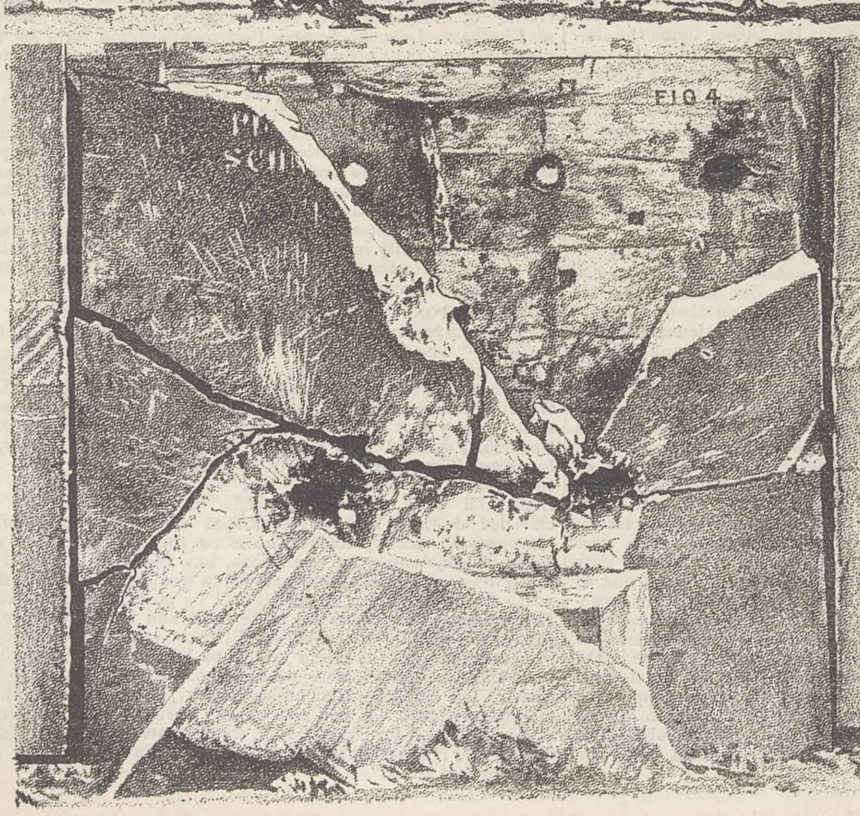


FIG 4.

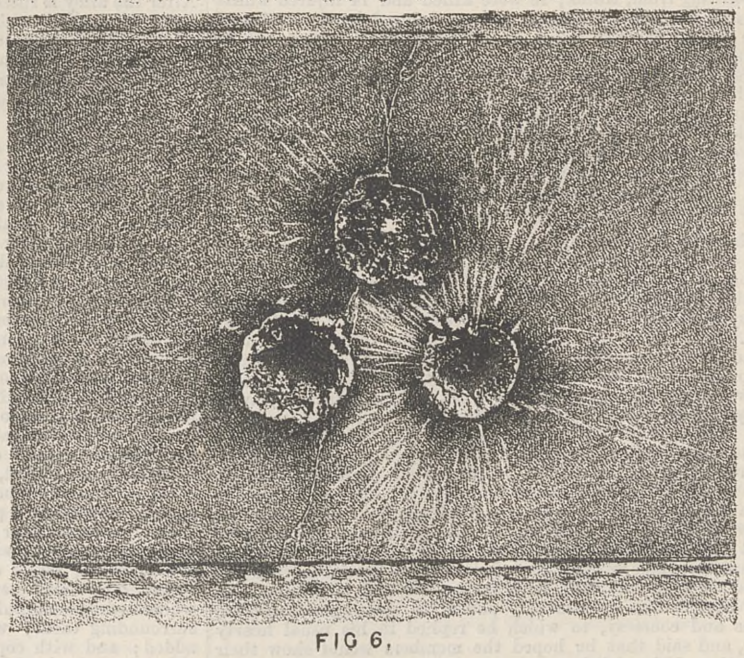


FIG 6.

PUBLISHER'S NOTICE.

*** *The Publisher begs to announce that* THE ENGINEER *will be published Next Week on* THURSDAY, *instead of* FRIDAY. *Advertisements intended for that Number must reach us before Six o'clock on Wednesday evening.*

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TO CORRESPONDENTS.

Registered Telegraphic Address—"ENGINEER NEWSPAPER, LONDON."

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must, in all cases, be accompanied by a large envelope legibly directed by the writer to himself, and bearing a* 1d. *postage stamp, in order that answers received by us may be forwarded to their destination. No notice will be taken of communications which do not comply with these instructions.*

C. H. N. (Fog Signals).—*We cannot publish letters containing claims to priority of invention.*

NEMO.—*Probably the small book by Adams on "Strains in Ironwork" would suit you—E. and F. N. Spon—or for a comprehensive treatise Graham's "Graphic and Analytic Statics," Crosby Lockwood and Co.*

J. L. N. (Grampound).—*So far as we understand your invention it is very old. Jacob's ladder wheels have been used on high falls with some success. No power is gained, but the efficiency of the machine is very fair.*

WOOLF HILL.—*There is a treatise by Wilson which will supply you with all the information you want. To burn* 2000 *lb. of coal per hour, a round chimney* 80*ft. high should not be less than* 4*ft. in diameter inside.*

JACK.—*The Manchester Association of Engineers at their meeting on Saturday decided to print Mr. Renolds' paper in full, and copies may be had on application to the secretary, Mr. F. Walthew,* 18, *Holland-street, Old Trafford, Manchester.*

C. W. R.—*You will find information in Molesworth, page* 254, *as regards torsion. Solid round shafts being* ·7, *solid square shafts are* ·87, *hollow cylinders, where inner diameter is to the outer as four to ten,* 1·26*; as five to ten,* 1·44*; six to ten,* 1·7*; seven to ten,* 2·08*; eight to ten,* 2·74.

FRISBY'S STOKER.

(*To the Editor of The Engineer.*)

SIR,—Can any reader give me the name and address of a maker of Frisby's stoker? C. AND R.

Edinburgh, December 8th.

FISH PLATES.

(*To the Editor of The Engineer.*)

SIR,—Will any reader kindly inform me, by means of an answer in your column "To Correspondents," what the term "fish-plate" is derived from? The article itself, of course, is well known; but what is the connection between the name and the thing signified?

Barrow-in-Furness, December 2nd. FISHER.

ANTI-FRICTION METAL FOR HEAVY MACHINERY.

(*To the Editor of The Engineer.*)

SIR,—Will you kindly permit us to ask the following question in the correspondence column of your paper, and oblige?—Will any of your correspondents kindly recommend a formula for an anti-friction metal suitable for running the necks of heavy machinery. The components of the alloy must be capable of melting in a lead pot over an ordinary fire, as it has to be run in position. M. A.

Aylesford, Dec., 1886.

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Remittance by Bill on London.—Austria, Buenos Ayres and Algeria, Greece, Ionian Islands, Norway, Panama, Peru, Russia, Spain, Sweden, Chili, £1 16s. Borneo, Ceylon, Java, and Singapore, £2 0s. 6d. Manilla, Sandwich Isles, £2 5s

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS, 25, Great George-street, Westminster, S.W.—Friday, December 17th, at 7.30 p.m.: Students' meeting. Paper to be read:—"Water Supply in Rural Districts," by C. E. Davenport, Stud. Inst. C.E. Tuesday, December 21st, at 8 p.m.: Ordinary meeting. Paper to be read with a view to discussion:—"The Use and Equipment of Engineering Laboratories," by Professor Alex. B. W. Kennedy, M. Inst. C.E.

THE ENGINEER.

DECEMBER 17, 1886.

THE LIFEBOAT DISASTER AT SOUTHPORT.

AMONG all the catastrophes which have been caused by the tremendous gales of last week, none is more lamentable or, in one sense, more astonishing, than what is known as the Southport disaster. On the night of the 9th inst., a ship was in peril off the mouth of the Mersey, and three lifeboats proceeded to her assistance, one from Southport, one from St. Anne, and a third from Lytham. The Southport and St. Anne boats were both capsized, never righted again, and no fewer than twenty-seven men of their crews were drowned. The Lytham boat accomplished her errand safely, and rescued the crew of the wrecked ship. It has always been understood that the modern lifeboat is self-righting; that is to say, that if upset she will come right side up again; and as the men invariably wear cork jackets, and the boats are well provided with life-lines, the loss of life is reduced to a minimum. To find now that two boats failed to right themselves in one storm is a very serious matter indeed, and demands the most searching inquiry on the part of the officers of the National Lifeboat Institution. During a discussion on steam lifeboats, which took place last spring, at the annual meeting of the Institution of Naval Architects, we heard it argued that the power of self-righting was a great defect in a lifeboat; but we are not aware that any competent authority has ever expressed a similar opinion. The Lifeboat Institution possesses 270 boats professing to be self-righting. Up to the end of 1885 they had been out 4700 times, and saved 12,000 lives. Up to that time boats had been capsized thirty-nine times, and there had been no loss of life caused by twenty of these upsets. The Institution also possesses twenty-two large boats, which have been out 653 times, and saved 1668 lives without being overturned. The smaller boats weigh two and a-half to three tons each. There are four extra large boats weighing ten tons each.

A few words about the history of the lifeboat will not be out of place here. Boats had often been fitted with cork and with casks lashed into them, but there was no regular lifeboat until about the year 1790. The self-righting boat was invented by a Mr. Greathead, and was constructed on the principle that if a spheroid be cut into segments like the "quarters" of an orange, and thrown into the water it cannot be upset without difficulty; and if upset will always right itself and float with the curved-up ends uppermost. The original boat built on this principle was used for the first time on the 30th of January, 1790, in a tremendous sea, and was so successful that several other boats were built on her model, and, it is said, saved between four and five hundred lives off the Tyne alone in the first twenty-five years. Save in details and dimensions, the modern lifeboat does not differ much from the original Greathead boat. That was 30ft. long, 10ft. beam, and from the gunwhale to the bottom of the keel 3ft. 3in. deep. The keel of 3in. plank formed a great convexity downwards, the bow and stern rising. Internally the boat was shallow, the space between the flooring boards and the bottom being filled in with cork. She had cork all round her, and cork at each end. The modern lifeboat has air casings, although cork is freely used. There is a large air chamber forward and another aft, and the keel is fitted with a heavy bar of iron from end to end. When such a boat is upset she is in a condition of most unstable equilibrium. She is borne up by the air vessels at either end to a large extent, and the centre of gravity is high out of the water. It might be possible to set such a craft upside down in smooth water and then to balance her, so to speak, on each end; but it ought to be impossible to do anything of the kind in a sea, because the smallest impulse on the port or starboard side would overset her. The keel will go down and the gunwale will come up. The boat will be full of water it is true, but the discharging valves will open, and she will rise and float again like a duck. Lifeboats have been tried over and over again and behaved properly. It used to be the custom, when a new lifeboat was given to any town, for the crew to take her out and purposely test her for stability and the power of self-righting. They are, we understand, now tried in a canal. We do not know if the practice of sea testing is maintained. It ought to be revived if it has drifted into disuse.

An inquiry has been begun at Southport by Sir Digby Murray representing the Board of Trade, while Captain Chetwynd appeared on behalf of the National Lifeboat Institution. The inquiry terminated on Wednesday, and may be said to have had no practical result. An attempt was made to show that the boats were badly managed; but this has little or nothing to do with the matter. Lifeboats must reckon with the chance of an upset; and it would be a most extraordinary coincidence that two boats should be mismanaged at the same moment. It was plainly stated that men remained alive under the boats for some time, and it is certain that if the boats had righted themselves the loss of life would have been very small. It has been said that a lifeboat at anchor if upset will not right herself. This is a very important question, and should not be left in doubt. A great deal of lifeboat work, especially in the south, is done at anchor. The boat is towed out by a steamer to windward of the wreck, she then lets go an anchor, and veers out cable, so that, dropping down before the wind, she can come quite close to the wreck without touching her, and so take off the crew. This being done, she hauls in her cable, so getting well away from the wreck, and then, setting her lug sails, she takes up her anchor and runs for shore. Now, if under such conditions the lifeboat, if upset, will not right herself, the peril incurred by the crew becomes tremendous.

It has before now been urged that the saving of life from wrecks ought to be a Government matter. That, in a word, the Government ought to support a life-saving staff all round our coast, and not leave the humane work to be carried out by private enterprise. To this, however, there are several objections; and it is worth while to state one or two of them here, because the whole question of lifeboat work may be opened up by the Southport accident. The present work could not, in the first place, be done by the Government for anything like the same money. But this is not the principal objection. The Government is inseparably connected with what is known as red tape; every Government must be. Now, lifeboat work and red tape are entirely opposed to each other. The work to be done is rough and dangerous, and can be discharged by none but volunteers. If a man took Government pay he would look only too often on going out to a wreck as a bit of Government compulsion. There would necessarily be officers, and one man would be over the head of another, and there would be an absence of spontaneity about the whole thing which would go far to render lifeboats useless. In return for this nothing would be gained. The work could certainly not be done better than it is now. In all human probability it would not be done nearly so well. So long as those who support the National Lifeboat Institution are satisfied no one else need grumble. It has done, and will continue to do, magnificent work, and with that we may rest content. If more boats can be had, use can be found for them; and the unfortunate occurrence, deplored by no one more sincerely than it is by the officers of the Institution, will doubtless lead to improvements being adopted which will in future render such catastrophes impossible.

MECHANICAL ENGINEERING AT HOME AND ABROAD.

So far as is known, mechanical combinations care nothing about the country in which they are used, and, broadly speaking, that which is right in one country ought to be right in another. It will be found, however, that this is apparently not the case. At all events, practice in mechanical engineering varies all over the world, and this not only in small matters, but in things which may be regarded, without putting much stress on the imagination, as fundamental. To what is the difference to be attributed? We think the answer must be that it is due, in large measure, though not altogether, to the personal proclivities, not of machines, but of the men who make them. Our friends in the United States, for example, are never weary of telling the world that the American locomotive is the best locomotive; and this they insist on, even while admitting that its evaporative efficiency is, for some reason which we shall not attempt to explain, about 30 per cent. less than that of the English engine. The American engineer still uses bar frames, and cast iron wheels, and small drivers, and outside cylinders, and fails to understand how an English engine can get along at all without them. It is of no use to tell him that English engines are hauling trains daily all over the country, at speeds equalled on only one or two crack United States lines, and this with a consumption of fuel small beyond what the United States can name. But this signifies nothing. The American engine is built by the thousand, and gets on very well in its own country; and American folk are well pleased with it, and admire its bell, and its big head-light, and its cow-catcher; and all the while English engineers wonder how such a rattletrap, roughly-built affair can be tolerated. It is not such a long time since shop drawings were unknown in celebrated American locomotive building establishments. Everything was set out on rods of pine and hickory, and when a new engine was to be built, the number of the sister engine was hunted up in the books, and the bundle of rods was fetched out of the pattern shop, and the work began. All that has been changed; but it still seems that the American locomotive cannot thrive on English soil, or the English locomotive within Yankee shores. If we turn to France again—to say nothing of Germany or Austria—we find things not only tolerated, but much liked, which are abominations to American and English engineers. Take, for example, the valve gear of a French engine. Even in its simplest form we have the excentrics overhanging the cranks outside. We have ourselves measured an engine in which the outside face of the outer excentric was, as nearly as possible, 3ft. from the outside face of the engine frame. Such overhanging gear as this would be intolerable on an English railway. Why should it be right at one side of the Channel and wrong at the other?

Again, let us take boiler practice. On the Continent water-tube boilers are freely used, they are almost as popular as the Cornish boiler is with us. If a Frenchman does not make steam in a generator of the Root or De Nayer type, then he will have elephant boilers. Of course boilers with internal furnaces may be seen in France and Germany, just as water-tube boilers may be seen in this country; but the Lancashire boiler never found a congenial home on the Continent, nor did the water-tube boiler in this country. Why is this? There is a great deal to be said in favour of both boilers. Why do not both find favour in English and French eyes? In the United States they do things in boiler engineering which no one dreams of doing in this country, and no evil consequences follow. In Pennsylvania they have been making boilers 16ft. long and 5ft. in diameter of two sheets of steel ⅜in. thick. There are only two longitudinal seams; no cross seams. These boilers are fired externally under one end. The products of combustion are returned through fifty-four tubes. Boilers of this kind have long been known in the States, and used with success. In this country the engineer who proposes to use an externally-fired boiler is looked upon as a Goth. If externally-fired boilers succeed in the United States, why do they not succeed in Great Britain? If they are failures in the United States, why do American engineers go on making them?

We could extend the list very largely were it necessary, which it is not. The subject is one of great interest, and the questions we have raised cannot be answered in a moment. A very favourite reply is that existing machinery is more or less a result of the survival of the fittest; but this is not quite true, or at least it does not go nearly far enough. We must seek further. The outside valve gear of French locomotives is, we think, largely due to Mr. Crampton. His were among the first successful locomotives seen on French railways. They had outside gear, and were accepted as patterns, from which the French engineers worked for many years; the result being that they have since become familiarised with mechanical combinations, the paternity of which Mr. Crampton would be the first to repudiate. In the United States, fifty years ago, the mechanical arts were far behind as compared with the point which had been reached in this country. There was not in the United States, from one end to the other, a mill capable of rolling a ¾in. side frame. So Bury's bar frames were adopted because they could make no others, and there were smiths quite competent to build up the comparatively small forgings used in these early engines. They could not make a cranked axle in the States, and so they used outside cylinders. There was no money available for the purchase of costly wrought iron wheels in England, and the country was blesssed with a pig iron unrivalled in England for purity, toughness, and strength; consequently cast iron wheels were used. All these things were found to answer fairly well; with little alteration they are used still. Men get into grooves and stick there, and so the American engine is now what it was a great many years ago, save that it is bigger; and American engineers educate themselves to think that they build their locomotives with outside cylinders and bar frames because outside cylinders are better than inside cylinders, and bar frames are better than plate frames, and so on. These gentlemen quite forget the reasons why these things were first adopted. Not in locomotives alone, but in many other things, American mechanical engineering differs from ours. The same is true of France, and Austria, and Belgium, and Germany. The young engineer when he first travels is likely to say that such un-English practice as he may discover must be all wrong, and evidences of greater or less folly on the part of others. Nothing can be further from the truth. English engineers must not claim to be infallible. Let it be remembered that mechanical engineering is not an exact science, and that the way in which it is practised is often a survival not of the fittest, but of the only possible, and we shall find that we have a key which will explain much that appears mysterious or perplexing to every engineer, no matter of what country, who studies the practice of another nation.

IRON AND STEEL RAIL EXPORTS.

THE rail trade of the year, as far as the export branches are concerned, has shown in the earlier part a decided retrogression, and in the latter part an increase at a rate sufficient to give for the whole of the year an enlarged trade with foreign buyers. In the first eleven months there were exported this year 12,199 tons of iron rails, and as the total for the same period of last year was only 13,729 tons, it is apparent that the small volume of the iron rail trade has not known any further decline of note. But the value of iron rails sent out last year was over £6, and for the present year it has been under £6 per ton. Coming to the more important steel rail trade, we find that in the first eleven months of last year the exports were 456,375 tons; whilst in the same period of the year that is now so near its close the exports have been 475,838 tons. It is noticeable that this increase is in the face of a serious falling off in the demand by several countries which were amongst our best customers. Russia has this year only bought little more than a third of the quantity she bought last year. Egypt has taken little, and our South African possessions have also taken much less; whilst our East Indian possessions, though very large buyers, have also had less this than last year. The United States and Canada have largely increased their purchases, and Australasia has also been a better customer. The total result is that above stated; and it is certainly gratifying to find that in the face of the enormous competition we have to face in the rail trade, we have been able this year to increase our export trade. The price of the rails is, however, less on the average, and thus the value of the exports is less. Last year the average price of the steel rails exported was about £5 10s. per ton; but this year it has fallen until, for the whole year's exports so far, it is under £5 per ton. Coming to the rail trade as a whole, we find that last year on the average we exported 42,500 tons monthly, and this year we have exported about 44,300 tons monthly; but, as we have hinted, the increase has been chiefly in the last few months, for in November alone the quantity sent out was 10,000 tons above the average. It is well known that there have been very large orders for steel rails booked of late, and though some of these must have in part swelled the tonnage of the quantities sent out, yet there is ground for the belief that, for some time to come, very heavy quantities of rails will be needed; and it is also to be noticed that the export rail trade has its influence on the home trade, for the briskness at some of the works has prevented that excessive competition for home orders that had been in progress despite the combination—or perhaps in consequence of that combination—which shut us out from certain orders and forced a greater struggle amongst the home makers for home orders. The producers just now have work ahead for a tolerably long period, and in that time there will be a fair exportation, though it is evident that the makers in the United States will strain every nerve to produce as much as they can for their own railways. Still, the tendency and the teaching of the rail export statistics is decidedly favourable.

SHIPBUILDING MACHINERY.

THE adoption of steel in place of wrought iron in the construction of ships has led to certain modifications and advantages in the plating which could not formerly be attained. Shipbuilders can now obtain steel plates of great length and width, and are thus enabled to have fewer joints, rivets, and butt-straps than were otherwise necessary. It is not long since 10ft. to 12ft. was considered a fairly long plate, and 4ft. was thought a great width. If these dimensions were exceeded, the iron manufacturer charged an increased price. Naturally, from motives of economy, shipbuilders were loth to exceed these limits. Now, however, all this is changed; steel plates can be obtained of considerably larger dimensions without increase of price in proportion to size. Perhaps the only limit in dimensions is the capability of the shipyard to handle and work the plates. Many of the shipbuilders have no rolls longer than 16ft., and their planing and punching machines confine many of them still to certain lengths and widths. There are indications, however, that these old tools and plant for dealing with short iron plates will very soon have to be laid aside, and either broken up or applied to other uses, to make room for machines of much larger calibre. Already some of our enterprising shipbuilders have provided themselves with enlarged plant. Messrs. Harland and Wolff, Belfast, have now a plate-bending machine, by Messrs. Shanks, Johnstone, that can admit a plate 27ft. long between the standards, and they have just put down planing and punching machines by other makers to correspond. On the Clyde, Messrs. Alexander Stephen and Sons are taking the lead in acquiring such machinery. They have just contracted with Messrs. James Bennie and Co., Glasgow, for a plate-bending machine with rollers 25ft. in length. This will be the largest machine of this kind on the Clyde. The top roller, which is to be 3ft. in diameter, will be raised and depressed by Messrs. Bennie's power gear, now so generally adopted, and which worked successfully on the large rolls which this machine is to supersede. Messrs. Bennie and Co., have also recently made several extra large punching and shearing machines, capable of operating on steel plates up to 2in. in thickness—some being of the lever type, now so much in vogue in Northern shipyards. These have gaps 42in. deep, allowing of a plate 7ft. broad being punched in the centre. It is not every shipbuilder that will be able to provide himself with machinery of such extraordinary dimensions, but unquestionably those who do and can advance so far will have great advantages in respect of securing contracts, and executing them at lowest possible cost.

