THE DRAINAGE OF FENS AND LOW LANDS BY STEAM POWER.

By W. H. WHEELER, M. INST. C.E.

No. VII.[1]

THE ARCHIMEDIAN SCREW PUMP.

THESE pumps, although frequently used for lifting water from drains for the purpose of cleaning them out, and other similar purposes, have seldom been applied in this country for the permanent drainage of land. They derive their name from Archimedes, the Syracusan, who lived 287 B.C., and invented this machine, during his stay in Egypt, for draining and irrigating land. They were subsequently used by the Romans. The Dutch have used them very extensively in Holland for raising water for the drainage of the Polders.

The screw pump consists of three parts. A solid cylinder in the centre, called the core, to which is attached one or more spiral screws, and sometimes an external case. The number of screws running round the core varies from one in the simplest machine, to three or four in those of larger character. The ends of the core terminate in gudgeons which revolve in bearings, the lower one fixed under the water, and the upper on a beam spanning the delivery opening. As the efficiency of this machine is not affected by the speed at which it runs, it is suitable for being driven by steam, wind, or hand power. In small pumps a crank handle is attached to the upper part of the core, and on this a pole with an eye through the centre, bushed with metal, is attached, the pole having cross handles at each end. One man works at the handle on the core, and one or more at each of the handles on the pole. It is reckoned that one man can raise in an hour at the rate of 1738 cubic feet of water 1ft. high, the pump making 40 revolutions a minute. If worked by machinery, the pump is driven by a spur wheel at the top geared into a bevel wheel and shaft.

The water level on the inlet side may vary without affecting the efficiency of the pump, except so far as the increased weight is concerned, due to the greater length required to meet the variation. But any change in the level on the delivery side immediately affects the efficiency. These pumps are not therefore adapted for use where there is much change in the level of the water into which they discharge. The angle which the pump forms with the horizon when fixed varies according to the ideas of different constructors, but generally it may be taken that the most efficient position for the pump is when the angle of tilt is rather less than the spiral angle. Thus, for a machine having a spiral angle of 40 deg. the angle of tilt for the pump should be 30 deg. The spiral angle is the form which the screw assumes with reference to the core, and is the angle made by a tangent drawn to the spiral on the cylindrical core, and a vertical line parallel to the axis of the cylinder. This angle varies from 30 deg. to 60 deg. The Romans usually made it 45 deg. In the most effective machines it varies between 30 deg. and 40 deg.

The discharging power of these pumps varies so much with the different circumstances under which they are worked, depending on the number of threads, the angle at which they are placed, the angle at which the pump works, and other matters, that it is difficult to give any precise formula for the quantity discharged. Upon pumps working under nearly similar conditions the discharge is as the cube of the diameter, and approximately it may be taken that, under favourable conditions, a pump 1ft. in diameter will discharge 0·32 cubic feet of water for every revolution. The number of revolutions varies according to the kind of power applied and the size of the pump. Small pumps of about 1ft. in diameter may be run at sixty revolutions a minute, the larger not reaching more than twenty. For drainage purposes it may be taken that these pumps can be run at from twenty to forty revolutions a minute. They have been used in Holland to lift the water 15ft. Mr. Korevaer, a Dutch engineer, who has investigated the matter, places the limit of height at 14ft., and the limit of discharge at 3500 (98½ tons) cubic feet per minute. The ten screws erected at Katatbeh, in Egypt, discharged 137·5 tons a minute each, making five to six revolutions a minute. The screws were enclosed in iron cases, but were found unequal to the weight of water they had to carry, and were consequently removed. Where the amount of water to be lifted much exceeds the useful capacity of these pumps it is customary to couple several together, all worked by the same engine. The useful effect of these pumps is about the same as scoop wheels, and varies, according to construction, from 50 to 85 per cent. of the power applied.

The Dutch screw pumps are constructed to work without an external casing, the wheel revolving in a semi-cylindrical trough of masonry. The weight of the water is thus borne on the masonry, and the screw is relieved of the strain. An example of one of these pumps is given in Fig. 3A.