A PROMISING MARKET FOR RAZORS.

CHINA is being talked about a good deal at present as one of the new markets which may be early opened up for English commerce. A toy railway has amused the Chinese mandarins so mightily that they are getting quite familiar with this example of the outer barbarians' iniquity. Not so very long ago, after they had conceded the right to make a line, they changed their minds, re-bought the line, and tore up the rails. They thought the engine the "evil one" himself, and would have none of him. The last engine was probably so small an "evil one" that the Celestials can tolerate the toy. But there is no superstition against razors. The Chinese are a shaving—not to say shaven—race. With them, to get rid of their hair must be little short of a religion, considering the awful implements of torture they use for the purpose. Some of these are now on view in Sheffield. If the Chinaman only knew the felicity of removing his hair with a Sheffield razor, he would never be gloomy again; and what a "boom" it would be! About 150 millions of people in the empire are obliged by the laws of the land to shave their heads. One barber is required for about every score of persons, which would give 7,500,000 barbers continually using razors. Give each barber four razors, and there is a grand total of 30 millions of razors in use among the Chinese. If this does not encourage the home cutlers to have a "cut in" among the almond-eyed people of the East, nothing will.

TRADE MARKS.

THE Master Cutler, Mr. G. F. Lockwood, states a point of much interest to cutlery manufacturers. The Cutlers' Company were asked to register a trade mark in Class 12, which was objected to by the Comptroller of Trade Marks, who laid down a rule that farriers' knives were not included in Class 12 under the generic term "cutlery." The Comptroller contended that a separate application must be made for such goods in Class 11, in which are included instruments, apparatus, and contrivances for surgical or curative purposes in relation to the health of man or animals. The Cutlers' Company vigorously contested this decision of the Comptroller, who has waived his objection, and laid down the rule that farriers' knives are to be considered knives, and not instruments. This branch of the cutlery industry is important, and the successful action of the Cutlers' Company has given much satisfaction.

LITERATURE.

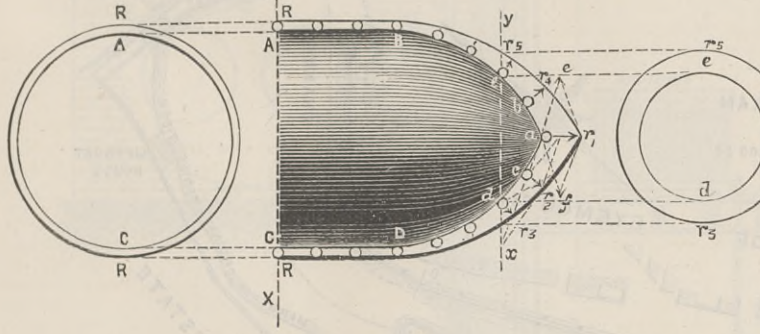
Electricity in the Service of Man: A Popular and Practical Treatise on the Applications of Electricity in Modern Life. From the German of DR. ALFRED RITTER VON URBANITZKY. Edited, with Copious Additions, by R. WORMELL, D. Sc., M.A. With an Introduction by JOHN PERRY, M.E., F.R.S. With nearly 850 Illustrations. Cassell and Company, 1886.

THIS is one of the most tantalising books it has ever been our lot to come across. That "too many cooks spoil the broth," is as true in bookwork as in the kitchen; and if ever good work was spoiled it is in this book. We have heard it said by one who should know, that no good general electrical treatise exists in the German language. Dr. Urbanitzky's work in its original form is unknown to us; but if Dr. Wormell and Professor Perry in their edition have been unable to satisfy our not too rigid requirements, the original is not likely to satisfy them. The translator and editor of another person's book is in a peculiar position, and doubtless wishes again and again that he had not undertaken the work, but had commenced to write on the subject *de novo*, and in this particular case we certainly wish this had been done.

Before discussing the book itself, let us enter a protest against some remarks in the preface and introduction. The former, page xvii., says, "It has been urged that the analogy—water analogy—may be carried too far; and, in particular, that the flow of water through a pipe, unlike the flow of electricity through a wire, has no effect on the region outside." All we can say is that the analogy in this particular *may* be very close indeed. Professor Perry in his introduction says, "It may be laid down as a general rule for electrical students, that he who has not a quantitative knowledge of the principles of electrical science will only waste his time in making original experiments." Unless we misinterpret Professor Perry, we contend that this statement is absolutely in error. If his contention is correct, then it is only to such men as Thomson, Tate, Ayrton, Perry, Wormell, Cumming, Chrystal, Niven, Rayleigh, Glazebrook, and Hicks, that progress has been or will be indebted. As a matter of fact, when we come to the hard-and-fast practical work, these men have contributed comparatively little. Could the inventors of the telegraph boast of the quantitative knowledge of these men, or the discoveries of electro-deposition? Had Gramme, Brush, or Edison much quantitative knowledge at their fingers' ends when they invented their machines? The cool assumption of scholasticism to be the vanguard, main body, and rear guard of progress, almost passeth the bounds of credence. These men, who claim so much for "quantitative knowledge," would claim infallibility if they dared. The real truth is that, with a few exceptions, their "quantitative knowledge" has been obtained after the practical work has been done—from the work, not before it. They are improvers, not initiators. The dynamo was an actuality before any "quantitative measurements" about it were made or known. Practical men will go on as they have gone on—blundering it may be, but blundering to a purpose, and when that purpose is achieved receiving the attention of the "quantitative critic," who calmly says, "You ought to have done so-and-so, and so-and-so!" Let us thank Heaven that Bell did not know of "Fourier's Mathematical Analysis," page 25; and let us, who pretend to have some familiarity with mathematics, say emphatically that the mathematicians blunder as much, with all their pretended astuteness, as the most unlearned blacksmith in his endeavours to construct a calculating machine. Hero worship is permissible; but we must claim other heroes than those mentioned by Professor Perry. Do we really owe so much to the mathematician? Do we owe nothing to Sturgeon? If the reader of F. C. Webb's book on "Accumulation and Conduction" does not come to the conclusion that Webb knew more about the inductive circuit in the sixties than Urbanitzky knows in the eighties, we shall be greatly surprised. Did not Sprague, in the sixties also, pave the way for the too-much-belauded book of Jenkin? What credit are we to give to De La Rive? Surely English students were not in so poor a plight before 1870 as the writer of this Introduction rather leads us to believe. While we would be just to Thomson and Maxwell, let us not be unjust to others who, in their sphere and with their opportunities, did good work, and work better suited to the understanding of the multitude than that of these celebrated men. In these latter days, intercommunication has been easy and literary activity great—facts which must be taken into account when comparing Cavendish with Thomson, or Green with Maxwell.

The English market has been flooded with so-called "popular" scientific books translated from foreign sources, and almost without exception these translated books are bad. Their science is antediluvian, their descriptions of apparatus are out of date, and altogether they must be looked upon as books made to sell. Fancy, in a book issued in 1886 having tables of declination only to 1880, and variations of inclination for Paris 1851, for London, 1880! Unless we are mistaken, the required figures to complete the tables could easily have been obtained from the Kew reports. Further on we get the measurements of incandescent lamps obtained at Paris and Munich; but, in our ignorance, we supposed that the improvements since the latest of these periods had led to something far superior to anything known in those days. But to resume. Why give the intensity of the earth's magnetism at Munich in 1871? Surely this book is to sell to English readers, readers who do not care what the magnetic intensity was at Munich in 1871, but who want to know what it is in London in 1886; yet a useless table is given, and the figures for Kew given only to 1884—two years ago.

It would be much easier to shut our eyes to the bad parts of the book, and content ourselves with a few general words praising the descriptive and historical parts—the printing and illustrations—but we feel that some unlucky wight has to make a stand against the production of books merely to sell. In this one the knowledge of the author concerning statical electricity is of the feeblest. The reader will have to unlearn almost all he learns from the book. Is the reader to understand that Reiss was the first to arrange a list of conductors, partial conductors, and insulators? On page 31 we are told that "another mode of generating electricity occurs in the chemical process of combustion." The author seems to imagine that the chemical process of consumption by fire is different to the chemical process of combustion when flame and smoke are unseen. On page 39 we read, "electrified bodies attract small particles of air, electrify them, and then repel them;" this in the paragraph on the gradual leakage of electricity. We should like to know what part the impurities, *i.e.*, other things than perfectly dry air, play in this process. Our schoolmaster taught that little leakage was present with absolutely dry air; and on page 47 the author seems to believe the schoolmaster. Which page shall we credit, 39 or 47? Reading pages 41, 42, 43, &c., we are led to ask are we reading a book of Noah's age, or are things what they seem? And we are still more mystified when we consider the diagram, page 49. The diagram, here reproduced, is very pretty, but unfortunately it is absolutely fallacious. The author attributes the greater density at the head of the pointed ellipse A B C D to the particles repelling one another. By the use of the parallelogram of forces he states that $a\,r_1$ is the resultant of the forces $a\,e$, $a\,f$, and also shows other resultants of the forces he supposes acting as $c\,r_2$, $a\,r_3$. Finally, he says, "The reason for the increase of the respective resultants may easily be seen from the drawing. As the curve increases, the angle between the component forces becomes smaller, and the diagonal, or resultant, larger. The rate at which the density increases may be seen by comparing r_1, r_2, r_3 in the figure. The density at any point is dependent on *surrounding* conditions, and not, as is stated here, the result of repulsion. The conditions on which the density depends can be made such that the density on any given portion of the surface *shall* be greatest. The distance between the opposing conductors, provided the medium between be homogeneous, is the one thing influencing the density. Distribution of electricity over the outside surface—and this is what is meant in this and other books—of a conductor is only a particular case, and not a law; in fact, we might quite as justly talk and write about distribution on the inside surface. Consider for a moment the conducting sphere and movable hemispheres described on page 45. Though the electricity is distributed over the surface of



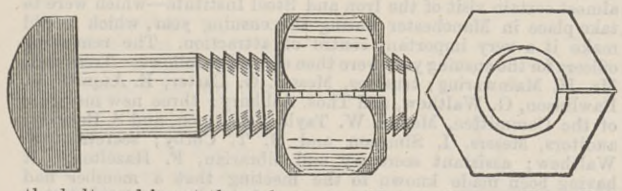
the hemispheres when removed from the sphere, an equal quantity is also distributed over the conducting surfaces of the room. Professor Perry must permit us to apply the initial paragraph of his introduction to this part of the book, changing the past to the present tense. Speaking of works published before 1870, he says: "In general, such information was (is) given as might be found useful by practical jokers. The information on magnetism was (is) of much the same childish order."

In our opinion the whole of Part I. of this book is worse than valueless, because it is full of errors, and therefore misleading. Had we to deal only with the latter part of the work, commencing page 227, we should have much to say in its favour; although we think this part would have been far better had one-half been left out. A large part of it has evidently been written to explain illustrations, and the text has not been illustrated to render it more clear. Who cares about much of the apparatus described, which never has and never will be of practical service? No doubt the pictures will help to sell the book, and therefore must not be despised.

We had intended to point out other weak points, but what is the use? The public will buy these prettily illustrated, neatly printed, showy books, whether they contain sound science or not. And if a critic happens to write against them it is put down to spleen or the result of a heavy lobster supper. Most emphatically do we decline to believe that either Dr. Wormell or Professor Perry, if writing an original work, would accept the views put forward in this translation.

LINET'S SAFETY BOLT AND NUT.

THE annexed sketch shows a new bolt and safety nut, devised by M. D. Linet, of Charleroi, Belgium. The thread is a right-angle triangle in section, having the base parallel with the axis of the bolt. The diameter of the nut is $\frac{1}{10}$th less than that of



the bolt, and is cut through on one side, as shown. The effect of this arrangement is a very tight grip on the bolt, while the flat surface of the thread at right angles to the strain opposes great resistance to unscrewing. Unlike many lock and safety nuts, this nut may be screwed up and unscrewed any number of times without losing its effect.

THE ROYAL AGRICULTURAL SOCIETY.

AT a Council meeting of the Royal Agricultural Society of England, held at the offices, 12, Hanover-square, W., on Wednesday, the recommendations of the Implement Committee as to the offer of prizes for engines at Newcastle, next July, were brought forward by Sir John Thorold, and adopted by the Council as follows:—Class I.: Portable agricultural engine, self-moving or otherwise, on the compound principle, not exceeding 8-horse power, £200. Class II.: Portable agricultural engine, self-moving or otherwise, on the simple principle, not exceeding 8-horse power, £100. The brake trials in Classes I. and II. will be designed to elucidate relative merit under the following heads, viz., construction; efficiency, *i.e.*, proportion of actual work done to work indicated; economy of fuel, of steam, of lubricant; perfection of combustion; price. The committee asked and obtained leave to transfer Classes III. and IV.—elevators for ensilage stacks and apparatus for compressing ensilage stacks—as presented in their report of last month, and offer in their place prizes as under:—Weighing machines for sheep and pigs, £20; weighing machines for horses and cattle, £25. At the same meeting the chairman of the Veterinary Committee reported that Mr. Clay had placed before them his scheme for a horse-shoeing competition, and they recommended that £50 be offered at Newcastle for shoeing-smiths, in three classes Class I.: Agricultural horses, £6, £4, £3, £2, £1. Class II.: Dray horses, £6, £4, £3, £2, £1. Class III.: Hunters and roadsters, £6, £4, £3, £2, £1. The competition to be confined to the district of the show—Northumberland, Westmoreland, Cumberland, and Durham—and no competitor to enter in more than one class.

A RAILWAY AND CANAL DISPUTE.

A WARM controversy of considerable interest in connection with the recent discussions on the revival and development of canal communication has been carried on for some months past between the Great Western Railway Company, the Board of Trade, and the Sharpness New Docks and Birmingham Navigation Company. Early in the present year the last named company submitted to the Board of Trade a memorial making serious allegations against the Great Western Company respecting the Thames and Severn Canal and the Upper Avon Navigation, both of which they declare have been rendered useless by the deliberate *laches* of the railway company. With respect to the Thames and Severn Canal, they explain that it commences by a junction with the Thames at Lechlade, and after a course of thirty miles terminates at Stroud at a junction with the Stroudwater Navigation, which communicates at a distance of seven miles with their Gloucester and Berkeley Ship Canal, and at a distance of eight miles—from Stroud—with the Severn at Framilode. The Thames Canal—they further state—is a large waterway throughout, its locks measuring 75ft. long by 12ft. 6in. wide.

The capital expended in its construction was £245,000, and there is a borrowed capital of £4500. The canal has paid no dividend since 1864, but with the assistance of the borrowed money it has been kept open for the passage of boats of light draft. The canal was constructed under an Act of 1783, supplemented by powers under several subsequent Acts, up to as late as 1879.

The want of funds preventing the canal being rendered more efficient, a Bill was promoted in 1865 to convert part of it into a railway, but the scheme was thrown out. Similar Bills in 1878 and 1882 were also defeated, mainly through the opposition of the memorialists and other canal owners. In the meantime a Mr. Potter, a large shareholder in the canal, and other shareholders, had been negotiating for the sale of a part of the canal to the Midland Railway Company for conversion into a railway, and this failing through the withdrawal of the Bill of 1882, they transferred four-fifths of the canal shares to the Great Western Company. Realising this, the Sharpness Company endeavoured to induce the railway company to repair and increase the efficiency of the canal; but although the Great Western carried on some dredging for a time, they finally stopped that work, and also the pumping, and discharged the engineers and staff. The memorialists are thus worse off than they were before, and they complain first that the purchase of these shares by the Great Western Company is *ultra vires*; and then—"That by this means they have practically acquired the Thames and Severn Canal. Certainly so far as to control its policy, its administration, its tolls, its repairs, and water supply, and its action generally, and they exercise this power, prompted by their interests as proprietors of a competing railway communication, and not with the sole view of doing that which is best for the canal and its traffic and the public desiring to use the same. The remaining shareholders are powerless, and have to stand by and watch the Great Western Railway Company administer the property as their own outside interests may dictate." They also complain of the wrong done to them and their interests as a communicating canal hitherto benefitting to a considerable extent from traffic to and from the canal; that the proceeding is a complete evasion of the liabilities which Parliament has imposed on railway companies who own canals in reference to this canal, while at the same time the company acquire the full benefits of a legal possession of the canal; and they urge that it may become a dangerous precedent. So much as to the Thames and Severn Canal.

The Upper Avon Navigation is described as an ancient navigation for barges extending from Evesham to Stratford-on-Avon, whence there is a canal communication to Birmingham, and also to the Midlands of England, *viâ* the Warwick canals. It is seventeen miles in length, and follows the course of the Avon, assisted by locks and weirs. At its Evesham end it joins the Lower Avon Navigation, which extends thence to Tewkesbury, where it joins the Severn. The Lower Avon Navigation is not under railway control, and is still looked after and maintained, and the locks and works are, generally speaking, in very good condition. In 1860 this waterway passed into the hands of the Oxford, Worcester, and Wolverhampton Company, and subsequently by the incorporation of that company, into the possession of the Great Western Company. The latter company carried on the navigation up to 1875, but then they abandoned the control and management, and since that time, according to the memorial, the navigation has become derelict, the locks are blown, except where the millers have, to retain their head of water, boarded up the upper lock gates. The Board of Trade is, therefore, in this case, also appealed to to deal with the matter, and to introduce legislation which will prevent a recurrence of such practices in future, and compel the Great Western Company to accept the obligations which attach by law to open and legal railway ownership.

The reply of the Great Western Company, to whom the Board of Trade forwarded the memorial, may be best indicated by a few extracts. They declare, in the first place, that (with one exception) they had nothing to do with the various schemes for converting the Thames canal into a railway; and as to the exception, in 1882, they explain that that attempt was neither to the interest of the company nor to that of the district, and it being known that they were opposed to the scheme, offers were made to them, by the proprietors of certain shares, of assistance to frustrate the project.

"Of this offer," they proceed, "the directors availed themselves, with the sole object of preventing the canal being closed as a navigation. Since that time the directors have been desirous of exercising the influence which they have so acquired, not only in maintaining the navigation in the state in which it then existed but of improving it, and they have always expressed their willingness, as far as they were in a position to do so, to assist in any way in which this object could be best effected. The statement that the canal has been allowed to fall into disrepair since 1882 is unfounded, and it is at the present moment in as good or better condition than it has been for a long period of years. It being unnecessary to continue pumping during the winter months when the natural supply of water is considerable, the pumping expenses have been reduced to avoid any unnecessary outlay, so that all available means may be appropriated to the improvement of the canal. The suggestion that pumping is to be permanently discontinued and the pump sold is, so far as the directors of this company are aware, entirely without foundation."

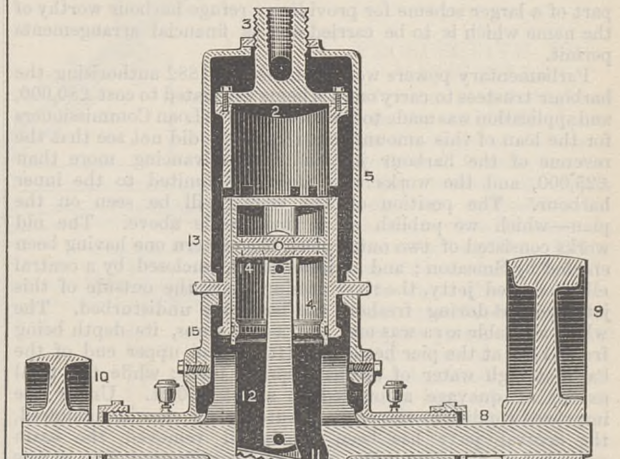
On another point in the indictment they say: "As a matter of fact, the Thames, at and below the point where the canal forms a junction with it, is so shallow that even if the depth of the canal had been sufficient, through traffic could not have passed in full boatloads unless the river had been deepened;" and they add, "that the whole of the revenue of the canal is expended in the maintenance of the works and the carrying on of the traffic upon it."

With respect to the Upper Avon Navigation, the Great Western Company say the facts are these:—"This company acquired in 1863 the West Midland Railway, of which the Oxford, Worcester, and Wolverhampton formed part, but they had nothing whatever to do with the proceedings which took place prior to that date with reference to the navigation of the Upper Avon. It was found on taking over the West Midland Railway and the Stratford-on-Avon Canal, which belonged to that company, that the person who was in charge of the canal looked after the Upper Avon, and as the company were interested in the canal, and a certain amount of traffic passed between the canal and the river, the arrangement was allowed to continue in operation. After a time, however, the locks were found to require substantial repair or renewal; and, looking to their interest in the traffic, the company considered that they would be justified in assisting to repair or replace them, and offered to co-operate with the traders in putting them in order and to pay one-half the cost, but the offer was not accepted. During the time the manager of the canal looked after the navigation, the whole of the tolls, which were supplemented by voluntary contributions from persons interested, were devoted to the repairs, the cost of which, with the exception of one period of three months in 1865, always exceeded the income, the company making up the deficiency." This rejoinder was answered by the Sharpness Company, who contradicted many of the statements, and several other letters passed between the various parties concerned, with the result that the Board of Trade in August intimated that the matter should receive careful consideration when further legislation is proposed on the subject.

To strengthen their case, a deputation of representatives of the Severn Commissioners, the Sharpness New Docks Company, and others, feeling aggrieved in this matter, rececently had an interview with the President of the Board of Trade. They were introduced by Earl Bathurst, and several members of the House of Commons. Some of these gentlemen having explained and enlarged upon the grievance urged against the Great Western Railway Company, the President pointed out that, as the result of an investigation, consequent upon the correspondence, the Board of Trade found that they possessed no such powers as would enable them to directly interfere in this matter. At the same time he expressed the opinion that the Great Western Company seemed to have somewhat strained their statutory powers in the course they had adopted; and incidentally alluding to the plea of the company that, considering the amount of traffic the canal was sufficiently maintained, he observed that the larger and more serious question involved was that of the monopoly of the railways through the buying up of canals and the diversion of the traffic to their railways. Nothing, he believed, was more clear than that Parliament intended that so far from their being monopolies, competition between the various modes of conveyance should as far as possible be encouraged; and certainly Parliament had, on all occasions, shown that where there was a disposition to close the great waterways in favour of railways, it would be willing to take a very strong view of the subject. These questions were very likely to be discussed in the coming session; he and his colleagues would give the gravest consideration to them, and he hoped to be able to introduce into any Bill that might be brought in on the subject provisions that would make the position more clear, and if there was any attempt to evade the law, would render it more easy to deal with such attempt.

A NOVEL ENGINE.

WE illustrate a novel engine designed by Mr. O. H. Castle, and exhibited at the recent Indiana State Fair and at the St. Louis Exposition. The Castle engine, as shown by the sectional view, is a vertical cylinder engine with a trunk piston acting one way. The piston 4 is the valve. The oscillation of the valve or piston to open or close the ports is given by the angularity or divergence of the crank from the axial line of the shaft. This motion, combined with the reciprocating movement produced by the crank proper, constitutes a novel, efficient, and



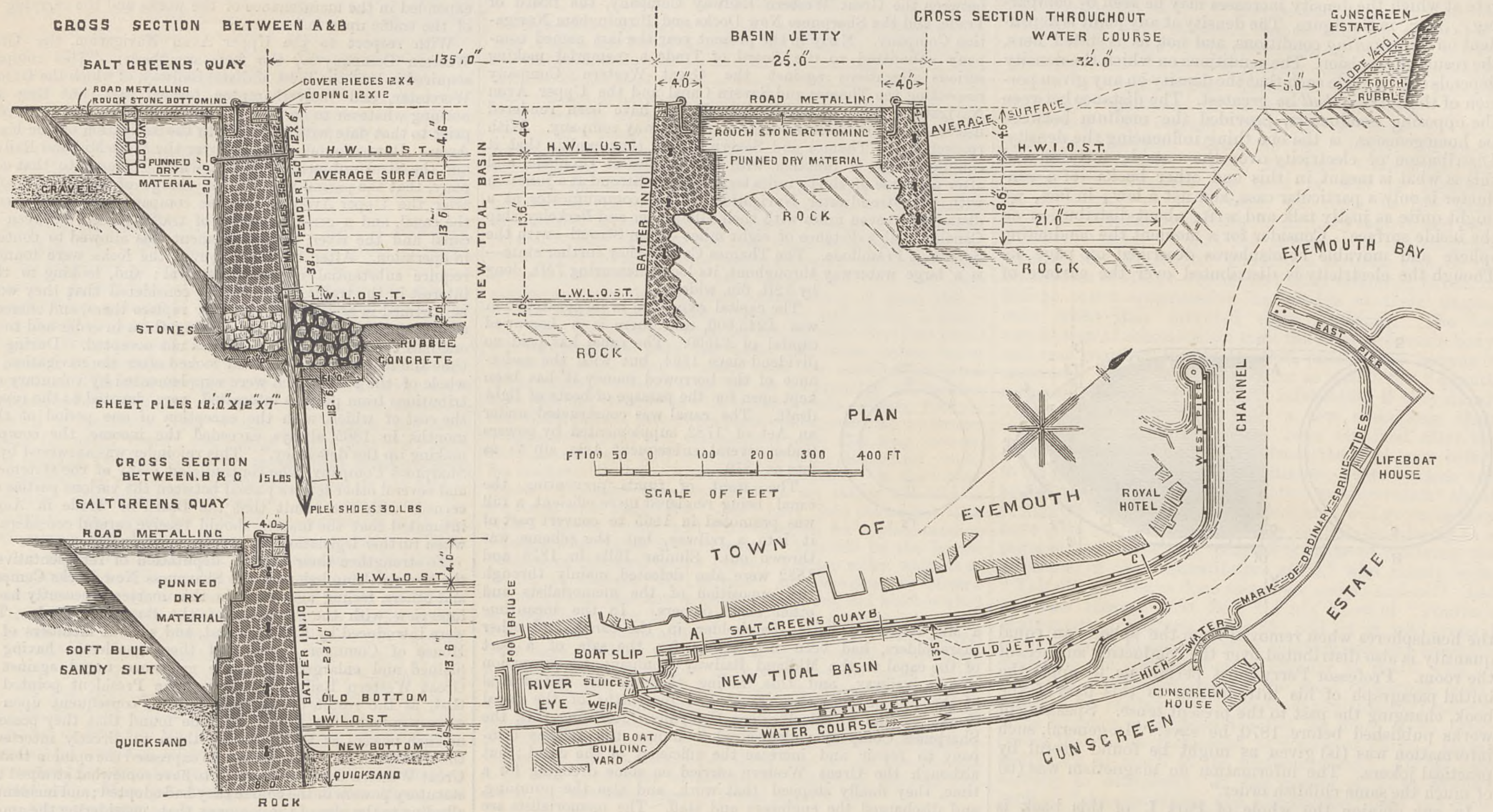
extremely simple mechanism for obtaining the proper distribution of steam and power therefrom. The base casting 1 contains the crank with counterbalances, the connecting-rods and boxes, and the lower part of the cylinder projecting into its upper part. Oil being placed in the case, is splashed upon all the moving parts as well as into the cylinder, where it is distributed as efficiently as desired.

These engines are manufactured by the Model Machine Works, Indianapolis, Ind.

THE Queensland Lands Department recently called for tenders for the erection of $106\frac{3}{4}$ miles of rabbit-proof fencing on the west of Hungerford.

EYEMOUTH HARBOUR.

MESSRS. THOMAS MEIK AND SONS, EDINBURGH, ENGINEERS.



EYEMOUTH HARBOUR.

EYEMOUTH is one of the most important of the numerous fishing towns on the east coast of Scotland. It is situated on the Berwickshire coast, eight miles north of Berwick-on-Tweed, and two miles from the main line of the east coast route to Scotland.

Attention was forcibly directed to this part of the coast in October, 1881, when the fishing fleet was overtaken by a storm which destroyed many of the boats and caused the loss of 130 lives. Most of these men were drowned within sight of their own homes in attempting to get into some one or other of the small harbours along the coast, the boats which escaped being generally those which made the fifty or sixty miles run to the Tyne.

The county of Berwick is represented in Parliament by the Hon. E. Marjoribanks, who has always taken a lively interest in the sea-fishing industry, and particularly in the question of harbour improvement, and it is to his assistance that Eyemouth is chiefly indebted for the works so far completed. Mr. Marjoribanks has always held the sound view that the expenditure of small sums of money upon a number of harbours dry at low water is unwise, and that the correct policy is to devote larger sums to selected places which can be developed so as to be really harbours of refuge. Eyemouth bay has been for many years pointed out by maritime engineering authorities as the best situation for a fishery harbour on this part of the coast, because of its proximity to the fishing ground and the natural advantages of the bay; and although the works now completed only make a small advance in the direction of providing shelter, they form part of a larger scheme for providing a refuge harbour worthy of the name which is to be carried out as financial arrangements permit.

Parliamentary powers were obtained in 1882 authorising the harbour trustees to carry out a scheme estimated to cost £80,000, and application was made to the Public Works Loan Commissioners for the loan of this amount, but that body did not see that the revenue of the harbour justified their advancing more than £25,000, and the works were therefore limited to the inner harbour. The position of the works will be seen on the plan—which we publish on a small scale above. The old works consisted of two outer piers, the eastern one having been erected by Smeaton; and an inner basin, enclosed by a central elbow-shaped jetty, the river passing down the outside of this jetty, so that during freshets the boats lay undisturbed. The whole available area was one and a-half acres, its depth being from 14ft. at the pier heads to 11ft. at the upper end of the basin at high water of ordinary spring tides; while the total extent of quayage amounted to about 1500ft. Under the improved conditions the original outer piers remain unaltered, the central jetty has been nearly all removed, the basin extended up the river valley, and the river diverted into a new course, while the depth has been increased over the whole area to 2ft. below low water ordinary spring tides, or 16ft. at high water of ordinary spring tides. The area is now four and a-quarter acres, and the quayage 3522ft., or between two and three times that formerly provided. Accommodation is now available for about 250 boats, in place of only 100 formerly. The works were executed in the following order. The new watercourse was excavated on the east side of the new basin site, so as to provide a passage for the river clear of it; and on its completion the new river wall, together with the old central jetty, served as a coffer-dam, within which the whole of the extension works were executed while the trade was being conducted undisturbed in the old basin. Next, on the completion of that portion, the trade was diverted into it, and the old basin enclosed by a temporary coffer-dam, the central jetty again acting as part of the dam while the necessary excavations and new quays were executed. The dam was then removed and the demolition of the central jetty undertaken, so as to throw the hitherto divided portions into one basin. The site of the works is in great part formed of rock, which is a kind of greywacke slate; its stratification is much twisted and tilted, and the prevailing angle a very high one. In crossing the site of the new basin it dipped obliquely, and was lost along a great part of the west side, where the overlying material was composed of soft blue sand and silt, which formed a very bad foundation for a considerable part of the works. In the old basin the bottom was composed of wet running sand until the rock was reached. The river diversion was excavated principally in rock, is 21ft. wide at the bottom and 32ft. at the coping, and has a fall of 1 in 230, its depth at the upper end being 11ft. On its east side the natural rock forms the bank, but on the west the rock was faced with concrete. The sections of the basin walls—see engravings above—were varied to suit the nature of the foundation; they are all 20ft. above the bottom of the basin, and are built partly of concrete and partly of timber piling and concrete. The east wall of basin consists simply of a facing of 3ft. thickness of concrete up to the surface of rock, upon which it is stepped back and carried up to the coping. The west wall for the upper half of its length, on a soft foundation, is closed with a row of piling along its front toe, the gauge piles, 8ft. apart, being carried up to the coping.

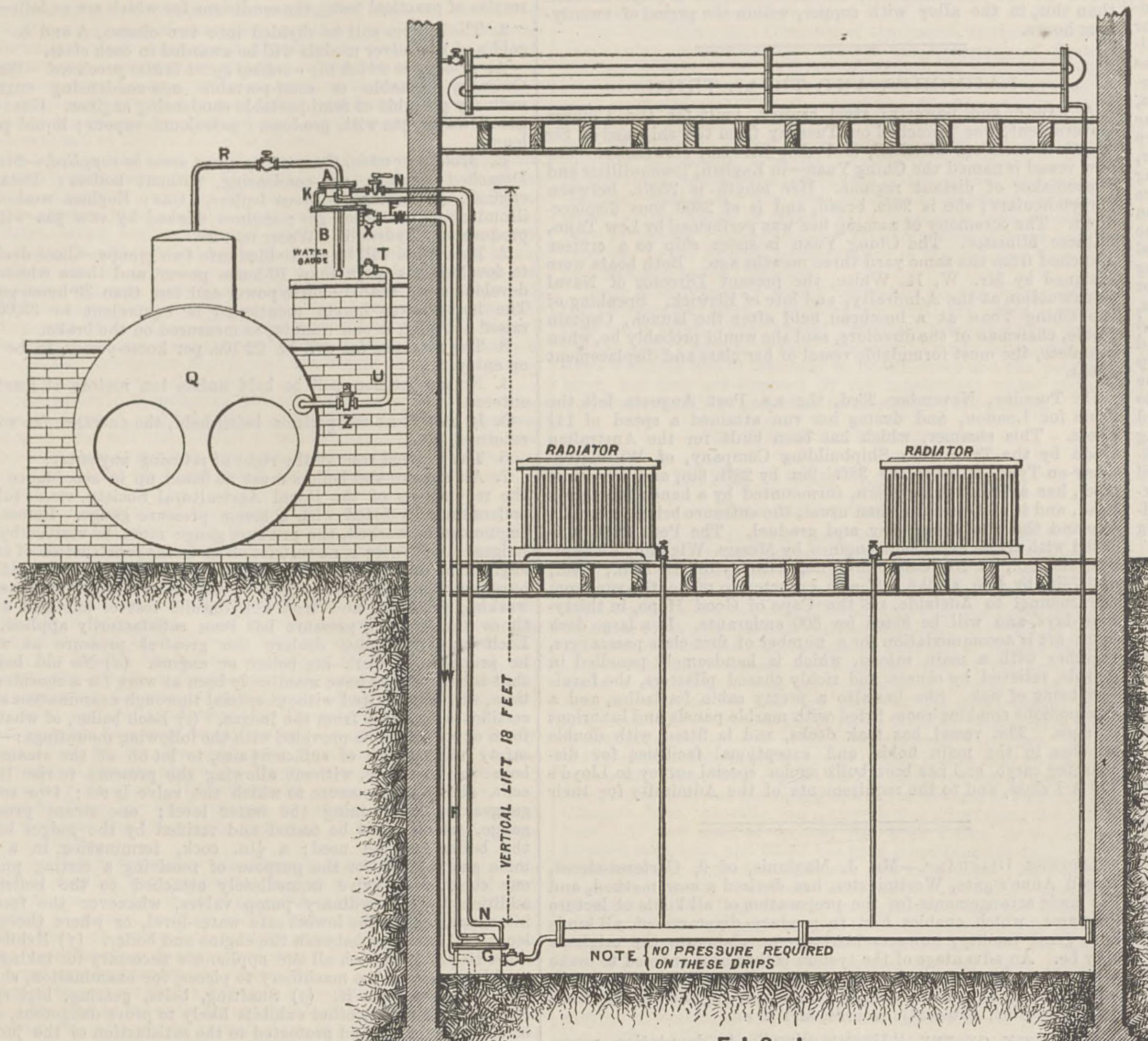
The concrete, founded on a layer of 2ft. 6in. depth of rubble bedded in the bottom, is 6ft. thick at the bottom, and is so built that it was free to sink independent of the piling, and did sink to the extent of about six inches, the surface being finished when settlement had ceased. A concrete toe was sunk in front of the piling to impart additional stability and resist sliding action on the soft bottom. The new quay in the old basin was carried down through the quicksand to the rock and founded at an average depth of about six feet below the old bottom; this operation was attended with considerable risk owing to the proximity of some heavy buildings, but was effected without accident. It is eight feet thick at the foundation, and is composed entirely of concrete with a pitch-pine coping. All the works have been executed in Portland cement concrete in the proportion of seven to one, the materials being obtained from the excavations and the cement from Messrs. Grimshaw and Sons, of Sunderland. It was all mixed by hand; large lumps of rough rock were incorporated with it, and a lot of old rails were likewise inserted. The finished concrete work is satisfactory in appearance, and is thoroughly sound. The excavations were run to spoil on the shore, the material having been got by hand and hauled out by a locomotive up two inclines. In excavating the rock both gunpowder and Nobel's blasting gelatine were extensively employed. The timber is all of uncreosoted pitch pine. Mooring rings and ladders were fixed at intervals of 50ft., and the quays were finished with twelve inches of broken stones. The total cost of the works has amounted to £22,200, and over two years have been occupied in their construction. The engineers for the works were Messrs. Thomas Meik and Sons, of Edinburgh; Mr. William Kidd, resident engineer; and Mr. George Lawson, contractor.

MANCHESTER ASSOCIATION OF ENGINEERS.

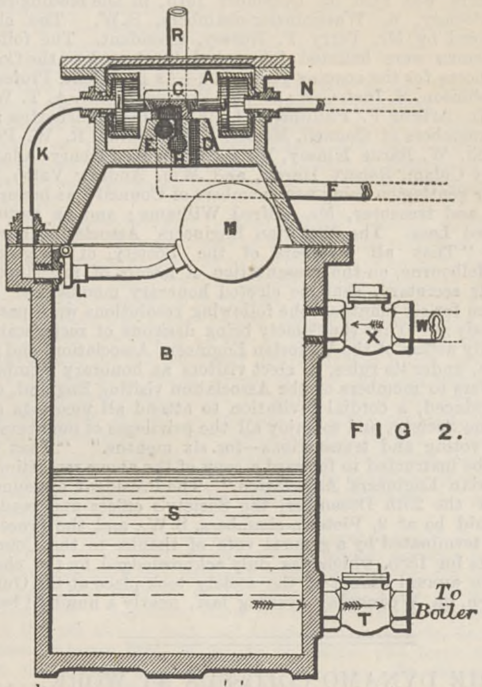
THE thirty-first annual general meeting of the members of the above Association was held on Saturday at the Grand Hotel, Manchester, Alderman W. H. Bailey, the president, occupying the chair. Before the ordinary business of the meeting was proceeded with, reference was made to the recent sudden death of one of the members of the Association, Mr. S. Brooks, of the Union Ironworks, West Gorton, and on the motion of Mr. Thomas Ashbury, seconded by Mr. John Horsley, it was resolved to send a letter of condolence to the family of the deceased gentleman. The chairman also introduced another matter, and remarked that he was one of those who attended a meeting held the previous week—and which was reported in these columns—to ascertain whether it would be advisable that the Iron and Steel Institute should visit Manchester during the ensuing year; from what took place at that meeting he might say that he had no doubt the Iron and Steel Institute would hold its autumn meeting in Manchester next year. The ordinary business of the meeting was then proceeded with, the first important item being the election of new members, and fourteen candidates for admission to the society were admitted to membership. The election of President for the ensuing year was next proceeded with, and on the motion of Mr. Thos. Ashbury, seconded by Mr. Horsley, and supported by Messrs. Alderman Burckley—Oldham—R. Rawlinson, and Councillor Asquith, Mr. Alderman W. H. Bailey was for the third year in succession unanimously elected to the presidential chair. Mr. Bailey, in returning thanks, said he believed it was unique in the history of the Association to have elected a President for the third time. Above all the honours and distinctions one got in public life, he looked upon the distinction they had just conferred upon him as a very great compliment, and he valued it in the highest possible manner. Alluding to the progress of the Association during the past year, he said they had now on their books 310 members, being an increase of fourteen annual honorary and sixteen ordinary members; and after paying all the calls upon the society, they had a balance in hand of £2600—a balance which he did not believe was possessed by any society of a similar character in the kingdom. During the year many valuable papers had been read before the members, and the Association was doing very valuable work in promoting the best interests of the important branch of industry with which it was directly associated, not only in contributing to the technical education of engineers in the district, but in fostering a friendly fellowship amongst its members. Passing on to general matters, the President remarked that it was with very great satisfaction he could say that there was now, he was certain, a slight improvement noticeable in trade. He believed we were at the beginning of an increase of trade right through the country, and especially in the engineering branches of industry. He, as a manufacturer of a number of the smaller appliances required in the engineering trade, could of course very soon feel any movement towards increased activity that might be going on, and he could say that he was getting busier, which was an indication that there was more work stirring amongst engineers. There was a marked increase in the number of boats that were being built, and in the number of large engines that were being ordered. In marine engineering especially there was a very definite improvement, and he hoped that at the commencement of the year every member of the Association might find himself fully employed at remunerative prices. In conclusion, Mr. Bailey referred to the various important events—the Jubilee Industrial Exhibition, the visit of the British Association, and the almost certain visit of the Iron and Steel Institute—which were to take place in Manchester during the ensuing year, which would make it a very important centre of attraction. The remaining officers for the ensuing year were then elected as follows:—Treasurer, Mr. H. Mainwaring; trustees, Messrs. G. Carter, E. Asquith, R. Rawlinson, G. Walthew, and Thos. Ashbury; three new members of the Committee, Messrs. W. Taylor, S. Dixon, and S. Boswell; auditors, Messrs. I. Simpson and M. T. Corby; secretary, F. Walthew; assistant secretary and librarian, F. Hazelton. It having been made known to the meeting that a member had been disabled, a grant of £100 was awarded. It was decided that the annual dinner should be held on the second Saturday in February next, and the arrangements were left in the hands of the Council.

BEXHILL-ON-SEA SEWERAGE.—The sewerage works of Bexhill have been completed at a cost of £5581, from the plans and under the superintendence of Mr. H. Bertram Nichols, Assoc. M. Inst. C.E., of Grosvenor-chambers, Birmingham—whose scheme was unanimously selected as being the best sent in in the recent competition. The work has been carried out by Mr. James Hayward, contractor, of Eastbourne, whose tender was accepted in February last, amounting to £5477. The work has been completed within the engineer's estimate, which amounted to £5600. The scheme embraces Bexhill and the village of Sidley, and has been carried out under the separate system, the bulk of the rainfall being excluded from the sewers. The sizes of the sewers vary from 9in. to 18in. in diameter for the stoneware pipes, in addition to which there is about a mile of egg-shaped sewer 2ft. 6in. by 1ft. 8in., making a total length of nearly six miles. A considerable length of the sewers are of Hassall's patent, this joint being used for the steep gradients, and where it has been found necessary to ensure a safe and water-tight joint. The sewers are constructed in straight lines, with even gradients, having manholes at every change of direction, and manholes, ventilators, and lampholes at every change of vertical deviation. Open ventilation is adopted generally at the road surface, but at the high portions of the district—which is of a hilly character—cast iron shafts are carried up above the houses, surmounted with Gibbs' weather-proof extractors. The manholes are provided with flap valves and sliding disc flushing valves where requisite. Automatic flushing tanks are placed at the dead ends of the sewers, capable of discharging at each flush about 600 gals. An important feature in the scheme is a large flushing tank on the main sewer, in connection with a stream, having a capacity of about 1600 gals., fitted with sluice, penstock, overflow, &c., having a 9in. outlet. The main outfall sewer is ovate in section, 2ft. 6in. by 1ft. 8in., and junctions on to the main sewer along the Esplanade, constructed by Lord De la Warr for the Bexhill estate, passing into outfall tanks, and from thence out to sea in cast iron pipes. The duties of clerk of the works have been in the hands of Mr. J. Downsborough, of Bexhill.

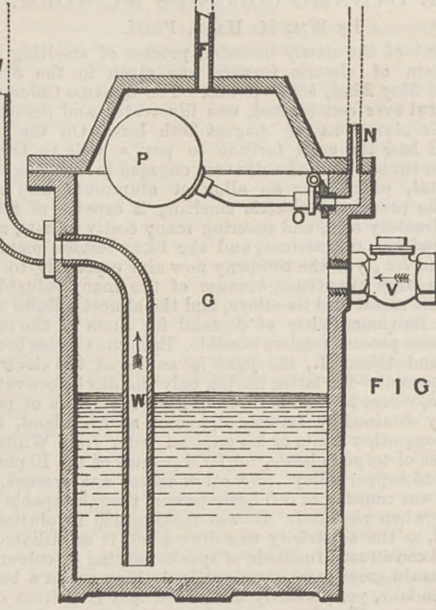
STEAM HEATING APPARATUS, LANCASHIRE AND YORKSHIRE RAILWAY, MANCHESTER.



F I G 1.



F I G 2.