Mr. W. Airy, in a paper contributed to the "Transactions" of the Institution of Civil Engineers in 1871 (vol. xxxii.) gives the results of experiments carried out by him to test the relative merits of screw pumps of different construction. The results he arrived at were:—(1) That the smaller the spiral angle, *i.e.*, the quicker the spiral, the flatter must the machine be laid to the horizon to produce its best effect. (2) That in an equal number of revolutions the quicker spirals will lift much more water than the slower ones. (3) That there is a great difference in the effect of the machines according as one end or the other is upwards. The advantage is greatly in favour of the machine when placed so that the acute angle which the thread makes with the core is downwards. With regard to the number of threads, Mr. Airy is of opinion that every machine should have as many threads as the conditions of ordinary workmanship and convenience will allow. That for screws of any size, say 6ft. or 7ft. external diameter, the width of the chambers should not be less than 18in. on the square, and the diameter of the core one-third nearly of the external diameter. These conditions allow four threads for a screw, whose spiral angle varies between 20 deg. and 30 deg.; three threads between 40 deg. and 50 deg.; two threads for 60 deg. The threads of the screws of the pumps upon which he experimented, and which he considered was the proper form to use, were made developable, by which term he meant a curved surface that would be unwrapped, laid flat, and inside a plane. The surface of the spiral thread, as ordinarily used, lying at right angles to the surface of the core, and such that if laid out flat the external edges would have more surface than the inner. Screws developed from a flat plate hold more water than those having threads at right angles to the surface of the core, and are easier to construct. The effect of the internal frictional resistance with a pump 3ft. in diameter, 10ft. lift, and running at twenty revolutions a minute, he found to vary from 4½ to 8 per cent. of the useful effect realised. The gudgeons being 4in. diameter absorbed 12 per cent. of the power applied. The best machines give off a useful effect of 85 per cent. of the power applied. For the most economical machine he considered that the spiral angle should not be less than 30 deg. nor greater than 40 deg.; and that the limit of height at which these pumps can be worked advantageously is 10ft.

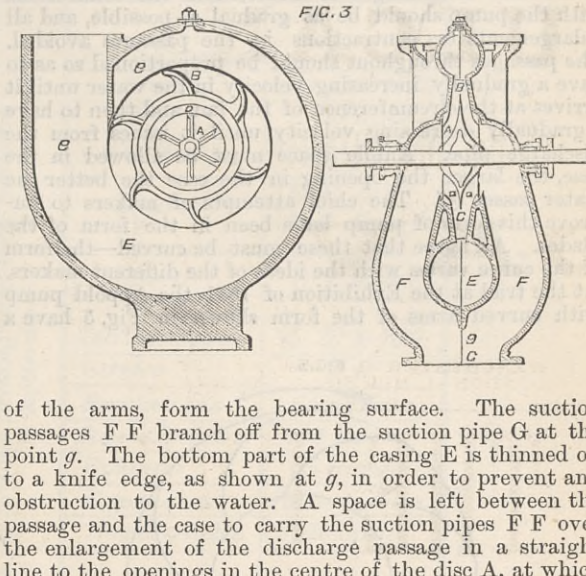
CENTRIFUGAL PUMP.

In giving the following description of the centrifugal pump, the subject has been confined, as far as practicable, to pumps with low lifts adapted for drainage purposes. Although the principle of the centrifugal pump was known more than one hundred years ago, and pumps of this description were made and used experimentally fifty years since, it was not until the great Exhibition of 1851 that they were brought into prominent notice. At the British Association meeting held at Birmingham in 1849, Mr. J. G. Appold exhibited a model of a centrifugal pump. By an exhaustive set of experiments, principally directed as to the best form for the fans, Mr. Appold gradually improved the discharging capacity, and was enabled to exhibit a pump at the Exhibition of 1851 which formed one of the chief features of interest, the public being astonished at the immense volume of water put in motion by a machine which appeared, both from its size and simplicity of form, to be quite inadequate to the result attained.