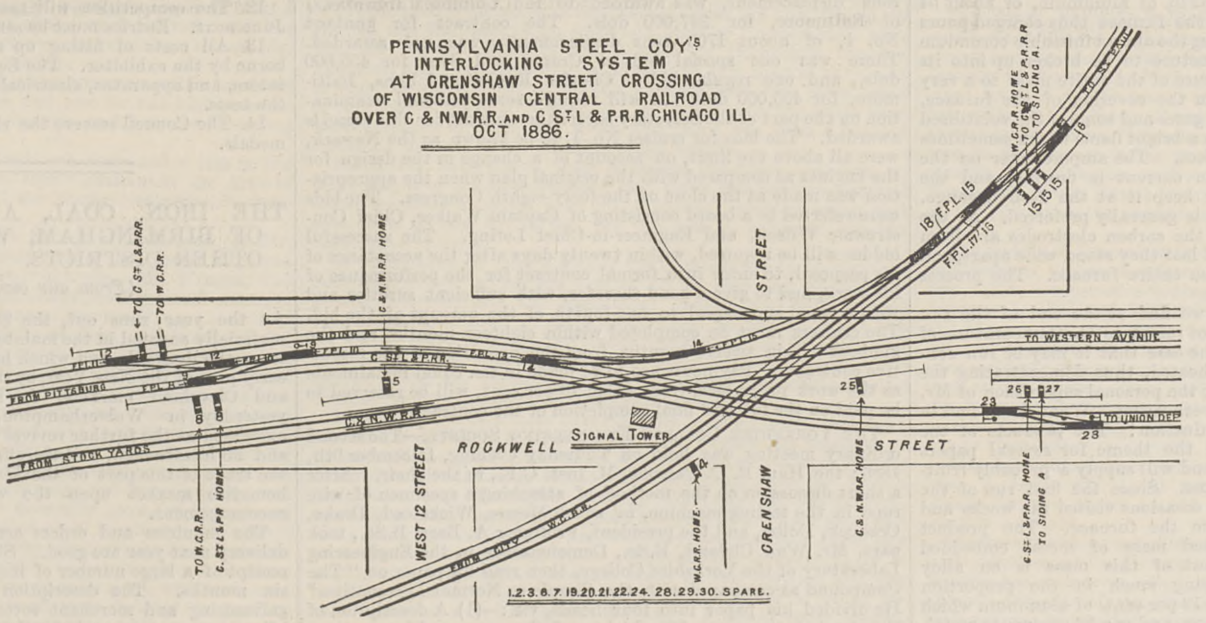


F I G 3.

ROYLE'S RETURN STEAM TRAP.

Our illustration represents an arrangement by which boilers can be supplied with the condensed water coming from steam apparatus generally, with the object of economy both of fuel and water. Return steam traps for this purpose are not new, and there are many forms that are successfully at work; but the inventor of Royle's return trap, which is shown in the illustration, has sought to overcome some of the practical difficulties which not unfrequently surround their effective operation. These difficulties are mainly, in the first place, a positive and reliable motion for operating the valves; and, secondly, a means of elevating the water when lying below the boiler level preparatory to feeding it into the boiler by gravitation.

The engravings represent the apparatus as fixed in the new offices of the Lancashire and Yorkshire Railway Company at Victoria Station, Manchester, where a return trap is taking the condensed water from a series of heating coils below the boiler level, and elevating and feeding it back to the boiler against 100 lb. pressure. The following is a brief description of the apparatus:—A, Figs. 2 and 3, is a steam chest on the top of the receiver B, having a three-port slide valve C, of which the port D communicates with the receiver B; the port E communicates through the pipe F with the drip box G, and the port H with the atmosphere. The slide valve C is actuated by pistons J and J working in open-ended cylinders affixed at each end of the steam chest A, as illustrated. The closed ends of the cylinder communicate, the one through the pipe K with the inside of the receiver B, through the valve L, actuated by the float M, and the other through the pipe N with the drip box G through the valve O, actuated by the float P. The fixing of the apparatus will be readily understood from Fig. 1, where the receiver B is shown fixed above, and arranged to feed back to the boiler the condensed water coming from a system of heating pipes and coils all draining into the drip box G, situated considerably below the boiler Q. Steam at the full boiler pressure is supplied through the pipe K to the steam chest A, and, entering through the open port D, presses down the water S, shown in the receiver B, and establishes an equilibrium between the boiler and the receiver, allowing the water to gravitate through the check valve T and pipe U to the boiler. Meanwhile the condensed water from the heating pipes, &c., has been entering the drip box G through the check valve V—as shown by the arrow—and as soon as the water in the drip box reaches the ball P, and lifts the valve O, the equilibrium of the pistons J and J is destroyed, and the slide valve C caused to travel to the right, so reversing the position of the ports, admitting steam at boiler pressure through the pipe F into the drip box G, and allowing the steam contained in the receiver B to exhaust. The condensed water in the drip box is by this means forced up the pipe W and through the check valve X into the receiver B until, as soon as it in turn reaches the float M, the slide valve C is self-actingly moved to the left into its former position, so admitting full steam pressure on to the water S, and feeding it to the boiler as before described. Meanwhile the condensed water accumulates in the drip box G, and as soon as it again lifts the ball P the same action is repeated, and so on continuously. Mr. Royle, of Manchester, is the maker.



INTERLOCKING SYSTEM ON THE WISCONSIN CENTRAL RAILWAY.

We illustrate the interlocking system recently erected at the crossing of the Wisconsin Central Railway, Chicago, and North-Western Railway, and Chicago, St. Louis, and Pittsburgh Railways. There are three double tracks, with crossings all meeting at one point of intersection. There are about 200 trains passing daily, which are all compelled to come to a stop, as required by the State law, and in this case distant signals are not used. Several other States now have laws which allow trains to proceed without stopping at level crossings where interlocking appliances are used, and it is hoped that Illinois railways will soon have the same privilege when going to the expense of erecting these elaborate safety systems.

The whole of the work has been carried out by latest improvements of the Pennsylvania's Steel Company's system, which is considered a very fine one, having given every satisfaction at busy junctions for the last five years. There may be some points of note in regard to the numbering and working, viz., one lever working two signals and a facing point lock. The working of the signal arms is changed by mechanical means, giving the required signal, perfect interlocking, and freedom to any train, movements which can be performed at the same time. Each signal arm 8, 11, and 15, is worked separately by the same lever. The interlocking for this machine was arranged by Mr. W. H. Green, formerly of the signal department, London and North-Western Railway Company.

PROSPECTIVE PRIVATE BILLS.

Judging at a first glance from the multitude of published notices of Bills and Provisional Orders for the coming session, it might easily be supposed that members were to have an unusually busy time in the committee rooms, especially with the railway schemes. This impression would, however, be promptly dispelled by the list of notices and plans deposited up to Wednesday last, when the limit of time for that purpose expired. As there was last year, so there is again a falling off in the number of projects for which the sanction of Parliament is to be asked—and on this occasion the decrease is yet larger. The total of railway, tramway, and miscellaneous Bills and Provisional Orders is only 132, or 34 fewer than there were for last session, and 56 fewer than for the session of 1885. Of these 132, 48 are railway Bills, as against 53 last year; 11 are tramway Bills, as against 13; 33 are miscellaneous Bills, as against 49; and 40 are Provisional Orders, as against 61. The greatest decline is, therefore, in respect to railways, and after that to Provisional Orders; but many of the railway schemes are extensive proposals, and the majority of Provisional Orders relate to tramways. Among the miscellaneous Bills are many referring to gas undertakings, but there is no electric lighting Bill. There is reason, however, to believe that a new Bill to amend the Electric Lighting Act of 1882 will be introduced, and meanwhile there is one electric tramway project. In striking contrast to the case two or three sessions ago, only three subway Bills appear so far—viz., Glasgow Subway, Thames Tunnel at Blackwall, and the City and Southwark Subway. We must defer a detailed examination of the measures to be brought forward.

THE SOCIETY OF ENGINEERS.

THE thirty-second annual general meeting of the Society of Engineers was held on December 13th, in the reading-room of the Society, 6, Westminster-chambers, S.W. The chair was occupied by Mr. Perry F. Nursey, president. The following gentlemen were balloted for and duly elected as the Council and officers for the ensuing year, viz.:—As President, Professor Henry Robinson, M. Inst. C.E.; as Vice-Presidents, Mr. A. T. Walmisley, Mr. Arthur F. Phillips, and Mr. M. Ogle Tarbotton; as ordinary members of Council, Messrs. J. R. Baillie, R. W. Peregrine Birch, W. Barns Kinsey, W. Schönheyder, Henry Adams, W. Newby Colam, Robert Harris, and Wm. Andrew Valon, the four latter gentlemen being new members of Council; as honorary secretary and treasurer, Mr. Alfred Williams; and as auditor, Mr. Alfred Lass. The Victorian Engineers' Association having resolved—"That all members of the Society of Engineers visiting Melbourne, on the presentation of letters of introduction from their secretary, shall be elected honorary members of the Association for six months," the following resolutions were passed unanimously:—"That the Society being desirous of reciprocating the friendly action of the Victorian Engineers' Association, and not being able, under its rules, to elect visitors as honorary members, hereby offers to members of the Association visiting England, and duly introduced, a cordial invitation to attend all meetings and visits of the Society, and to enjoy all the privileges of membership—except voting and transactions—for six months." "That the secretary be instructed to forward a copy of the above resolution to the Victorian Engineers' Association." The President announced that after the 25th December, the Society's offices and reading rooms would be at 9, Victoria-chambers, S.W., and the proceedings were terminated by a general vote of thanks to the Council and officers for 1886, which was duly acknowledged by the chairman. The annual dinner of the society took place at the Guildhall Tavern, on Wednesday evening last, nearly a hundred being present.

THE DYNAMO COLOSSUS AT WORK.

By WM. H. HALE, Ph.D.

AN account of the newly invented process of smelting by the Cowles system of electric furnace was given in the *Scientific American* of May 22nd, 1886—p. 328. The dynamo Colossus, the most powerful ever constructed, was illustrated and described in the *Scientific American* of August 28th last. On the 16th of September I had the good fortune to pay a visit to Lockport, N.Y., just in time to find the dynamo engaged in smelting its first run of metal, which was an alloy of aluminum and copper. Although the process of electric smelting is capable of reducing the most refractory ores, and securing many costly metals, such as potassium, sodium, magnesium, and the like, besides metalloids, boron, silicon, &c., yet the company now aim especially to secure aluminum in large quantities, because of the many valuable properties of that metal and its alloys, and the almost infinite variety of uses and inexhaustibility of demand for them at the reduced price which this process renders possible. Both the Cowles brothers, Eugene H. and Alfred H., the joint inventors of the electric furnace, were present—the latter having only the day before returned from Europe, where he had been exhibiting specimens of product as previously obtained by smaller dynamos at Cleveland, having secured, among other fruits of his trip, an order from Whitehead, manufacturer of torpedo boats, for 6000 pounds of the 10 per cent. aluminum and copper alloy. No other visitor was present. The big dynamo was running at 380 horse-power, though capable of 500 horse-power when required. It was making 420 revolutions per minute, and, as the electricity was drawn off, it scintillated in a brilliant and continuous fusillade of sparks varying in colour from white to emerald green, and occasionally flashing out in a burst of unusual splendour, yet perfectly controlled and free from danger to the spectators. The dynamo is driven by water power. The waterways were constructed by Holley, and are replete with ingenious appliances for utilising all the power there is, and for keeping the water at a uniform level. The water wheels used are double turbine with horizontal shaft, each turbine being 8ft. in diameter. The dynamos—for there is also a smaller one—occupy a room by themselves intermediate between the turbine wheel room and the furnace room.

Passing to the furnace room, we see where the energy of the dynamo is being expended. The furnaces are built larger for the Colossus than those used with smaller dynamos, and are charged with 60 lb. granulated copper, 60 lb. corundum, and 30 lb. coarse charcoal, besides the pulverised lime-coated charcoal used as packing. This mixture contains over 32 lb. of aluminum, or about 54 per cent. of the corundum. Into the furnace thus charged pours the current from the Colossus, fusing the almost infusible corundum like wax, causing its molecular structure to be broken up into its elements, and raising the temperature of the entire mass to a very high heat. Vent holes are left in the covering of the furnace, through which escape the liberated gases and some of the volatilised aluminum, the whole glowing with a bright flame which sometimes darts up to the height of many feet. The amperemeter on the wall shows with what force the current is flowing, and the attendant must watch it closely to keep it at the desired gauge. A force of 2000 to 2400 ampères is generally preferred. As the index approaches the higher limit the carbon electrodes are from time to time drawn asunder, till at last they stand wide apart, and the current flows freely through the entire furnace. The process of reduction takes about two hours.

Returning to the dynamo room, we find at the end of the run that the bearings of Colossus are not raised to the temperature of blood heat; and it proves to be the case that it may be run continuously without becoming overheated, thus demonstrating the excellence of its construction under the personal supervision of Mr. Brush. The bane of dynamos is overheating. What do we find in the furnace at the end of the reduction? The products of the electrical furnace have furnished the theme for several papers already before scientific societies, and will supply a probably fruitful field of research for time to come. Since the first run of the dynamo, I have on several other occasions visited the works and seen the charges withdrawn from the furnace. The product appears in the form of a fused mass of metal embedded in the surrounding carbon. Most of this mass is an alloy of copper and aluminum, varying much in the proportion of the two. Mostly it exceeds the 10 per cent. of aluminum which gives the alloy of maximum strength, and is a brittle white metal, which is again fused with the addition of more copper to such an alloy as may be required. But the furnace gives many other products. Sometimes there are found small fused rubies and sapphires. The sub-oxide of aluminum—never found in nature, and never before known to exist or to be capable of formation—is always present in larger or smaller quantities. I have also seen specimens of beautiful white fibrous alumina. With other charges, sub-oxides of silicon and titanium are found—very curious products indeed. The intense heat even partially fuses the carbon, and the electrodes are converted into graphite. The rush of visitors has been so great that the company have been compelled to restrict facilities for admission latterly. Important economical as well as scientific results have been already attained by the dynamo. The price of aluminum alloys has been reduced to a scale adopted by reckoning the value of the contained aluminum at 2 50 dols. a pound, previous sales of that metal having been at the rate of 75 cents per ounce. The 10 per cent. alloy is said to be the strongest metal known, though alloys of a less per cent. have great utility, being tougher, but not so strong. Krupp cannon require a tensile strength of 70,000 lb. per square inch of wrought steel, the labour on which raises its cost to 75 cents or a dollar a pound. Some specimens of the alloys made by the Colossus, which are simply cast, not wrought, have recently shown the phenomenal strength of 131,000 lb. per square inch.

Since writing the above, I notice the statistics of production of different metals in the United States for 1885, as given in the *Scientific American* for November 6th, 1886. In that table the whole amount of aluminum produced during the year is stated as 3400 oz., aluminum being then regarded as a precious metal. The capacity of the Colossus will enable it to reduce a larger amount than this, in the alloy with copper, within the period of twenty-four hours.

LAUNCHES AND TRIAL TRIPS.

A LARGE and powerful steel cruiser, built for the Chinese Government, was launched on Tuesday from the shipyard of Sir W. G. Armstrong, Mitchell, and Co., Elswick, Newcastle. The new vessel is named the Ching Yuan—in English, Tranquilliser and Peacemaker of distant regions. Her length is 250ft. between perpendiculars; she is 28ft. broad, and is of 2300 tons displacement. The ceremony of naming her was performed by Lew Tajin, Chinese Minister. The Ching Yuan is sister ship to a cruiser launched from the same yard three months ago. Both boats were designed by Mr. W. H. White, the present Director of Naval Construction at the Admiralty, and late of Elswick. Speaking of the Ching Yuan at a luncheon held after the launch, Captain Noble, chairman of the directors, said she would probably be, when complete, the most formidable vessel of her class and displacement afloat.

ON Tuesday, November 23rd, the s.s. Port Augusta left the Tyne for London, and during her run attained a speed of 14¼ knots. This steamer, which has been built for the Australian trade by the Tyne Iron Shipbuilding Company, of Willington-Quay-on-Tyne, is 360ft. by 38ft. 9in. by 28ft. 6in, and is built of steel, has a long raking stern, surmounted by a handsome figure-head, and is of finer form than usual, the entrance being unusually fine and the run being easy and gradual. The Port Augusta is fitted with triple expansion engines by Messrs. Wigham, Richardson, and Co., of Newcastle-on-Tyne, with cylinders 29in., 44in., and 74in. by 48in. stroke. She is expected to make the run from the Channel to Adelaide, *viâ* the Cape of Good Hope, in thirty-nine days, and will be fitted for 800 emigrants. In a large deck house aft is accommodation for a number of first-class passengers, together with a main saloon, which is handsomely panelled in marble, relieved by ornate and richly chased pilasters, the furniture being of oak. She has also a pretty cabin for ladies, and a commodious smoking-room fitted with marble panels and luxurious lounges. The vessel has teak decks, and is fitted with double winches to the main holds, and exceptional facilities for discharging cargo, and has been built under special survey to Lloyd's 100 A 1 class, and to the requirements of the Admiralty for their list.

LECTURE DIAGRAMS.—Mr. J. Maginnis, of 9, Carteret-street, Queen Anne's-gate, Westminster, has devised a new method, and has made arrangements for the preparation of all kinds of lecture diagrams, which enables him to produce diagrams of all kinds with great facility, however intricate or elaborate the originals may be. An advantage of the system is that he is enabled to make perspective views of machines as easily as other views, and that minute accuracy is easily obtained in maps, graphic curves, indicator diagrams, automatic records, and so on.

A SAMPLE OF THE "UNEMPLOYED."—A deputation representing the unemployed recently asked the Queensland Premier to afford relief. Sir S. Griffith said he would see what could be done, and asked the men desiring work to leave their names and addresses at the Immigration Office. The Immigration Agent had an application from employers who want 100 men for railway and other works, at which the men can earn up to 7s. per day, but only fifteen men accepted the terms. The *Colonies and India* says, numbers of agricultural labourers are required at various places, but the men decline £40 a year with rations.

CONTRACTS FOR THE UNITED STATES NEW CRUISERS.—The Secretary of the Navy on Monday, November 29th, awarded the contract for building cruiser No. 3, to be known as the Baltimore, to the firm of Cramp and Sons, Philadelphia, for 1,325,000 dols. This is the protected double-bottomed cruiser of about 4400 tons displacement, with engines of not less than 8000 horse-power. The contract for cruiser No. 2, of about 3700 tons displacement, and not less than 6000 horse-power, was awarded to the Union Ironworks, of San Francisco, for 1,017,500 dols. This vessel is to be known as the Charleston, and is a copy of the Naniwa, now in the Japanese Navy. Contract for gunboat No. 2, of about 870 tons displacement, was awarded to the Columbia Ironworks, of Baltimore, for 247,000 dols. The contract for gunboat No. 1, of about 1700 tons displacement, was not awarded. There was one special bid of Cramp and Sons for 455,000 dols., and one regular bid of Charles Reeder and Sons, Baltimore, for 495,000 dols. It will require some personal examination on the part of the Secretary before the contract for this vessel is awarded. The bids for cruiser No. 1, to be known as the Newark, were all above the limit, on account of a change in the design for the engines as compared with the original plan when the appropriation was made at the close of the forty-eighth Congress. The bids were referred to a board consisting of Captain Walker, Chief Constructor Wilson, and Engineer-in-Chief Loring. The successful bidder will be required, within twenty days after the acceptance of his proposal, to enter into formal contract for the performance of his work, and to give a bond therefor, with sufficient sureties and with a penal sum equal to one-fourth of the amount of the bid. The cruisers must be completed within eighteen months, and the gunboat within twelve months, from the execution of the respective contracts. Payments are to be made in ten equal instalments as the work progresses, from which 10 per cent. will be reserved to be paid on the full and final completion of the contract.

THE YORKSHIRE COLLEGE ENGINEERING SOCIETY.—The second ordinary meeting was held on Thursday evening, December 9th, 1886; the Hon. R. C. Parsons, M. Inst. C.E., in the chair. After a short discussion on the method of attaching a specimen of wire rope in the testing machine, in which Messrs. Wicksteed, Drake, Cradock, Dolby, and the president, Professor A. Barr, B.Sc., took part, Mr. Wm. Cleland, B.Sc., Demonstrator in the Engineering Laboratory of the Yorkshire College, then read his paper on "The Compound as compared with the Simple or Normal Locomotive." He divided his paper into four heads, viz.:—(1) A description of the simple locomotive; (2) a history of the compound locomotive; (3) to examine why the compound is economical; (4) to compare the results of the simple and compound locomotive. After describing the simple locomotive, he proceeded to give a short history of the compound, referring to Nicholson's continuous expansive system, as described by Mr. Samuells, in a paper read before the Institute of Mechanical Engineers in 1852, claiming him as the real inventor of the compound engine. He proceeded to trace the growth of the compound, describing Mallet's system, and its improvement by Borries in Germany. Coming nearer to our own times, he took up the system of F. Webb, followed by a description of that of Mr. Worsdell, of the Great Eastern Railway; and lastly, of the type constructed this spring by the North British Railway Company (Nesbitt's patent). As to the compound engine being economical, he came to the conclusion that it was, but only very slightly so at the present time. He thought, however, that more authoritative tests were required upon this point. As to the efficiency of the compound engine, he thought that at present it was more suitable for heavy goods traffic, and that for express service the simple engine was at present the most economical and gave the best results. He had no doubt, however, that in the future the compound locomotive would supersede the simple one. The discussion, in which the president, the chairman, and Messrs. Wicksteed, Mannier, Silcock, Dolby, and Tempest took part, was adjourned till the next meeting, January 17th, 1887.

MOTORS FOR ELECTRIC LIGHTING.

THE Council of the Society of Arts are prepared to award two gold medals and four silver medals for prime movers suitable for electric light installations. The medals will be awarded on the results of practical tests, the conditions for which are as follows:—

1. The motors will bs divided into two classes, A and B. One gold and two silver medals will be awarded in each class.

A. *Motors in which the working agent is also produced.*—Steam: Ordinary portable or semi-portable non-condensing engines; ordinary portable or semi-portable condensing engines. Gas: Coal gas or water gas with producer; petroleum vapour; liquid petroleum.

B. *Motors to which the working agent must be supplied.*—Steam: Detached engines, non-condensing, without boilers: Detached engines, condensing, without boilers. Gas: Engines worked by illuminating or other gas; engines worked by raw gas without producers. Hydraulic: Water motors.

2. Each class will be subdivided into two groups—those declared to develope not more than 10-horse power, and those which will develope more than 10-horse power and less than 20-horse power. The horse-power herein mentioned is equivalent to 33,000 lb. raised 1ft. high in one minute, as measured on the brake.