Practically the form of pump shown at the Exhibition is the pump of the present day, no material improvement having been since effected. Although the general principle on which the pump acts is simple, the determining of the proportion of the different parts, and of the effect of the shape of the fan, is extremely difficult, requiring complex calculations, the data for which are so scanty as to render them not to be relied on unless checked by actual experiment. There are two types of centrifugal pumps, one of the form exhibited by Mr. Appold at the Exhibition with horizontal spindle, the other of the turbine form with vertical spindle. The first type of pump is almost invariably fixed above the level of the water, and consists of an outer iron case of a circular form, in which revolves a disc with a certain number of blades attached on each side of it, generally six. The water enters at the centre, and is discharged at the circumference. The blades are cast on a centre boss, on which is keyed a steel spindle working through two stuffing-boxes cast on the case, the driving power being geared to this spindle. To the case are attached the suction and delivery pipes.

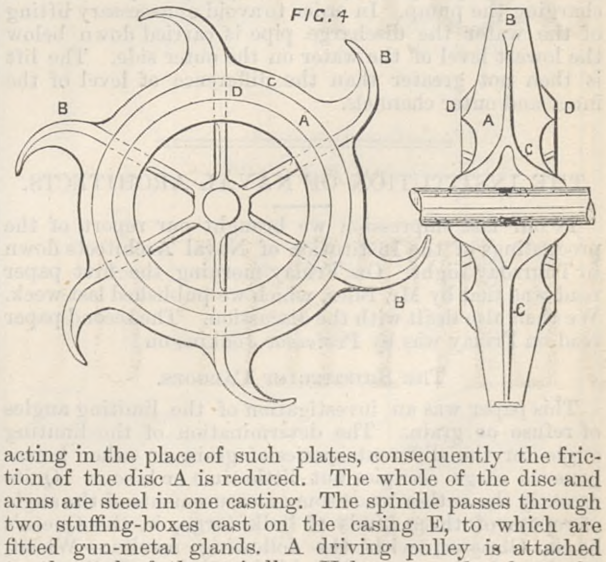
The following description of a centrifugal pump is taken from a paper read by Messrs. J. and H. Gwynne at the British Association meeting, held at Norwich in 1868, and partly from the patent specification of the pump patented by them in 1868. Fig. 3 shows front and side sectional elevation of this pump. The pump consists of an outer case E, with a disc or impeller A, having six arms or blades B cast on a centre boss. A centre plate C springs from the boss and gradually decreases in thickness to a knife edge, bringing the separate currents of water into each side of the disc without producing an eddy or reflux. The arms are radial for two-thirds of the length, and curve off towards the periphery in an opposite direction to the line of rotation, in order to direct the water into the sweep of the case and prevent it rushing against the outer side of the discharge passages. Two rings D—see also Fig. 4—one at each side

FIG. 3



of the arms, form the bearing surface. The suction passages F F branch off from the suction pipe G at the point *g*. The bottom part of the casing E is thinned off to a knife edge, as shown at *g*, in order to prevent any obstruction to the water. A space is left between the passage and the case to carry the suction pipes F F over the enlargement of the discharge passage in a straight line to the openings in the centre of the disc A, at which point they curve into the top of the openings. The discharge passage is sprung from the periphery of the disc in the form of a helix or volute, commencing at the top of the case E and gradually increasing till it reaches the full size of the discharge pipe E[1]. That part of the pump casing E which contains the impeller A is made of the same shape as the profile of the impeller, and similar in section and of just sufficient size to permit the impeller to revolve, the bearing rings D being accurately fitted to the turned recesses in the casing. By this means the usual side plates on the discs of centrifugal pumps are not required, the peculiar form of the pump casing

FIG. 4



acting in the place of such plates, consequently the friction of the disc A is reduced. The whole of the disc and arms are steel in one casting. The spindle passes through two stuffing-boxes cast on the casing E, to which are fitted gun-metal glands. A driving pulley is attached to the end of the spindle. Valves are placed at the bottom of the suction pipe to retain water when the pump is not at work. The area of the disc is equal to the area of the inlet and outlet pipes at all points. As these pumps, when working at their best speed, discharge every revolution three times the cubical contents of the disc, the discharge passages are three times the cubical capacity of the disc. By a simple arrangement the dis-