3. The entrance fee will be £2 10s. per horse-power, to be paid on entry.

4. No competition will be held unless ten motors at least are entered.

5. In case of no competition being held, the entrance fee will be returned.

6. The Council reserve the right of refusing any entry.

7. All engines and boilers must be fitted up in accordance with the regulations of the Royal Agricultural Society, viz.:—(*a*) All boilers must be fitted with a steam pressure gauge. Before any engine can be worked, the pressure gauge must be verified by the judges. (*b*) There is no restriction as to the construction of steam engines or boilers, but the judges must be satisfied that the bursting strength of the engine or boiler is at least four times its working pressure, and that a hydraulic test of one and a-half times the working pressure has been satisfactorily applied. (*c*) Each exhibitor must declare the greatest pressure at which he proposes to work his boiler or engine. (*d*) No old boilers, that is boilers that have manifestly been at work for a considerable time, will be admitted without special thorough examination and a certificate of safety from the judges. (*e*) Each boiler, of whatever form or size, must be provided with the following mountings:—Two safety valves, each of sufficient size, to let off all the steam the boiler can generate, without allowing the pressure to rise 10 per cent. above the pressure to which the valve is set; two sets of gauges for ascertaining the water level; one steam pressure gauge, which must be tested and verified by the judges before the boiler can be used; a ½in. cock, terminating in a ½in. male gas thread, for the purpose of receiving a testing pump; one check feed valve immediately attached to the boiler, in addition to the ordinary pump valves, whenever the feed is introduced below the lowest safe water-level, or where there is a length of feed pipe between the engine and boiler. (*f*) Exhibitors must be provided with all the appliances necessary for taking the working parts of the machinery to pieces, for examination, should the judges require it. (*g*) Shafting, belts, gearing, high-speed machinery, and any other exhibits likely to prove dangerous, shall be securely fenced and protected to the satisfaction of the judges, but such approval shall not relieve the exhibitor from his own liability.

8. The points of merit considered of the greatest importance are:—(*a*) Regularity of speed as to revolutions per minute under varying loads. (*b*) Regularity of speed during the various parts of one revolution. (*c*) Power of automatically varying speed to suit arc lights. (*d*) Noiselessness. (*e*) First cost. (*f*) Cost of running. (*g*) Cost of maintenance.

9. The tests will be carried out under the direction of three judges appointed by the Council of the Society of Arts, who will report to the Council, and will confer with them on the awards.

10. The Council will publish the awards in the *Journal* of the Society of Arts. They reserve the right of publishing descriptions of any of the motors, and the competitors must afford every facility for this purpose.

11. The competitors must take upon themselves, in exoneration of the Society, all claims in respect of damage—if any—resulting from the testings, and must renounce all claims for compensation for any injuries, real or imaginary, that they may incur from alleged or actual imperfection in the testings, or from any statement in the report or description published.

12. The competition will take place in London about May or June next. Entries must be sent in by February 28th, 1887.

13. All costs of fitting up and working the motors must be borne by the exhibitor. The Society will provide the brakes, indicators, and apparatus, electrical and other, necessary for making the tests.

14. The Council reserve the right of withholding any or all the medals.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

AS the year runs out, the Staffordshire iron market is being materially assisted in the maintenance of the firmer tone which is so greatly desirable, and which happily, it is believed, will mark the early part of the New Year, by the increased strength of the Scotch and Cleveland markets. In Birmingham this afternoon, and yesterday in Wolverhampton, the greatest satisfaction was expressed at the further revival which is seen this week in Glasgow and Middlesbrough, and the effect cannot but be of advantage to the trade of this part of the kingdom. The good position of the hematite market upon the west coast is another factor of encouragement.

The inquiries and orders arriving for manufactured iron for delivery next year are good. Sheet makers this afternoon were in receipt of a large number of inquiries for execution over the next six months. The description of sheets needed were mainly galvanising and merchant sorts. Purchasers chiefly made their offers at present prices, but makers were little disposed to accept forward business on such terms. They are convinced that prices of raw material and of the finished article will advance. The majority of the makers were therefore content to book small additions to their present orders. Prices were again very strong. Galvanising sheets of 24 gauge are firm at £6 10s., and 27 gauge £7 10s.

There is no falling off in the activity among the galvanisers, and much gratification is expressed at the cabled intelligence from Sydney of a decided improvement in that market, accompanied by a tendency to advance in prices. The conditions affecting South American and Indian trade also continue favourable. Encouraged by the prospects of a busy year in this industry during 1887, one of the black sheet making firms in the Tipton district, who have been recently contemplating entering the galvanising business, has now definitely resolved upon the venture. This week the contract has been signed for the erection of the necessary buildings. Prices are strong, and quotations in respect of a select few favoured brands are from 22s. 6d. to 25s. per ton in excess of the late minimum figure. As the black sheet makers advance their quotations, the less conspicuous galvanising firms will move upwards in their rates. £10 5s. to £10 10s., f.o.b. Liverpool, is quoted for ordinary qualities.

In the bar iron and allied branches there is rather more doing in best quality iron. It is peculiarly satisfactory that certain of the marked iron firms are just now exhibiting increased confidence in the possibility of still securing a good market for Staffordshire best iron, in spite of all competition. They are determined that Staffordshire iron shall not only maintain its high reputation, but that it shall compel a sale.

One best bar iron firm, in particular, has of late sent direct representatives to India and the colonies to acquaint themselves with the exact needs of consumers out there, and to send home all information which may enable the firm to command a market. This revived confidence, in the face of severe competition from steel and second-class iron, is of much promise. Earl Dudley's bars keep at £7 12s. 6d.; bars of other best firms, £7; and second branded qualities, £6. Medium and common quality bars are in moderate call at £5 10s. down to £4 15s.

The plate mills do not manifest increased activity, and competition from other parts of the kingdom is taking off the bulk of the orders. Common plates are £6 10s., and boiler qualities £7 10s. to £8 10s., and on to £9 and £10 for superior makes.

Strips, hoops, angles, and rivet iron find a moderately good sale, and the mills will mostly be able to keep going steadily up to the holidays, though they may not have many orders to carry over into the new year. Narrow gas strip is quoted £4 17s. 6d. to £5, and common hoops £5 to £5 10s. Puddled bars are fetching more money, and £3 7s. 6d. to £3 12s. 6d. is now freely quoted, though some buyers are getting supplies at under these figures. Stocks in some makers' hands are heavy, and the forges are not employed by any means so well as the mills.

Steelmasters in Birmingham this afternoon reported a somewhat increased demand, and the settled anticipation was again expressed that next year will bring about a decided improvement. Works, alterations, and extensions are just now in progress by some local steel firms, in the confident belief that these anticipations will be realised.

In no department of the market was the good effect of the stronger upward movement in the North more apparent to-day than in pigs. Sellers of Midland and native pigs were in receipt of plenty of inquiries for delivery over the first half of next year. They, however, acted with caution, since the expectation is indulged in that further advances are sure to be established in the early part of next year. The blowing-out of furnaces in Northamptonshire and Derbyshire of late, owing to the unsatisfactory prices, has limited the supply by 5000 or 6000 tons per week, and makers who are in a position to still accept business are very independent on the score of quotations. Some of them this week demanded a 6d. to 1s. advance over Thursday last.

Lincolnshire pigs were to-day quoted 41s. delivered here; Derbyshires, 37s. 6d. to 38s. 6d.; and Northamptons, 36s. to 37s. Deliveries of pigs are above the December average, which is a very satisfactory feature. Hematites, in consequence of the large demands from the steel masters, are strong at 53s. to 54s. 6d. delivered here for forge sorts from the Cumberland and Lancashire districts.

Production in the native pig trade is increasing. Some of the medium class pig iron makers are selling a good portion of their old stocks in addition to finding a quick sale for their current make. Holders of stocks, in view of the improving prospects, are less inclined to book forward at present prices, especially as pig iron from the competing districts is dearer. Best pigs are 52s. 6d. to 55s., and common cinder 28s. 6d. to 30s.

Scientific iron making rather than rule-of-thumb work is extending, I am glad to know, in this part of the kingdom. One direction in which this advance in manufacture is showing itself is in the larger number of manufactured ironmasters who are having periodically analysed the pigs which find their way to their puddling furnaces. Thus the managers are kept posted up with the exact constituents of the raw iron which they are working, and greater uniformity in the quality of the rolled iron produced is guaranteed. There is, however, abundance of room for the further extension of this practice, and in the best interests of trade it may well be hoped that further extensions will soon take place.

The engineers and machinists are, on the whole, fairly engaged, some of the leading firms being active on home orders for the season, and there are good lines on hand for marine engines and steam pumps for export. The heavy ironfounders are also fairly situated with contracts for mills and forge work, pipes, and columns. The light ironfounders report a steady trade.

Some fair inquiries are again on the market for the Indian Railways. One, which will be quite acceptable, is from the South Indian Railway Company, which requires 4000 tons of steel rails, 22,948 pairs of iron fish-plates, 99,520 steel fish-bolts and nuts—Ibbotson's patent—206,000 cast iron sleepers, 77,212 wrought iron tie-bars, 158,250 wrought iron cottars, and 158,250 wrought iron gibs. For the Indian State Railways there are required wagon ironwork, under frames, screw couplings, and buffers; and the Oude and Rohilkund Railway Company, is inquiring for ten six-wheeled coupled locomotives and tenders.

From Invercargill, New Zealand, there comes an order for about 1300 tons of cast iron water mains, and also for two high-pressure horizontal engines and Galloway boilers, and two double-acting continuous deep well pumps.

The South Staffordshire iron trade has sustained a loss in the death of Mr. Stephen Thompson, senior partner in the firm of Messrs. S. Thompson and Son, of the Manor Ironworks, Wolverhampton.

The death is also announced, at the age of sixty-four, of Mr. Frederick Wragge, one of the best-known and most respected members of the North Staffordshire iron trade. Mr. Wragge, who was a native of Derbyshire, was for thirty years general manager of Earl Granville's Shelton collieries and ironworks.

The South Staffordshire Institute of Iron and Steel Works' Managers had before them, at their meeting at Dudley on Saturday, a paper by Mr. R. Edwards, of Walsall, on "The Impurities of Iron, and the method of dealing with them." The paper was of a technical character, and the author expressed the opinion that ironmasters and ironworks' managers would be doing much to combat the foreign competition with which they were threatened by informing themselves more fully of the chemical properties of iron making. He lauded the puddling furnace for its reliability, and the uniformity of results which it generally gave, and expressed the opinion that the only furnace that could at all compete with it was the Siemens open hearth. In the discussion which followed blast furnace practice was referred to, and several members expressed the strong opinion that the parallel lines, with their construction, caused much trouble through their liability to produce scaffolding. The best form of lines were those with a smaller diameter at the top, gradually increasing down to the bosh.

The Birmingham compressed-air power scheme received the attention of the North Staffordshire Mining Institute at their meeting, at Stoke-on-Trent, on Monday. Mr. J. Lucas explained that the object of the scheme was to substitute compressed air for steam for driving the numerous small or moderate-sized factory engines in a district of Birmingham, and it was in contemplation to apply the same principle to the Potteries. The air would be compressed to a pressure of four atmospheres by large air-compressing engines worked by steam at a central station, and be conveyed in mains through the central streets of the district, and from those mains service pipes would be taken off to the various power users. An Act of Parliament had been obtained, and all the necessary arrangements had been made.

The question of improving the canal communication between Birmingham and Bristol is not being allowed to drop. To-night—Thursday—the Mayor of Birmingham is announced to preside at a meeting at the Queen's Hotel, at which an address on the "Improvement of Canals," specially with reference to the route from Birmingham to the Bristol Channel, will be delivered by Mr. Robert Capper, secretary to the Swansea Harbour Trust. Mr. Capper is an authority of considerable eminence upon questions of docks and navigation.

The Cradley Heath chainmakers are buoyed up by public support in their endeavours to secure an advance in wages. They do not make such progress as they anticipated, but they await with confidence the issue of the struggle. Several matters affecting the trade are being considered by them, and they have determined to present a memorial to the House of Commons, praying that an Act should be passed prohibiting all girls under the age of fourteen from working in the chain trade.

The Wolverhampton Chamber of Commerce, at their meeting on Wednesday, received a letter from the Secretary of State for Foreign Affairs, in which Lord Iddesleigh, in accordance with a request of the Council, forwarded information which had been supplied by the English Consul at Madrid. The locks in common use in Spain, it was stated, were not what would be termed in England first-class articles. They were very cheap and met the requirements of the people. English locks up to the present had found no market in Spain, but a few foreign locks—French, and especially German—were sold. The most important manufactories for locks were in the North of Spain, at Arreparaleta and Mondragon. Lord Iddesleigh further stated that a collection of locks had been promised to the English representative in Madrid, and they would be forwarded to the Chamber.

There is at present a strong opposition to the laying down of further tramway lines in Birmingham until the cable system has been fairly tried. The Central Tramways Company have renewed Parliamentary notices of their intention to apply for powers to lay down a double line of tramway in Broad-street and the neighbourhood, but they are opposed by the inhabitants whose property, they declare, will be prejudicially affected by the change.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—During the past week the market, so far as pig iron is concerned, has shown a strong, hardening tendency, and there has been some further upward movement in prices. This, however, has been due more to outside influences than to any real improvement in trade here. The condition of the large iron using branches of industry in this district, although the tone, as regards the future, is decidedly more hopeful, does not at present show any appreciable improvement, and with the close of the year there is rather a contraction than an expansion of buying. The reports received, during the last few days, of the improvement in the American iron trade, and the advance there in prices, have tended to strengthen the belief to which I have referred in previous "Notes," that a considerable trade from the United States may be looked for next year; these, with reports also of improvement in many of the foreign markets, and the strong upward movement in warrants from Glasgow, have naturally had a stimulating effect upon the market here. A good deal of anxiety has been shown to secure long forward contracts, and there has been a considerable inquiry from merchants for extended deliveries into next year. Makers, however, have shown a decided disinclination to commit themselves to anything like long forward engagements, and for both local and district brands makers have in some instances put up their prices. Hematites, although firmer, have not shown any appreciable advance upon last week's prices, and for some classes of finished iron late rates are scarcely being maintained.

The Manchester iron market on Tuesday brought together a full average attendance, and there was a good deal of animation in the market, although the actual business doing was comparatively small. Reports of improving prospects in some of the foreign markets, and anticipations of a large trade coming from America, which were freely expressed, tended to produce a buoyant tone generally, and the present feeling was one of hopefulness for the future. For long forward delivery considerable sales of pig iron could have been made, but makers were not disposed to entertain the offer put forward by buyers, and as for present requirements, there is very little iron really wanted. Actual transactions were of no very great weight within the last week or so. Some moderately large sales have been made for delivery into next year, and this has led to a stiffening in prices. Lancashire makers who have recently booked a tolerably large quantity over the first six months of next year, at an advance upon their then current rates, have now put up their list prices 9d. per ton, and for delivery equal to Manchester the present minimum figures are 38s, for No. 4 forge, and 39s. for No. 3 foundry, less 2½ per cent. In some of the district brands much the same kind of thing has taken place; one or two of the Lincolnshire makers have booked moderately large orders at rather low figures, and they have now put up their prices about 1s. per ton upon the minimum rates, practically bringing them up to the full list rates of other makers, and for delivery equal to Manchester the average prices are now 36s. 6d. to 37s. 6d. and 38s., less 2½, for forge and foundry Lincolnshire, with 40s., less 2½, the minimum quoted price for Derbyshire foundry delivered here. Outside brands offering in this market have also in some instances shown a marked advance upon late rates, some of the Scotch makers quoting 2s. per ton above the prices they were prepared to take last week, and there has been a decided stiffening in some of the Middlesbrough brands.

Hematites have shown more firmness, but there has been no large weight of business offering, and there has been no material actual advance in prices, good No. 3 foundry qualities being still obtainable at 53s. 6d. to 54s. per ton, less 2½, delivered into the Manchester district.

In manufactured iron a steady trade continues to be done in bars and sheets, which are firm at £5 for bars and £6 10s. for sheets, delivered into the Manchester district, and with makers only disposed to book for early specification at these figures; but for hoops there is only a very poor demand coming forward, and as work in hand runs out orders are being competed for at lower figures, £5 5s. per ton being now the full average price that is being obtained for hoops delivered equal to Manchester.

There seems to be a more cheerful tone in the reports that I get here and there as to the prospects of the engineering branches of trade, and amongst boiler makers there is more actual work coming forward, whilst the large orders which are being given out by the Lancashire and Yorkshire Railway Company for locomotives, upwards of forty having been placed recently with a local firm, and these being now followed by another sixty, are giving a little stir to the locomotive building trade. Beyond this, however, there is no present actual improvement in trade in this district, and the inquiries which are now coming forward show rather a falling off than otherwise with the close of the year. A rather more hopeful tone characterises the reports issued this month by the leading trades union societies connected with the engineering branches of industry; but it can scarcely be said there is any very appreciable improvement so far as the condition of employment is concerned. The returns of the Amalgamated Society of Engineers show certainly a decrease in the number of unemployed on the books, but it is so slight as to be almost imperceptible, and the number of members in receipt of out-of-work support remains at about 8 per cent. for the whole of the society. So far as the Manchester district is concerned there is no improvement whatever, and, as compared with other districts, the number of members in receipt of donation benefit is above the average, and amounts to about 8½ per cent. of the local membership. The reports sent in from the various branches of the Steam Engine Makers' Society are decidedly better in tone, and there is, if not a large, a satisfactory decrease in the number of unemployed, the members actually receiving out-of-work support being now under 4 per cent. of the membership. The reports as to the condition of trade show that an improvement is beginning to be felt in stationary engine shops, marine centres are better, and some of the iron and colliery districts show a slight improvement. The Bolton and St. Helen's districts, which have been extremely quiet, are better off for work, but in the Manchester district trade is still only dull, and with the exception of a few firms engaged chiefly on special work, there is not much doing.

The nominations for the post of general secretary to the Amalgamated Society of Engineers, in the place of Mr. John Burnett, have now been sent out by the council, and they show that two of the candidates have withdrawn, one of these being Mr. John Wilson, the present acting general secretary, and the contest now virtually lies between Mr. Robert Austin, the secretary of the Manchester district, and Mr. John Anderson, the third assistant secretary at the head office.

Since the presentation of the report of the Manchester Ship Canal Consultative Committee, several meetings of the board of directors have been held, and although nothing definite has transpired as yet, I understand that a definite scheme will very shortly be put forward, and this in such a manner as to afford a very strong guarantee that the project will be successfully carried forward.

The Manchester and Salford Trades' Council, in their annual report which they are about issuing to their members, do not take any very sanguine view as to the prospect of an early improvement in trade, and the most they can say is that evidences are visible of some slight change for the better. As to the causes of the depression in trade which has been so long experienced, the council set down over-production as one of the powerful factors, and it is urged that the extraordinary improvements which have been and are continually being made in the manufacturing power of machines and in appliances for saving labour, although they have been a great benefit to humanity in some respects, and in some branches of industry have lightened the burden of labour, have, however, now reached such a stage of development, and have introduced so great a competition with the muscular powers of man, that they could not be regarded altogether as an unmixed blessing.

There is still only a moderate business doing in the coal trade, and even in house-fire coals the usual winter advance in prices has so far been only very partially carried out, whilst for other sorts of fuel for iron making, steam, and general trade purposes, prices, with a few exceptions, show little or no improvement whatever. At the pit mouth best coal averages 9s.; seconds, 7s. to 7s. 6d.; common house coal, 5s. 9d. to 6s.; steam and forge coals, 5s. to 5s. 6d.; burgy, 4s. 6d. to 5s.; best slack, 3s. 6d. to 4s.; and common sorts, 2s. 9d. to 3s. per ton.

For shipment there is a tolerably good demand, with 7s. to 7s. 3d. per ton being got for steam coal delivered at the high level, Liverpool, or the Garston Docks.

Barrow.—There is a quieter demand this week for all qualities of hematite pig iron, and the market generally is weaker. But most makers are very firm in their dealings with buyers, and although prices have been reduced, and now stand at 45s. per ton net at makers' works for prompt deliveries of Bessemer pig iron, some of the best makers are not selling, nor are they offering to sell, parcels at such rates, believing as they do that, after the turn of the year, trade will improve and prices advance. The business doing in Bessemer iron is quiet, although the consumption is well maintained all round. The business doing in forge and foundry iron is quiet, and prices stand at 44s. 3d. per ton. The output of the furnaces is fully maintained, and it is probable that stocks will also be steadily held until a rise is experienced in the markets. The steel trade remains very brisk, and makers have great hopes of a continuance of activity throughout the greater portion of next year, not only from the orders they have already booked, but from the prospect of new business which is presenting itself on all hands. The rail trade is especially brisk, and the mills are fully employed on orders from home, foreign, and colonial sources. The value of ordinary heavy sections of rails is maintained at £3 17s. 6d. per ton net at makers' works. There is also a steady tone in other qualities of steel, and the prospects of the new year are encouraging for merchant qualities, forgings, plates, bars, wire, nails, and the miscellaneous other products of this district. Engineers are well employed on marine work, and an improved business is confidently expected. The strike of marine engineers a few days ago at Barrow has been settled by a compromise in the direction of a diminution of pay for night-work. Some orders for boilers and repairs to ships have been placed. The tone of the finished iron trade is steadier, and a fair but not active trade is doing. Iron ore finds a good market, and prices remain at from 9s. to 11s. per ton, the latter being the quotation for the best parcels of Lindal Moor and Hoobarrow samples. The coal trade is steady, and both coal and coke are firmer. Shipping is fairly employed, considering the time of the year, and freights are good.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

The South Yorkshire collieries sent to Hull last month 130,944 tons against 128,264 in the corresponding month of 1885; for the eleven months the weight is 1,297,968 tons against 1,210,648 from January to November, 1885; the increase thus amounting to the large total of 87,320 tons. Denaby Main is at the head of the list with 13,328 tons. Russia is again the leading customer, having taken during November 6739 tons as compared with 5062 tons in the corresponding period of last year. For the eleven months from January to November, 1885, the weight taken to North and South Russia from Hull was 133,482 tons, an increase of 18,679 tons on the quantity exported for the eleven months of 1885.

The middle of December finds hematite iron for the Bessemer and Siemens processes rather under the quotations for December, 1885. The comparative course of values may be indicated. On January 1, 1885 and 1886, the values were respectively 52s. 6d. and 52s. per ton; on March 1, 51s. and 50s.; on July 1, 50s. and 49s.; on September 1, 49s. and 48s. On December 7, 1885, hematites suddenly jumped up to 52s. 6d. per ton, but did not remain long at the figure. Since early in September, there has been a steady upward movement to about 51s. and 52s. per ton, and the market is very steady. The present rise in hematites is mainly due to the advance in freights of about 1s. 6d. per ton. A steady decline has marked forge iron—from 36s. to 33s. per ton. or rather less. A firmer tone is at present perceptible; but there is no change for the better in the common iron trade, which could scarcely be worse.

The year drawing to a close has been marked by singularly few trade disputes, and not a single strike in our staple industries. At Workington, however, the steel workers of Messrs. Charles Cammel and Co., of the Cyclops Works, here, have struck, with the employés of another company, for an advance of 15 per cent. in wages.

In the edge tool trades the manufacturers have their books well filled, chiefly on continental and Australian account. A very large business is being done with Germany, which takes the finest quality of tools produced. It is somewhat extraordinary that the country which supplies us with the poorest goods which enter our markets should require our best productions; yet it is easily accounted for. The German workman insists on having English-made tools to fashion his wares. The German merchants have command of the business in Austria, Roumania, Servia, and Bulgaria. A large quantity of English-made tools were at one time re-exported from Germany to Spain; but now that the Spanish tariff has been rendered less prohibitory, this is about at an end. Spain, it is anticipated, will soon draw her supplies direct, in edge tools as well as in cutlery, the duty on the latter goods having been reduced from 30 to 15 per cent.

South American orders for sheep shears have been very satisfactory this season, and local firms are now engaged on orders for North America and California. These markets are also yielding good orders. A pleasant feature of the sheep shear production is the revival of activity in South Africa, particularly in the Cape of Good Hope district. There is no "boom" to speak of, but a steady demand has set in for edge tools generally as well as shears, saws, and files. The Cape is also ordering cutlery more freely, and on the whole the signs are more cheerful than at any time since the Transvaal retrocession, For spades, forks, shovels, and similar articles, there is a good home and Australian demand. The improved shapes and diminished weight of the newer patterns are telling favourably on the Colonial and foreign markets, as well as in the home districts, where foreign-made goods are still too frequently seen.

It is interesting to note that the average price of steel exported last month was £7 10s. This quotation somewhat damps the ardour with which the increased volume of business is regarded. It is more evident, month by month, that the steel sent abroad consists largely of the Bessemer and other low class steel. This is particularly the case with all markets, and more particularly in the business done with the United States. For fine saws and other noted tools the Americans still call for thoroughly trustworthy crucible steel, but it is quite clear that the bulk of the trade is not now in that direction.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland pig iron market has been in a somewhat excited state during the last few days. Consumers have shown considerable anxiety to purchase, and several sales have been made at advanced rates. Sellers, however, are unwilling to commit themselves far ahead, and consequently the amount of actual transactions has been limited. At the beginning of the market held on Tuesday last, buyers were very eager, and paid as much as 34s. per ton for No. 3 g.m.b. Later, when less favourable reports had been received from Glasgow, a quieter tone prevailed, and 33s. 6d. to 33s. 9d. were the prevailing figures for No. 3, for prompt delivery. The total sustained advance on last week's price is therefore 9d. to 1s. per ton. Makers generally refuse to take less than 34s. 6d. per ton for No. 3, and some even ask 35s. The demand for forge iron is poor, and sales have been made at 31s. 9d. per ton, which is only 6d. per ton advance.

Warrants have risen in value from 32s. 9d. to 34s. 3d. per ton, sales at the latter figure having been effected at Glasgow.

Messrs. Connal and Co.'s stocks at Middlesbrough and at Glasgow showed last week increases in both places. The quantity held at Middlesbrough was, on the 13th inst., 299,238 tons, or an increase of 363 tons. At Glasgow the stock was 840,180 tons, or an increase of 100 tons.

Shipments from the Tees continue satisfactory for the time of year. On the 13th inst. 26,145 tons had been sent away, which is 6000 tons less than during the corresponding portion of November, but 6000 tons more than in December 1885.

The value of goods, exclusive of coal and coke, exported from Middlesbrough during November, was £150,872, being an increase of £43,320 as compared with November last year.

The tonnage of new vessels built at the Hartlepools this year will fall considerably below that for several previous years. Messrs. W. Gray and Co. have built eight vessels, six of iron and two of steel, with a total capacity of 13,117 tons. Messrs. E. Withy and Co. have built only one iron steamer, of 2176 tons burden. Messrs. Irvine and Co. have constructed no new vessel at all.

The new salt boring operations are causing the north side of the Tees, opposite to Middlesbrough, to look exceedingly lively—indeed, that part of the district may be said to have an active and prosperous appearance beyond any other. The wooden erections towering up to a considerable height, which indicates bore holes in progress, are becoming quite prominent features in the landscape; and the telegraph poles and wires crossing the marsh land in every direction suggest that each such erection is an active centre of business, requiring frequent communication with the outer world. Some foreshore land in the neighbourhood of these bore holes has recently been valued at over £900 per acre, probably in the belief that salt might be found below. On the Middlesbrough side of the river similar foreshore land used formerly to be sold at about one-third the above figure.

It seems that steamship owning is beginning again to become a paying investment, provided the management is good, and the first cost of the vessel is small. Iron screw steamers, nearly new, and which have been laying up until better times, may now be bought at from £5 to £6 per ton of carrying capacity. Such vessels employed in the Baltic or Mediterranean trades at present rates of freight will pay as much as 15 per cent. to their owners. As they could naturally be insured for an amount which would completely cover their cost, the original capital would be restored in case of total loss. Perhaps the worst thing for owners is to keep their vessels till they become obsolete in type or in machinery. In that case it must require a considerable annual deduction from the dividends to maintain the principal sum at its original value.

The Central Marine Engineering Company of Hartlepool has again invited its friends to see one of its triple expansion marine engines in motion. The engine in question has cylinders 25⅜in., 42in., and 68in. in diameter respectively, by 45in. stroke, and is capable of working up to 1400 indicated-horse power. It is intended for a screw steamer called the Maryland, and is secured to one of the erecting tables in the large machine shop. The trial was successful as far as it went; though obviously with no resistance except that offered by friction, the power exerted can only have been small.

The North of England is not free from labour difficulties. The Cleveland blast furnace men, noticing that pig iron has gone up 3s. 6d. per ton, have claimed 5 per cent. advance. The employers, in reply, have declined to accede to the demand, on the ground that at all events it is premature. The Northumberland coalowners have determined to abolish the sliding scale, and obtain, if possible, a reduction of wages to the extent of 15 per cent. The men, in reply, have offered 5 per cent.; but this having been declined, negotiations are for the present broken off. The men's case has been conducted by Mr. Burt, M.P., and Mr. Fenwick, M.P.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE Glasgow pig iron market has been excited this week, in consequence of prices of warrants having advanced to a higher figure than has been reached in the course of the present year. The continually recurring accounts of improved trade in the United States have had a powerful effect upon the market; and although stocks are large, and the market for g.m.b. limited, some of the better brands of makers will have become scarce, and the other conditions of the market at the moment are such as to favour an upward movement.

Scarcely any iron has been sent into the public stores in the past two weeks, the number of furnaces making ordinary pigs has been reduced, and those producing hematite increased. The latter quality of pigs is in request among the workers of steel, and the total make of it is going into consumption at home, so that there is not the same necessity of adding to stocks as before, even when the shipments were small. In the past week the shipments have been of considerably greater amount than for a succession of weeks. They were 7260 tons, as compared with 4289 tons in the preceding week, and 5086 tons in the same week of 1885.

Business was done in the warrant market on Friday at 43s. 3d. cash. On Monday there was increased disposition to purchase, and the quotations advanced to 43s. 9d. Tuesday's market was very excited, and in the forenoon the cash price of warrants was run up to 44s. 4d., coming back to 43s. 9d., advancing again to 44s., and closing with sellers at 44s. 0½d. cash. On Wednesday the quotations were from 43s. 11½d. to 43s. 9½d., and back again to 44s. 1d. cash. To-day—Thursday—the market was quieter, with business at 44s. to 43s. 8d., closing with buyers at 43s. 9d. cash.

There has been a very marked advance in the prices of makers' iron:—Gartsherrie, f.o.b. at Glasgow, No. 1, is quoted at 49s. 6d. per ton; No. 3, 44s. 6d.; Coltness, 53s. and 45s.; Langloan, 49s. 6d. and 44s. 6d.; Summerlee, 52s. 6d. and 44s. 6d.; Calder, 49s. 6d. and 43s. 6d.; Carnbroe, 45s. and 42s.; Clyde, 46s. 6d. and 42s.; Monkland, 45s. and 41s.; Govan, at Broomielaw, 45s. and 41s.; Shotts, at Leith, 47s. 6d. and 45s. 6d.; Carron, at Grangemouth, 46s. 6d. and 43s. 6d.; Glengarnock, at Ardrossan, 46s. and 42s. 6d.; Eglinton, 44s. 6d. and 40s.; Dalmellington, 46s. and 41s.

Makers of malleable iron are speaking of increasing their prices owing to the state of the pig iron market, and it is possible that there may even be a further increase in the price of steel.

Experiments which have been proceeding for several weeks at the Blochairn works of the Steel Company of Scotland with Archer's process for heating furnaces with gas made from intermediate oils are pronounced to be highly successful. The same process is also being tested as supplying gas for lighting purposes, and it is reported that it has given astonishing results, the gas being quite as good as that made from the best coal, while it can be manufactured at about a third of the present cost of coal gas. The invention is causing quite a flutter of excitement among the Scotch oil companies, and the Corporation of Glasgow has appointed a committee, with power to employ scientific assistance, to fully investigate the value of the gas as adapted for lighting.

The Scotch hematite pig iron trade is becoming very busy, and in the course of the past week a number of additional furnaces have been put on to the production of hematite, in order to supply the necessities of the local makers of steel.

In the past week there was shipped from Glasgow locomotives worth £1345 for Calcutta, and £7500 for Bombay; the hulls and engines of two stern-wheel steamers, value £16,200, for Rangoon; machinery £60,000, of which £52,000 is a marine engine for a Russian war vessel sent to Sebastopol, and £5000 a marine engine for Calcutta; sewing machines, £2330; steel goods, £6800; and general iron manufactures, £26,500.

The coal trade has not been quite so brisk in the shipping department during the past week, partly owing to the detention of vessels by the recent stormy weather. At Glasgow 20,647 tons were despatched; Greenock, 174; Ayr, 5336; Irvine, 2008; Troon, 6463; Leith, 3422; Grangemouth, 5292; and Bo'ness, 4593 tons. For splint coal the inquiry on the part of shippers is good, and the prices are well maintained, while the rates for other qualities are nominally without change.

Messrs. Merry and Cuninghame are reported to have acquired the mineral leases of Spittalhill, which at one time belonged to the Clyde Coal Company.

There is again some trouble with the colliers in the Glasgow district. It was expected that they would work quietly till the beginning of the New Year, but as it is reported that one of the coalmasters in the district has given a second 6d. a day of an advance of wages, the men seem to be of opinion that they can force the increase over the whole district.

The miners at Newbattle have recorded an advance of 10 per cent. and a 1d. extra per ton, and those at Arniston have commenced working eleven days a fortnight on 10 per cent. advance and 2d. per ton on the rough coal and 3d. on the parrot coal.

The miners of Ayrshire have passed a resolution recommending the men of Cumberland to make an immediate demand for an advance of 10 per cent., while the miners of Ayrshire will demand another 6d. day; and in the event of this not being conceded early in January, measures will be taken to enforce the advance. They have also resolved to make the eight hour day general. The connection between Ayrshire and Cumberland is that both places supply the same markets.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

A STRONG testimony to the excellence of the sliding scale was paid at a large meeting of colliers on Monday in Tredegar. It was also resolved to divide South Wales and Monmouthshire into four divisions, for the better working of the scale by efficient representation. Meetings were called for Merthyr on Saturday, and Aberdare on Monday next for the same and other objects.

Considering the stormy weather, the foreign coal export trade has been tolerably good in respect of quantity, though prices remain in the old groove. Rhondda coals are quoted as low as 7s. 3d.; best, 8s. 6d. Small steam is in less demand, and market is falling. House coals rather flat.

The influence of the weather was shown on the Newport coasting trade last week, the total being under 20,000 tons. As for Swansea, its total coal shipments amounted only to about 15,000 tons, or half the ordinary quantity, and the great complaint there is, that the repair of vessels this week constitutes the principal work of the port.

The Albion, the last of the large collieries now sinking, is progressing well, and confidence in the great undertaking is shown by the township that is springing up, and by the new coal waggons getting ready. I noticed at Harris's Navigation last week, the loading of Albion wagons; so the management start with a quality which I hope will soon be equalled by their own.

Harris's Navigation is doing well. The output is well maintained, and the hillside, which a few years ago was a wood, now harbours a population fast closing upon 4000 people. But here, and at similar collieries visited, the fact was only too apparent that capacity is far in excess of requirement. "Half work" may be stated as describing pretty accurately the condition of things at most of the collieries.

Improvement is shown in the inquiries for steel sleepers; blooms also are in demand, and good cargoes are being sent to America.

General trade is said to be waiting upon Providence, but iron and coal are waiting upon general trade, and with its improvement our industries must improve. Coalowners are somewhat disheartened, but ironmasters are more hopeful. I see that Treforest is to be fitted with the Siemens plant. Repairers are busy at work. The old Anchor Works of Wood's at Pentyrch are being utilised, and De Bergue's appear to be renovated ready for a start. Dowlais and Cyfarthfa are more lively, and the same may be said for all the principal works.

The sharpness with which movements are watched was strongly shown at the late little spurt in the rail trade. Every industry dependent wanted the "first bite." Ore went up, coke went up, and if ironmasters had not shown considerable skill, any small benefit that was derived would have been more than lost.

A case is now *sub judice* before the coroner concerning a fatality on Cefn Pennar incline, by which three colliers were killed. These men were riding to their work upon the incline when a collision took place on account of the points being blocked. Whatever the issue, it should lead to such an arrangement as to prevent anything of the sort. The up and down lines should be distinct and separate, and then the only accident to be feared is the breaking of the chain, which may be modified by the fork arrangement connected with the chain.

A foundry at Aberdare and another at Swansea are in the market.

Public feeling is aroused at Swansea on the subject of dry dock accommodation, a large vessel, the Peveril, having been sent to Cardiff to be dry docked, her projecting rudder preventing its being done at the sister port.

In the tin-plate trade, the brawling amongst the men has been followed by the louder brawling and destructive efforts of the storm, and at several works stoppages have been the result. Last week the make was about one-half the average, and prices in consequence have gone up. This better price is waking up some of the works which have been idle, and I am glad also to record restarts where works have stopped owing to differences in the matter of wages. Pontymister starts this week. There are disputes still pending at Aberavon affecting 1000 men.

Plates have been going up, and all at 13s. have been quickly cleared. Quotations range up to 14s. for ordinary cokes, some offering for 13s. 6d. to 13s. 9d. Siemens steel are in good demand at 14s.; some makers ask 14s. 2d. Ternes are going steadily up to 14s. It is expected that prices all round will advance, so many works being closed.

Last week Swansea makers shipped nearly 25,000 boxes of tin-plates. Present stock 159,497 boxes.

Wernddu Colliery dispute is still unsettled.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE improvement in the different iron markets of this country not only keeps up, but in some branches has even increased. In the former cases, the books being well filled with orders and the combination being in force, it has been possible to raise the prices a little, whilst from all these causes prices have become firmer all round where no rise has as yet been effected. There is more general confidence, and buyers find it more and more difficult to make contracts at old figures for forward delivery. In Silesia the situation is much better than it was; the pig iron prices have settled down with firmness, and merchant bars have also lately gone up, though it is questionable if the rise will last long, as the Wrought Iron Convention could not be established. Ores keep up, and have even risen a trifle in prices, and freights of Spanish have improved; so they are a little dearer. Pig iron has well maintained its price this week in Rheinland-Westphalia, and stocks are rapidly decreasing. Spiegel has again risen a little, and export is brisk. Forge pig finds ready sale, and the prices have a tendency to rise continually. Bessemer and basic pig are still neglected, but not quite so much so as lately. In foundry pig there is a slight improvement, inasmuch as quotations are adhered to. In bar iron there is an undeniable improvement, and the mills are still fully employed; so that some of them were able to command M. 2 to 3 per ton rise. At a recent tendering for railway stores not one tender was below M. 100, whilst all the others rose to M. 105 per ton, which plainly indicates the advance in prices of wrought iron bars. Girders are noted M. 7 in advance of former prices, and not M. 9, which was mentioned as probable in last report. Boiler and common quality plates show a decided change for the better in price, but here also much will depend upon whether the combination be definitely formed. Thin sheets are in very urgent request, and thirty-seven firms rolling these sheets have just sent out their circulars decreeing that henceforth Nos. 1 to 10 shall be at ground price; 11 to 15, 5; 16 to 19, 10; 20 to 21, 15; 22, 20; 23, 30; 24, 40; 25, 50; and No. 26, 60 p.c. extra. The price is still rising, and is at present noted at M. 130, occasionally at 132 p.t. Of wire rods there is nothing new to report, and the same may be said of steel rails, but if the steel works could accept the prices offered their books might be filled up with foreign orders for a long time to come for ingots, slabs, blooms, billets, and sheet bars for American account chiefly. Here and there a few orders seem at last to have found their way to the machine shops, but in general there is great complaint of want of work, still these few orders inspire hopes of speedy improvement. The brassfounders did not do so well last month, the prices scarcely covered the cost of making, and receded during the period.

In Belgium the market is again firm, not so much on account of the domestic demand, though some of the ironworks are well employed, as because of the foreign orders coming in, which enables the Convention to keep firmly to its quotations. It would seem that English houses wishing to contract there for iron, to be used in constructive work for India, have not met with the readiness, on the part of the Convention, to contract at the prices they expected. It might be reasonably asked, what brings English firms over to Belgium to place orders which could most likely be better executed in England? There can be but one reply, namely, to gain a few shillings per ton. But this can only be to the loss of somebody else, for it is well known that, quality for quality, Belgian iron is no cheaper than English. It is to be hoped that a strict supervision of the finished structure will be exercised, or the Indian Government may some day have to suffer. This is Free Trade certainly, and to raise a question about its dogmas is heresy; nevertheless, it is hard to believe that this phase of it, at any rate, brings any advantage to either India or England. The same reasoning applies almost equally to the orders for rails for Australia, which come here and are paid for out of loans subscribed for by English people; and it should not be overlooked, that in this way not only do English works suffer, but the shipping interest as well, in the carriage of the goods to their destination, whilst it nourishes the maritime aspirations of our rivals.

There is a mania just now for establishing branches abroad. Those for Russia have been mentioned, then there was a talk of a South German firm starting a branch locomotive factory in Italy, and now it appears "The Berlin Maschinen Fabrik" contemplates establishing a work for the manufacture of torpedoes in Italy, where the chief of the company—Herr Schwarzkopf—and an assistant now are, as is said, for the purpose of making the preliminary arrangements for it. A short time ago the same firm sent six experienced workmen to Constantinople to fit up torpedoes for the Turkish Government. Whether these branch establishments conduce to profits is questionable.

Scarcely a week passes by without some great Chinese functionary and suite visiting some work or other in Germany, Belgium, or England, and some days since the Chinese Minister of Commerce paid one to Krupp's establishment at Essen. After the two wars with China, it was triumphantly proclaimed that now China would be opened up to all the world. The irony of fate, however, willed exactly the reverse, for the whole world has been opened up to China, and one hemisphere is already nearly overrun by them, whilst in the other they are to be found chasing about in all directions. Whether the nations which made the greatest sacrifices to attain this will reap their due share of benefit from them seems a matter for speculation. For the time being Germany is unquestionably the favoured nation, and at this moment war ships, marine engines, torpedo-boats, engines and torpedoes, guns and projectiles of all sorts are being made for China here, and probably other things besides. If John Chinaman requires anything, from a hobnail to an electric plant, the Germans are on the look out and are sure to be at hand, and, it is said, are the most accommodating of all those seeking for it. The Belgians pin their hopes of great success upon the fact of their country being only an insignificant Power, from whom the suspicious Chinese Government has nothing to fear, whereas it is in continual fear of being over-reached by the greater Powers with which it enters into relations. This fiction should be diplomatically driven out of their heads. It has already been remarked in a continental paper that nowhere has it transpired that England, as is its usual custom, has yet smuggled—*sic*—itself into China's good graces. Well, there is yet time enough, for China will take a long time to deliberate before taking action with regard to its railroads; but still no time should be lost in taking the proper steps to be efficiently represented, in so far as English industry is concerned. It is not enough that it should be represented by merchant firms out there, because there is a certain amount of the political element mixed up in the matter which must be reckoned with. So as little is to be expected from our diplomatic agent, a special one, as has already been urged in this place, should be employed to watch over and take care of our interests, and see that we do not come in the last for the race which is sure to come off sooner or later between the nationalities concerned.

MR. ROBERT HOGARTH PATTERSON, a well-known writer on finance, and who was for several years one of the gas referees under the Board of Trade, died on Monday.

AMERICAN NOTES.

(From our own Correspondent.)

New York, Dec. 4th.

The orders for foreign material are likely to be of very large dimensions during January. Agents have been in negotiation with consumers throughout Pennsylvania and Ohio, and the requirements for the coming six months are being carefully estimated. The opinion prevails that no reactionary tendencies are at work either in the iron trade or in any other branch of industrial activity. Consumers feel obliged to pay the higher prices now being asked, and will do so without even murmuring. Steel billets are selling in Pittsburgh at 33 dols.; old rails, at 26 dols. 50c.; puddle bars, at 31 dols. to 32 dols.; imported Bessemer, at 22 dols. 75c.; grey forge iron, 17 dols. to 18 dols.; nails, 2 dols. 15c. to 2 dols. 25c.; and steel rails, 35 dols. to 36 dols. 50c.

Advices from Chicago show firm prices ruling there, especially in merchant steel for agricultural and tool-making requirements. The carriage works, the wagon works, and all smaller industries are renewing their orders for material for the first quarter of the year.

The agricultural interests have been very successful in disposing of their crops, and the market is feeling the stimulus in many ways.

Strong prices characterise every branch of trade. The hardware manufacturers are very busy and the manufacturers of small railway material such as nuts, bolts, splice bars, and spikes have a winter's work in hand. Combinations are being made for the purchase of lands in the South containing coal, ore, limestone and valuable timber lands. The Standard Oil Company has just made a purchase of 500,000 acres of timber.

Land in Eastern Kentucky is reputed to be as rich in its mineral resources as Northern Alabama, but it has been beyond the reach of enterprise for lack of railway facilities. A line of railroad will be built into this region early in spring. There is a speculative tendency in the production of mineral and timber properties in the lake region in the north-west. Large purchases have been made of iron ore and copper territory, and railway facilities are to be supplied involving the construction of some 1500 miles of road. Railway authorities estimate that next year's construction of main line will reach not less than 9000 miles, being very nearly the mileage of 1882, the greatest year in American railway construction. The repairing and extension requirements will absorb about 6000 miles of rails, and heavy contracts will be placed for rail supplies in January, and it is probable that prices will range from 35 dols. to 36 dols. All kinds of old material are very scarce in this market. Several lots were contracted for in this market this week at 22 dols. 50c., and negotiations are pending to-day for 15,000 tons of Bessemer pig for which 20 dols. is being asked.

NEW COMPANIES.

The following companies have just been registered:—

Manchester Electric Supply Company, Limited.

This company was registered on the 3rd inst., with a capital of £10,000, in £10 shares, to create and produce electricity, and to supply the same for the production and transmission of power, for lighting purposes or otherwise, as may be thought advisable. The subscribers are :—

	Shares.
J. Thornton Chancellor, C.E., 31, Market-street, Manchester	1
W. H. Vaudrey, 9, St. James's-square, Manchester	1
*A. Bromley Holmes, 1, Crosshall-street, Liverpool, engineer	1
J. C. Vandrey, Liverpool, engineer	1
*J. F. Allbright, Mansion House-buildings, Queen Victoria-street, engineer	1
*R E. Bell, Crompton, Mansion House-buildings, engineer	1
W. A. Ryle, Arc Works, Chelmsford, engineer	1

The number of directors is not to exceed six; qualification, registered shares or stock of the nominal value of £100; the first are the subscribers denoted by an asterisk, who are appointed for seven years. Messrs. A. B. Holmes, and J. C. Vaudrey, are appointed managing directors.

Patents Trust, Limited.

This company proposes to acquire British, colonial, and foreign patent rights and other privileges granted for any inventions, and to work and develope the same. It was registered on the 2nd inst., with a capital of £10,000, in £1 shares, with the following as first subscribers :—

	Shares.
J. Allison, 189, Hungerford-road, N., clerk	1
E. A. Adcock, 4, Queen's-terrace, St. John's Wood, draughtsman	1
J. H. Murrell, 135, Waterloo-road, clerk	1
L. Hall, 7, Evendale-road, Brixton	1
H. H. Smith, 2, Victoria Mansions, S.W., merchant	1
F. Jago, 12, Lady Somerset-road, Highgate-road	1
C. H. Siebert, 35, Cowper-road, South Hornsey, clerk	1

Registered without special articles.

Numidian Marble Company, Limited.

This company proposes to acquire mining and quarrying rights in the French dependency or colony of Algeria, and for such purpose will adopt an agreement of 13th ult.—unregistered—entered into with Signor de Monte, Achille de Monte, and Emile de Monte for the purchase of lands and marble quarries, situate in the province of Oran, Algeria. It was incorporated on the 7th inst., with a capital of £200,000, divided into 32,000 ordinary shares of £5 each, and 400 preference shares of £100 each. The subscribers are :—

	Shares.
W. Bruce, Gulliford, 5, Barton-road, West Kensington, fruit broker	1
A. G. Griffith, 5, Guildford-street, W.C.	1
F. H. Kingham, Watford, Herts, chartered accountant	1
R. C. Bates, R.N., Trent-road, Brixton Hill	1
A. Kennedy, Ailsa House, Balham	1
H. Johnson, Bloomsbury Mansion, Hart-street, solicitor	1
E. A. Hughes, 2, Gray's-inn-place	1

The number of directors is not to be less than four nor more than seven; qualification, forty shares; the first are Lieut.-General Sir Andrew Clarke, C.E., Messrs. Hy. Currie, G. Petrie, C. J. Phipps, and L. L. Woodhouse. The managing directors and each director other than any honorary director will be entitled to £200 per annum, and the chairman to £300 per annum.

Polgooth Tin Mine, Limited.

This company was registered on the 8th inst., with a capital of £10,000, in £1 shares, to acquire from Thomas Fell, the Polgooth Tin Mine, parish of St. Austell, Cornwall. The subscribers are :—

	Shares.
J. Campbell, 41, Gowlett-road, East Dulwich, director of a company	1
T. Everett, Warwick-road, Hornsey, accountant	1
W. Wrenn, 2, Crown-court, Threadneedle-street, stock and share dealer	1
C. Biggs, 32, Great St. Helen's, accountant	1
W. B. Heath, 2, Crown-court, sharebroker	1
H. Mansell, West-green, Tottenham	1
M. McAvoy, 46, Moray-road, Tollington Park, book-keeper	1

The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first.

Swiss Pure Ærated Waters Company, Limited.

Registered on the 6th inst., with a capital of £2000, in £1 shares, to carry on at Plymouth the business of ærated water manufacturers. The subscribers are :—

	Shares.
W. W. Curtis, Plymouth, chartered accountant	1
W. Snawdon, Stonehouse, Plymouth, merchant	1
J. Greenway, Plymouth, solicitor	1
R. Jennings Bellait, St. Ives, Cornwall, contractor	1
J. G. Sloggett, Plymouth, engineer	1
J. Snawdon, Plymouth, marble merchant	1
E. Tout, Plymouth, wholesale grocer	1

Registered without special articles.

Trade Mark Owners' Mutual Protection Association, Limited.

This association was registered on the 3rd inst., as a company limited by guarantee to £5 each member, for the protection and registration of trade marks and designs in the United Kingdom, the colonies, and abroad, and to promote legislation in respect of same. The subscribers are :—

*W. H. Wills, Bristol, tobacco manufacturer.
*F. J. Thompson, King's-road, St. Pancras, manager to Bass, Ratcliffe, and Gretton, Limited.
*C. H. Curtis, 74, Lombard-street, gunpowder manufacturer.
J. T. Skinner, 30, Milk-street, merchant.
G. H. Hildyard, Great Dover-street, manufacturer and merchant.
*C. Cheswright, sen., 1, Wharf-road, City-road, managing director, Betts and Company, Limited.
*H. C. Stephens, Aldersgate-street, ink manufacturer.

The committee is to consist of not less than five, nor more than twenty-five members, or managers acting on behalf of firms or companies who are members. The subscribers denoted by an asterisk are members of the first committee.

Union Electrical Power and Light Company, Limited.

This company proposes to produce electricity, or electric current or force, for light, heat, motive power, and means of communication, and generally to carry on the business of electrical engineers and contractors. It was registered on the 6th inst., with a capital of £500,000, in £5 shares, with the following as first subscribers :—

	Shares.
Arthur G. Miller, 21, Mincing-lane, colonial broker	10
W. T. Ansell, 50, Old Broad-street, electrical engineer	10
W. Clark, 53, Chancery-lane, patent agents	10
H. Perey Horne, 49, Gloucester-gardens, W., solicitor	10
J. Pirie, 35, Eastcheap, corn factor	10
H. Drake, Devon House, Forest Hill	10
J. A. Timmis, C.E., 4, Great George-street	10

The number of directors is not to be less than seven; the subscribers are to appoint the first, and determine their qualification; qualification for subsequent directors, fifty shares; remuneration, exclusive of expenses, £1500 per annum.

King's College Engineering Society.—A *conversazione* on December 3rd given by this society was attended by about 800 people, and passed off very successfully. The visitors were received by the Principal, the Dean of the Department; the President of the Society, Mr. A. F. Moore; and the Vice-president, Mr. A. H. Preece. The entrance hall was very prettily decorated by specimens of pottery kindly lent by Messrs. Doulton and Co., and Defries' safety lamps on the staircase were greatly admired. The exhibits in the large hall, lighted by Messrs. Sugg and Co., consisted of photographs, machinery, and models, including a telpherage model constructed by Mr. W. P. Adams, which was especially admired. In the library an excellent display of microscopes was provided by Fellows of the Royal Microscopical Society and others, the ladies being especially interested in this exhibit. Some very pretty and interesting experiments were carried out during the evening in the Wheatstone Laboratory, and a collection of historical models was displayed in the George III. museum. A valuable display of art porcelain by Messrs. Phillips, of Oxford-street, and a very successful organ recital given at the beginning of the evening in the chapel by Mr. Pernham added to the attractions. The musical society gave a selection of music in the large hall. During the evening the workshops were open and the students were seen at their ordinary work, including testing, casting, foundry work, and fitting. The Metallurgical Laboratory was also open. The arrangements were exceedingly well carried out in the college, which affords excellent accommodation for a large gathering, and the guests appeared to be well pleased. Amongst the things which were shown was a new heat indicating paint invented by Mr. Henry Crookes, of 4, Westminster-chambers. The paint is red, but when heated becomes darker until black, according to temperature, and resumes its proper colour when cold. Applied to bearing caps it would indicate any serious heating.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Applications for Letters Patent.

*** When patents have been "communicated" the name and address of the communicating party are printed in italics.

7th December, 1886.

15,967. Blacking Boxes, H. J. Allison.—(*S. M. Bixby, United States.*)
15,968. Railway Car Brakes, A. Dieu, London.
15,969. Half-leggings, P. F. Allen, London.
15,970. Certain Apparatus, W. H. Blackwell, Brightside.
15,971. Celestina, G. H. Best and W. G. Ackerman, Bridport.
15,972. Soles for Lawn-tennis Shoes, &c. I. Frankenburg, Manchester.
15,973. Pouches for Tobacco, &c., H. Wheeler and W. Rhodes, Manchester.
15,974. Treating Coal to Improve its Qualities for Heating, &c., A. McDougall, Penrith.
15,975. Automatic Delivery of Prepaid Liquids, W. Hallam, A. Pickard, W. Pickard, and J. Scott, Cheetham.
15,976. Automatic Delivery of Prepaid Articles, W. Hallam, A. Pickard, W. Pickard, and J. Scott, Cheetham.
15,977. Hat Bands, W. H. Hope, London.
15,978. Compound Armour-plates of Aluminium Alloys, &c., Metals, E. H. Cowles, London.
15,979. Combined Chair, Reading Desk, &c., H. G. Powell London.
15,980. Electric Apparatus for Stopping Steam, &c., Engines, B. Taylor, Halifax.
15,981. Electric Apparatus for Stopping Marine, &c., Engines, B. Taylor, Halifax.
15,982. Lighting Lamps, H. Trotter, London.
15,983. Kitchen Ranges, G. W. Courtier, London.
15,984. Protecting, &c., Knitting Pins, E. Williams, Birmingham.
15,985. Envelopes, J. E. Krucker and C. Gulath, United States.
15,986. Publican's Liquor Check, J. C. Tanner, London.
15,987. Fasteners, G. W. Mohrstadt, Harborne.
15,988. Constructions in Tiles, &c., H. P. Dunnill and F. R. Smith, Shropshire.
15,989. Centres of Circular Brushes, T. R. Voce, Birmingham.
15,990. Depositing Tanks, G. Rodger, Liverpool.
15,991. Manufacturing Gas, C. J. Sandahl, J. Birchall, and J. Musson, Liverpool.
15,992. Weft Bobbin, R. Walsall, Leeds.
15,993. String Fuse, A. W. Cronquist and C. O. Lundholm, Polmont.
15,994. Cork-screws, C. H. Hudson, London.
15,995. Odourless Antiseptic Soap, R. Wharry and G. Dyson, London.
15,996. Lock-stitch Sewing Machines, G. T. Tugwell, Red Hill.
15,997. Production of Chlorine from Chlorides of the Alkalies, W. P. Thompson.—(*H. Reimann, Germany.*)
15,998. Alarm Apparatus for Doors, &c., J. Bryant, London.
15,999. Machines for Cutting Metals, W. W. Hulse, London.
16,000. Lathes, W. W. Hulse, London.
16,001. Treatment of Cigarette Tubes, O. Melachrino, London.
16,002. Exhibiting Words in Succession, F. H. Berry, London.
16,003. Driving Mangling, &c., Machines, W. H. Harvey, Bristol.
16,004. Procuring Precious Metals from their Ores, J. Nicholas and H. H. Fanshawe, London.
16,005. Communication of Electrical Signals, H. Joyce, Q. A. McConnell, and G. Lowthian, London.
16,006. Closing Leaks in Vessels, W. W. Popplewell.—(*I. Meisler, United States.*)
16,007. Securely Fastening Window-sashes, J. Dedden, London.
16,008. Photographs, &c., Inserted in Lids of Fancy Boxes, &c., A. Bassano, London.
16,009. Machinery for Rolling Glass, G. F. Chance, London.
16,010. Umbrellas, &c., W. Holland, London.
16,011. Organs, W. J. Ledward, London.
16,012. Printing Photographic Picture, E. Edwards.—(*H. Brand, Germany.*)
16,013. Boiler Feed Regulator, C. O. Wyman, London.
16,014. Necking Tool for Working Bottle Necks, J. Soper, London.
16,015. Automatic Closing Bung for Casks, &c., L. M. R. Paille, London.
16,016. Moulding Sugar, F. Scheibler, London.
16,017. Protecting Books, H. L. Pattinson, London.
16,018. Automatic Greasing Apparatus, R. L. and E. Dunford, and G. Emens, London.
16,019. Buffers, W. L. Wise.—(*W. R. S. Jones, India.*)
16,020. Driving Churns, C. G. P. de Laval, London.
16,021. Photographic Apparatus, A. J. Boult.—(*L. de Torres, Spain.*)
16,022. Caustic Soda, &c., G. Eschellman and K. Markel, Liverpool.
16,023. Boxes, &c., W. Dickie and W. Inglis, Glasgow.
16,024. Hearing Trumpets, A. Young, Glasgow.
16,025. Self-feeding Apparatus, T. Gerrard and R. Milne, Glasgow.
16,026. Carriage Axles, C. A. Jeneen.—(*E. M. Earle, Jamaica.*)
16,027. Spades, &c., J. T. R. Fussel, London.
16,028. Sealing and Securing Articles, H. A. Pickering, London.
16,029. Producing Heat, &c., C. M. de Montgrand, London.
16,030. Supporting Nose-bags, &c., W. Lockwood, Sheffield.
16,031. Corking Bottles, &c., H. J. Haddan.—(*J. V. M. Ebrard, France.*)
16,032. Braces, &c., H. H. Lake.—(*T. O. Potter, United States.*)
16,033. Clasps, &c., H. H. Lake.—(*T. O. Potter, United States.*)
16,034. Capsule Machines, E. Segar, London.
16,035. Tools, H. H. Lake.—(*E. M. Parkhurst, United States.*)
16,036. Delivery of Letters, &c., H. H. Lake.—(*S. May, United States.*)

8th December, 1886.

16,037. Machinery for Estimating Weights, T. C. Bell, Newcastle-on-Tyne.
16,038. Casting Metals, R. M. Deeley, Derby.
16,039. Treating Sewage, W. H. Hartland, Glasgow.
16,040. Slide-rest, J. Newton, Longport.
16,041. Gas Stoves, T. Wrigley, T. Pickup, and G. Proctor, London.
16,042. Runners, &c., of Umbrellas, &c., W. H. Richards, Birmingham.
16,043. Lubricators, D. Nowell.—(*W. Y. Thomas, United States.*)
16,044. Floating Apparatus for Discharging Ships' Cargoes, W. Goodwin, Liverpool.
16,045. Last Stand, A. Pemberton and G. N. Brearley, Bradford.
16,046. Axle-boxes for Wheeled Vehicles, D. France, Manchester.
16,047. Hardening Steel Wire, &c., G. Ashworth and E. Ashworth, Manchester.
16,048. Straining Gas Tar, &c., A. Thomas, West Cowes.
16,049. Galvanic Batteries, S. F. Walker, Cardiff.
16,050. Dynamo-electric Machines, S. F. Walker, Cardiff.
16,051. Injectors, W. Johnson, Birmingham.
16,052. Rail Jointing of Permanent Way of Railways, &c., W. L. Meredith, Gloucester.
16,053. Producing Combustible Gases from Liquid Hydrocabons, B. H. Thwaite, Liverpool.
16,054. Pitch Chains and Pulleys, W. Woollason, Lincoln.
16,055. Regulating the Temperature of Enclosed Spaces, O. G. Ladelle, London.
16,056. Regulating the Temperature of Enclosed Spaces, O. G. Ladelle, London.
16,057. Regulating the Temperature of Enclosed Spaces, O. G. Ladelle, London.
16,058. Combination Instrument for Draughtsmen, J. Lockie, Glasgow.
16,059. Spinning and Doubling Cotton, W. Hasselby, Manchester.
16,060. Bicycle Handles, R. U. Martyn and G. Jewell, Clynton.
16,061. Stripping Comb, R. S. Collinge, Manchester.
16,062. Motion for Whipping or Edgeing Machines, J. Riley and J. Elam, Leeds.
16,063. Cleansing, &c., Tobacco Pipes, G. R. Adams, Dundee.
16,064. Bicycles, &c., S. Vale, Walsall.
16,065. Cleaning Metal Plates, &c., R. B. Thomas, London.
16,066. Treating Wool, &c., A. Morel, Liverpool.
16,067. Circulation of Water in Steam Boilers, A. A. Rickaby, London.
16,068. Type-writing Machines, M. Hearn, London.
16,069. Stern Wheel Steamers, J. McGregor, London.
16,070. Cruet or Castor for Table Salt, A. Berkeley, London.
16,071. Joint for Earthenware Sanitary Pipes, W. Meats, London.
16,072. Metal Lids for Jugs, Tea-pots, &c., W. Storer, London.
16,073. Pirn or Cop Winding Machines, G. Young, London.
16,074. Lamps for Bicycles, &c., H. Salsbury, London.
16,075. Receptacles for Holding Matches, S. A. Grant, London.
16,076. Crinolette, F. O. Badcock, London.
16,077. Trousers Stretcher, W. Wall, Bradford.
16,078. Treating the Bark of Rhea, &c., Plants, E. Casper, London.
16,079. Lighters for Pipes, &c., C. R. E. Bell, London.
16,080. Steam Traps, J. H. Galloway and J. W. Galloway, London.
16,081. Back Forks for Bicycles, &c., T., F., and E., Warwick, London.
16,082. Mouths of Bags, &c., D. A. B. Murray.—(*T. Cleary, New York.*)
16,083. Combined Mitre Cutter, &c., W. Sanday, London.
16,084. Submarine Mines, D. Campbell and G. L. Schultz, London.
16,085. Armatures for Dynamo-electric Machines, E. Jones, London.
16,086. Apparatus used in Foundries, J. Butler and J. Evans, Manchester.
16,087. Musical Boxes, J. Y. Johnson.—(*A. L'Epée and L. E. J. Thibouville France.*)
16,088. Extinguishing Fires, H. W. Langbeck and O. Damm, London.
16,089. Signalling by Sound, H. W. Langbeck and O. Damm, London.
16,090. New Dynamo-metric Expansion Gear, G. Downing.—(*J. L. E. Landelle, France.*)
16,091. Coffee Pots, Countess I. S. Aspang, London.
16,092. Letters, &c., for Facias, &c., A. M. Clark.—(*J. Dodon, France.*)
16,093. Fluid Motor, J. G. Haller, I. Magnus, and F. M. Rogers, London.
16,094. Guides for the Cords of Venetian Blinds, &c., H. Heal, London.
16,095. Hair Brushes, J. T. Long, St. Barnabas.
16,096. Superseding the Crayon for Drawing Patterns, G. C. Crabbe, Exeter.
16,097. Candleholders for Candelabras, L. Blumfeld.—(*C. Erhard, Germany.*)
16,098. Leg Guards, W. Sykes, Horbury.
16,099. Oil Lamps for Railway Carriages, J. Roots, Crofton.
16,100. Wire Brushes, G. F. Rigby, Sheffield.
16,101. Letting-off Motions in Looms, J. Pinder, Bradford.
16,102. Tripod Stands, J. E. Thornton, Moss Side.
16,103. Safety Edge for Driving Belts, J. Taylor, Manchester.
16,104. Bracket and Stand for Displaying Boots, &c., F. McIlvenna and W. J. Smart, Manchester.
16,105. Vortex Outlet Ventilator, J. Craig, Maryport.
16,106. Sanitary Carts, R. W. Tayler and L. L. Simpson, Bury St. Edmunds.
16,107. Extinguishing Mineral Oil Lamps by an Automatic Arrangement, W. Dale, Kilburn.
16,108. Seamless Rubber for Condenser Machines, W. and J. Terry and F. Rawnsley, Halifax.
16,109. Electric Miners' Safety Lamps, S. F. Walker, Cardiff.
16,110. Operating the Rising and Falling of Shuttle Boxes, F. Leeming, Halifax.
16,111. Protecting Bobbin Heads, W. Rishworth, Bradford.
16,112. Primary Electric Batteries, J. C. Lemmens and H. G. Cottrell, Liverpool.
16,113. Boilers for Treating Wood, &c., J. M. Walton, Manchester.
16,114. Shuttle Guard for Looms, S. Shore and W. May, Manchester.
16,115. Dividing Dough to Form Loaves, G. Johnston, Glasgow.
16,116. Testing Screw Bolts and Nuts, A. Murray, Glasgow.
16,117. Universal Swivel Non-exhaust Rotary Engine, J. S. Wood, Northumberland.
16,118. Production of Sulphide of Zinc, &c., H. Kenyon, Manchester.
16,119. Tool-chest, &c., Locks, C. Corbett, Wednesfield.
16,120. Chains, &c., A. J. Gasking, Birmingham.
16,121. Driving Belts, G. H. Smith and B. Cooper, London.
16,122. Swivels, J. F. and A. C. Goode Birmingham.
16,123. Pumping Engines, R. C. Sayer, Newport.
16,124. Dog Biscuits, R. Glover, Essex.
16,125. Tramcars, &c., R. Glover, Essex.
16,126. Watches, &c., F. B. von Wechmar, Birmingham.
16,127. Steam Boilers, W. Robertson, Dublin.
16,128. Converting Old Steel Rails into Metallic Sleepers, E. D. Pass.—(*La Société Anonyme des Mines de Fer de l'Anjou et des Forges de Saint Nazaire, France.*)
16,129. Wearing Cylinders Equally Round, &c., J. Thom, Annan.
16,130. India-rubber, G. Walker, London.
16,131. Rotary Apparatus, &c., G. D. P. Rawlings, London.
16,132. Flax-spinning Machinery, A. B. Wilson, Belfast.
16,133. Instantaneous Pipe Connection, E. J. Rossiter, Bradford.
16,134. Ring Trimmings, C. Seel, Barmen.
16,135. Pumping Engines, E. Kaselowsky, London.
16,136. Safety Mechanism, E. Kaselowsky, London.
16,137. Woven Fabrics, S. O'Neill, Manchester.
16,138. Hammerless, &c., Guns, W. Anson, London.
16,139. Breech loading Small Arms, J. D. Dougall, London.
16,140. Velocipedes, A. Easthope, London.
16,141. Portable Electric Call Alarm, J. R. and H. F. Tozeland, London.
16,142. Making Oil Gas, F. B. Fowler, London.
16,143. Oil Lamp, J. G. Henrich, London.
16,144. Lamp-glass Cleaner, R. Chidley, London.
16,145. Electric Railway Systems, M. H. Smith, London.
16,146. Barrel Musical Instruments, C. D. Imhof.—(*D. Imhof, Germany.*)

16,147. Automatic Brake Apparatus, E. Kaselowsky, London.
16,148. Launching Torpedoes, E. Kaselowsky, London.
16,149. Forging Conoidal Projectiles, &c., C. Fairbairn and M. Wells, London.
16,150. Stretcher for Trousers, C. G. Terry.—(*W. A. and H. S. Rollins, United States.*)
16,151. Primary Voltaic Batteries, W. Webster, London.
16,152. Improved Air Engine, J. Dodd, and E. and H. N. Ratcliffe, London.
16,153. Knitted Stockings, &c., A. P. Sheffield, A. W. Wills, and H. Earp, London.
16,154. Bedsteads, E. A. Bingemann, London.
16,155. Grabs, &c., W. Matthews, C. Cornes, and W. Pitt, London.
16,156. Novel Arrangement of Repeating Guns, H. A. Silver and W. Fletcher, London.
16,157. Construction of Switch, A. Slatter, London.
16,158. Candle Holders, H. Dalgety, London.

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16,159. Delivering Cigars, &r., E. G. Colton and J. Freeman, London.
16,160. Dropping Torpedoes from Torpedo Boats, &c., G. B. Rennie, London.
16,161. Ppinting from Zinc Plates, T. R. Johnston, Murrayfield.
16,162. Triple Expansion Engines, H. J. H. King, Newmarket.
16,163. Alarm Signal, &c., W. Burgess, Worcestershire.
16,164. Ink Pads, H. Baumgarten, Liverpool.
16,165. Accurate Tri-section of an Arc, &c., I. J. Murphy, Belfast.
16,166. Perambulators, J. Lloyd, Birmingham.
16,167. Clothes-pins, J. Johnson, Blyth.
16,168. Issuing Tickets, &c., W. Minto, Stockton-on-Tees.
16,169. Corrugated Iron Buckets, &c., A. H. Walker, Dudley.
16,170. Fastenings for Gloves, &c., G. R. Stokes, Hanley.
16,171. Planing Wood, S. S. Hazeland, Cornwall.
16,172. Copying Writings, &c., W. Gibbs, Halifax.
16,173. Knitting Machines, J. W. Kiddier, Nottingham.
16,174. Toothed Wheels, G. Dixon, Ramsbottom.
16,175. Forming Undulated, &c., Edges in Quilts, J. Kippax, Bolton.
16,176. Packing Rings, J. V. Taylor, Manchester.
16,177. Wind Motor, J. Griffiths, Wrexham.
16,178. Ship's Davit Stand, Boat Stand and Davit Combined, G. Cowley and M. Hunter, Bishopwearmouth.
16,179. Toy Teething Pad, G. W. Herbert, Birmingham.
16,180. Cylinder Drying Machines, E. Smith, Yorkshire.
16,181. Hat Boxes, H. H. and A. Turner, and W. H. Blackwell, Lancashire.
16,182. Surface Scrubbing, &c., T. Cockcroft, Liverpool.
16,183. Cleaning the Interior Surfaces of Hollow Cylindrical Shaped Articles, T. Cockcroft, Liverpool.
16,184. Umbrella Stand, R. A. Holmes, Leeds.
16,185. Gas Fittings, M. Bibbero, Birmingham.
16,186. Gas Engines, &c., R. Kershaw, London.
16,187. Roundabouts, W. Reynolds, jun., and C. T. King, London.
16,188. Hatching Apparatus, E. Witt, London.
16,189. Economic Gas, &c., Stove, J. Lowe, London.
16,190. Ropes, &c., T. C. Barraclough.—(*B. Arnold, United States.*)
16,191. Bicycles, F. Weck, London.
16,192. Bicycles, J. R. C. Taunton, London.
16,193. Automatic Candle Shade Holders, F. Trier, London.
16,194. Coating Printed, &c., Paper with Films, G. Rydil, London.
16,195. Bicycle, J. Green, London.
16,196. Firing Blasting Charges, J. Lauer, London.
16,197. Sand Moulding Machines, A. Rice, London.
16,198. Suspenders, G. R. McDonald, Peckham.
16,199. Egg-turner, T. Brown, London.
16,200. Dynamo-electric Generators, F. C. Phillips and H. E. Harrison, London.
16,201. Distribution of Electric Energy, R. Dick and R. Kennedy, Glasgow.
16,202. Ships' Logs, G. W. Heath, Middlesex.
16,203. Improvements in Lamps for Burning Hydrocarbon Oils, &c., G. Furnace, London.
16,204. Hydraulic Lifts, T. Meacock, Middlesex.
16,205. Hydraulic Lifts, T. Meacock, Middlesex.
16,206. Braces, O. Bannier and C. Würtz, Hamburg.
16,207. Device Applied to Camera "Backs," L. J. Gautier, London.
16,208. Artificial Hands, J. B. Bowes, Ontario.
16,209. Apparatus for Regulating Electric Lamps, J. D. F. Andrews, London.
16 210. Transmitting Electrical Currents, &c., J. D. F. Andrews, London.
16,211. Regulating Electrical Currents, J. D. F. Andrews, London.
16,212. Wagon and other Wheels, R. W. B. Creeke, London.
16,213. Window Sashes and Frames, W. Murray, London.
16,214. Breech-loading Sporting Fire-arms, E. Harrison, London.
16,215. Galvanic Batteries, Sir W. Vavasour, Bart., London.
16,216. Pianos, &c., P. A. Newton.—(*J. Hardman and L. Peck, United States.*)
16,217. Taps, &c., A. T. Clarkson, London.
16,218. Knitting Machines, A. J. Boult.—(*P. Bevernage-Standring, Belgium.*)
16,219. Stopping, &c., Machinery, H. H. Lake.—(*H. P. Feister, United States.*)
16,220. Lubricator, H. Seck, London.
16,221. Pencil and Ink Eraser, F. M. B. Bertram, London.
16,222. Fire-lighters, H. B. and W. O. Wedlake, London.
16,223. Buffers, H. O. Fisher, London.
16,224. Coating Metals with other Metals, E. Morewood, Llanelly.

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16,225. Hinges for Step Ladders, &c., A. Edmondson, J. B. Moorhouse, and T. A. Procter, Skipton-in-Craven.
16,226. Smoke Liberator or Conductor, J. Gowland, Ogleforth.
16,227. Smoke Consumer, F. J. Browne, London.
16,228. Lawn Tennis Court Marker, F. J. Browne, London.
16,229. Ornamenting Glass, E. Lee, Leeds.
16,230. Grain Elevators, W. G. Herbert, Liverpool.
16 231. Operating Parts of Screwing Machines, &c., F. Hanson, Halifax.
16,232. Tension Check Springs, F. W. Lamsdale.—(*T. H. Hicks and M. L. Rossvally, United States.*)
16,233. Belcher and other Bracelets, &c., J. Baker, Birmingham.
16,234. Ventilating Fans, W. Matthews and J. Yates, Manchester.
16,235. Stoppers for Cans and Bottles, H. G. Hellier, London.
16,236. Wax Rods for Weaving, W. Parkinson, Manchester.
16,237. Solitaires, &c., G. F. Spittle, Birmingham.
16,238. Horseshoes, S. J. White, London.
16,239. Butter Churns, R. and T. Stockdale, Halifax.
16,240. Boxes for Vice Screws, S. Davies, Llyswen, R.S.O.
16,241. Spool, J. Jepson and S. Wilkinson, Halifax.
16,242. Rock Drills, C. W. Thompson, Surrey.
16,243. Moulds for Jars, J. Denison, Armley.
16.244. Purification of Sewage, &c., T. B. Wilson, Manchester.
16,245. Looms, G. Morton, Glasgow.
16,246. Tramcar Displacer, J. Chadderton, Lancashire.
16,247. Preventing Laps in Scutching Machines, J. B. Black, Ballymena.
16,248. Clasp for Albums, H. Lehmann, Berlin.
16,249. Valve-gear, D. W. Porteous, Paisley.
16,250. Mules for Spinning, H. Ashworth, London.
16,251. Cleaning Rails of Tramways, A. Dickinson, Birmingham.
16 252. Crank Arms, J. Conlong, London.
16,253. Metal Buttons, E. Hilton.—(*E. Hilton*, ———.)
16,254. Looms, &c., J. Clegg, Manchester.
16,255. Lamp Bracket, C. Church, London.
16,256. Dress Fastenings, T. Parker, Newcastle-on-Tyne.
16,257. Primary Balancing Electric Battery, L. Héndlé and J. N. Moerath, London.
16,258. Aromatic Diamines, &c., W. P. Thompson.—(*Ewer and Pick, Germany.*)
16,259. Shuttle Guards for Looms, A. Hunerwadel, London.
16,260. Desk for Reporters, D. Williamson, London.
16,261. Diaphragm Shutters, J. M. Elliott, Glasgow.
16,262. Steam Engines, J. T. Marshall, London.
16,263. Heating Apparatus, W. R. Dennis, London.
16,264. Raising, &c., Fluids, J. C. Stephenson, J. Marshall, and M. F. W. Bristed, London.
16,265. Supplying Perfume by means of a Coin, E. G. Colton, Hendon.
12,266. Packing Cases, &c., T. W. Duffy and W. J. Cousins, London.
12,267. Checking Workmen's Time, L. E. Scafe, London.
12,268. Blowing and Moulding Glass, &c., J. Armstrong, London.
16,269. Steam Boilers, M. M. Jackson, London.
16,270. Clear Ice, C. D. Abel.—(*C. Linde, Germany.*)
16,271. Boilers, C. J. Copeland and S. F. Prest, London.
16,272. Pipe Joints, A. Ramsden, London.
16,273. Dynamo-electric Machinery, E. Desroziers, London.
16,274. Regenerative Furnaces for Melting Iron, &c., T. Lockerbie, London.
16,275. Bottles for Aerated Liquids, H. Codd, London.
16,276. Breaking, &c., Flax, &c., F. G. Lange, London.
16,277. Centrifugal Apparatus, E. Seger, London.
16,278. Mezzotint Engraving, G. H. Bolland and M. H. P. R. Sankey, London.
16,279. Uncoupling Railway Vehicles, &c., E. J. Hill, London.
16,280. Heat Radiators, J. Russell and J. S. Rosser, London

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16,281. Valve Motions of Rock Drills, D. Donald, Penryn.
16,282. Centrifugal Cream Separators, W. Horner, Liverpool.
16,283. Ball and Socket Rowlocks for Boats, D. W. C. Piggott, London.
16,284. Figured Fabrics, &c., T. Taylor and J. Warburton, Manchester.
16,285. Lamp Reflectors, F. W. Hayward, Norwich.
16,286. Foundry Ladles, J. Craven and W. Chapman, Leeds.
16,287. Vacuum Boxes, W. McDougall and J. Mossman, Glasgow.
16,288. Sewing Machines, T. Shakespear, Birmingham.
16,289. Contracting Slit Socket Connecting Joint for Pipes, &c., J. Reid, Birmingham.
16,290. Condensing, &c., Gases, J. B. Hannay, Glasgow.
16,291. Shedding Machines of Looms for Weaving, J. Butterfield, Halifax.
16,292. Root Cutters, &c., W. Corbett, Birmingham.
16,293. Securing and Ornamenting Parquetry, I. Ickringill, Bradford.
16,294. Window Sash Fastener, H. T. Bassett, Wolverhampton.
16,295. Spinning Jute, &c., A. McCulloch, Dundee.
16,296. Wrought Iron or Steel Boxes for Axletrees, J. G. Harrison, Birmingham.
16,297. Hook for Dressers, &c., E. W. Cleversley, London.
16,298. Securing Rails in Railway Chairs, J. A. Wilson, Sheffield.
16,299. Railway Trucks for Supporting Tarpaulins, J. Little, London.
16,300. Thumb Pieces, &c., for Wicket Keeping Gauntlets, E. Brice, Woodstock.
16,301. Sweeping Roads, &c., J. Boag, Glasgow.
16,302. Boot and Shoe Fastener, H. W. Huckvale, Over Norton.
16,303. Trundling Hoops, H. Westman, Birmingham.
16,304. Plough Harness, J. MacKenzie, Cork.
16,305. Rack Pulley, W. J. Oakes, Aston.
16,306. Electro-magnetic, &c., Motors and Dynamos, G. A. Adams, Liverpool.
16,307. Meat-chopping Machines, W. Scheffel, Berlin.
16,308. Locks, W. Machin and J. Whitehouse, Birmingham.
16,309. Pocket Cigar-cutter, J. D. Carter, London.
16,310. Tobacco Pipes, &c., J. Bennett, London.
16,311. Reed Organs, H. W. Metcalf, Worcester, Mass., U.S.
16,312. Joiner's Adjustable Bench Stop, W. Illingworth, London.
16,313. Railway, &c., Couplings, J. H. Betteley, London.
16,314. Checking Distance Ridden, &c., J. H. Betteley, London.
16,315. Metal Handles, W. H. Bulpitt, Birmingham.
16,316. Wheels, A. Dickinson, Birmingham.
16,317. Gas Bracket Attachment, F. Holroyd, Halifax.
16,318. Apparatus for Advertising Purposes, W. Goode and G. W. Brewitt, London.
16,319. Economical Candle-stick, G. Lynn, Kingston-on-Thames.
16,320. Preservation of Fish, &c., F. Edwards, London.
16,321. Patent Adjusting Skewer, E. L. Stacey, London.
16,322. Valve Gear, C. W. Pinkney, London.
16,323. Metallic Rims, &c., of the Wheels of Bicycles, &c., T., F., and E. Warwick, London.
16,324. Starting the Action of Syphons, &c., W. and W. H. Cowan, Edinburgh.
16,325. Metal Boxes, J. A. Lloyd, London.
16,326. Distribution of Electric Energy, R. Dick and R. Kennedy, Glasgow.
16,327. Photography, J. Urie, sen., and J. Urie, jun., Glasgow.
16,328. Billiard Tables, W. Buttery, London.
16,329. Automatic Air Tester, P. Pfleiderer.—(*A. Wolpert, Germany.*)
16,330. Tobacco Pipes, J. J. and J. V. Müllenbach, W. J. and C. J. Thewald, London.
16,331. Suspenders, &c., A. J. C. Graf, London.
16,332. Hat Pegs, T. Everitt, London.
16,333. Velocipedes, J. E. Holloway, London.
16,334. Pressure Gauges, G. Brewer.—(*U. A. Chauveau and J. G. Jourdan, France.*)
16,335. Uniting the Ends of Bands, G. O. Wray, Bedford.
16,336. Drain Pipes, R. Shouler, London.
16 337. Repairing Shafts, P. Ginet and A. Emmanuel, London.
16,338. Lamps, C. Crastin and W. Beale, London.
16,339. Mattresses for Couches, &c., G. F. Redfern.—(*P. Rostagnat and A. Rey, France.*)
16,340. Securing Spokes to Rims of Velocipedes, W. Bown, London.
16 341. Leather Splitting Machines, H. H. Lake.—(*E. F. Bradford, United States.*)
16,342. Nut Fasteners, J. A. Wiedersheim, London.
16,343. Playing an Improved Game, O. Dietrich, London.
16 344. Tennis Bats, J. Malings and W. Muckle, London.
16,345. Rotary Gas Engine, C. D. Alexander, London.
16,346. Road-sweeping Machines, W. T. Carter and J. Keeble, London.
16,347. Loading of Coals, &c., F. W. Walker, Leeds.

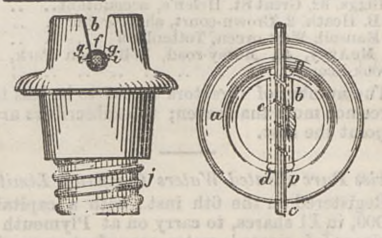
SELECTED AMERICAN PATENTS.

(*From the United States' Patent Office official Gazette.*)

349,022. Telegraph Wire and Insulator Fastening, *Jno. Wilson, New York, N.Y.—Filed December 26th*, 1885.

Claim.—(1) The combination, with the insulator having the transverse groove *b*, angular projections *g* of the side walls, and the wider bottom portion, *d*, of said groove, and with the telegraph wire laid in said groove, of a fastener coiled around the wire in the groove and forming chocks against said projections,

349,022.

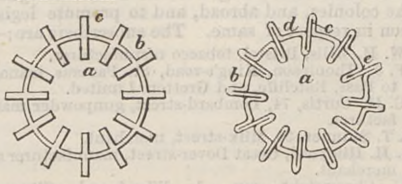


substantially as described. (2) The combination, with the insulator having the transverse groove *b*, angular projections of the side walls, and the wider bottom portion of said groove, and with the telegraph wire laid in said groove, of a fastener coiled around the wire in the groove and forming chocks against said projections, said fastener having stops at the ends against the sides of the insulator, substantially as described.

349,060. Boiler Tubes, *Jean P. Serve, Givors, France.—Filed February 6th*, 1886.

Claim.—(1) The tube herein described for boilers and condensers, having solid and massive wings upon its surface or surfaces, as distinguished from a tube having a wavy, corrugated, undulated profile in transverse section, substantially as herein set forth. (2) The tube herein described for boilers and condensers, having its metal folded closely upon itself to form solid and massive wings upon its surface or surfaces,

349,060.

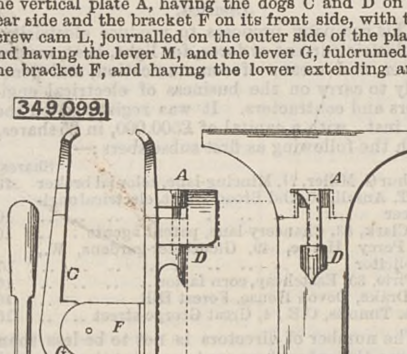


substantially as herein set forth. (3) The tube herein described for boilers and condensers, having its metal folded upon itself to form wings upon one surface, and having strips or pieces *f* inserted within such folds and projecting beyond the other surface, whereby are produced solid and massive wings projecting from both surfaces of the tube, substantially as herein described.

349,099. Bench Clamp, *S. G. Hosack, East Saginaw.—Filed June 15th*, 1886.

Claim.—(1) The combination, in a bench clamp, of the vertical plate A, having the dogs C and D on its rear side and the bracket F on its front side, with the screw cam L, journalled on the outer side of the plate, and having the lever M, and the lever G, fulcrumed to the bracket F, and having the lower extending arm

349,099.



H, engaging the screw cam, and the upwardly extending clamping arm G1, for the purpose set forth, substantially as described. (2) A bench clamp provided with the vertical slot B, and having the dog D on its rear side, in combination with the vertically movable dog C, having the headed shank secured in the slot B, and the excentric cam-bearing under the headed shank, for the purpose set forth, substantially as described.

349,123. Hoisting Machine, *William Roth, New York, N.Y.—Filed March 29th*, 1886.

Claim.—(1) The unequal armed lever M and means,

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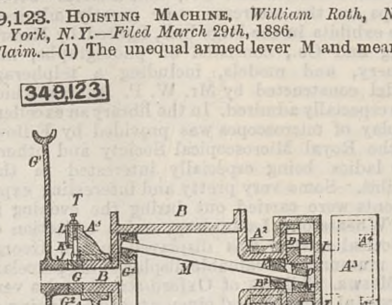
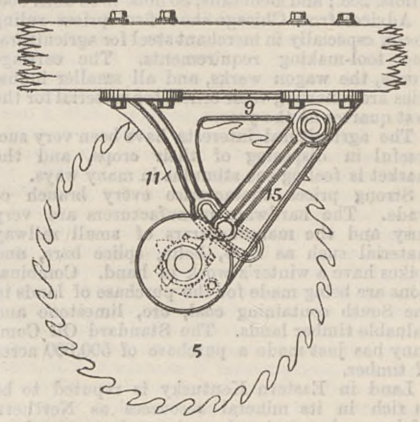


as the operating shaft G and wheel G^2, for gyrating the longer end, in combination with the wheel D, operated by the shorter end and with the internally geared wheel B^3, and the windlass B, and the chain C, arranged for joint operation, substantially as herein specified. (2) The gyrating spur-wheel D, having the projections D^1 and means for operating it, in combination with the casing A^3, internal projections A^4, yoke F, rollers I, and the internal gear B^3, and mechanism, as B C, operated thereby, arranged for joint operation, as herein specified. (3) The unequal armed lever M, shaft G, and wheel G^2, for gyrating the longer end and the cylindrical bearings of said shaft, balls O and inclosing boxes P, in combination with the wheel D, operated by the shorter end, and with the internally geared wheel B^3, windlass B, and chain C, all arranged for joint operation, as herein specified. (4) The lever M and universal joints therefor, the gyrating wheel D, internal gear B^3, and connected mechanism, as B C, in combination with the shifting pawl J, slide K, spring L, and housing or supporting frame A^5 and with the wheel G^3 on the operating shaft G, and wheels G^1 G^2, all arranged for joint operation, substantially as herein specified.

349,356. Circular Saw Mill, *William F. Parish, Minneapolis, Minn.—Filed May 3rd*, 1886.

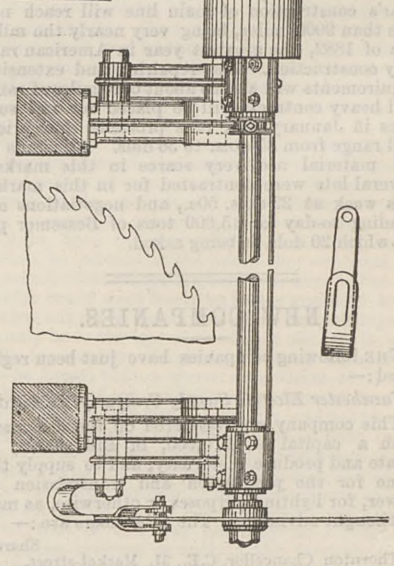
Claim.—(1) The combination, with a circular saw, of an independent swinging overhead frame, a top saw mounted on said swinging frame, and a depending arm or hanger, to which said swinging frame is adjustably secured at a point between its pivot and the saw arbour, substantially as described. (2) The

349,356



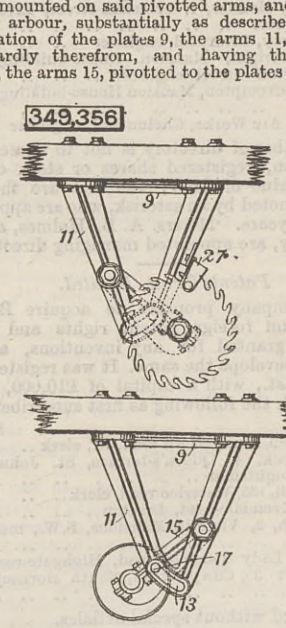
combination, in a circular saw mill, of the overhead swinging frame with the top saw mounted thereon, the independent slotted arms 11, and the bolts adjustably securing said swinging frame to said depending arms, all substantially as described. (3) The combination, in a circular saw mill, of the plates 9, the depending arms projecting at an angle therefrom and

349,356



provided with the slots 13, the pivotted arms 15, having the bolts 17 passing through the slots 13, the arbour mounted on said pivotted arms, and the saw 5 on said arbour, substantially as described. (4) The combination of the plates 9, the arms 11, projecting downwardly therefrom, and having the slots 13 therein, the arms 15, pivotted to the plates 9, the bolts

349,356



17, passing through said slots 13, the arbour, and saw, all substantially as described. (5) The combination, with the top saw, mounted on the pivotted arms 15, of the curved bar 27, adjustably secured upon the pivot bolt 16, and having the forked end with bearing blocks 29 upon the opposite sides of the saw, substantially as described.