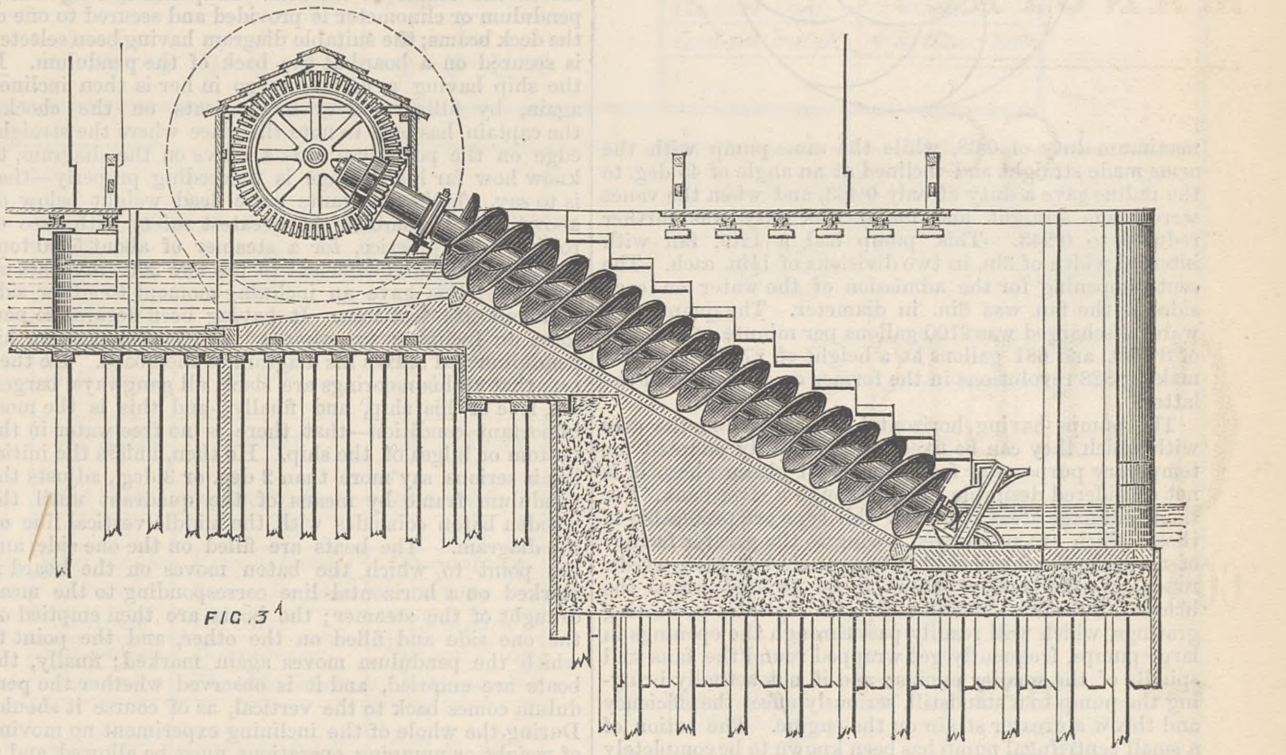


FIG. 3A

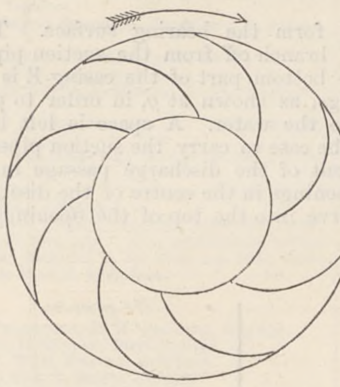
Fig. 3A—DUTCH SCREW PUMP FOR DRAINAGE WORK.

[1] For article No. VI., see THE ENGINEER, April 8th.

charge pipe from the pump is made to act as a condenser for the steam from the engines.

The points essential to a good pump, and common to all makers, are that the shape of the vanes should be such as to facilitate the movement of the water so that it should enter and leave without shock, and should therefore correspond as nearly as practicable with the path described by any fillet of it from the interior to the exterior of the fan. All changes of direction in the connections with the pump should be as gradual as possible, and all enlargements or contractions in the passages avoided. The passages throughout should be proportioned so as to have a gradually increasing velocity in the water until it arrives at the circumference of the fan, and then to have a gradually decreasing velocity until it issues from the discharge pipe. Ample space must be allowed in the case, the larger the opening in the case the better the water passes off. The chief attempts of makers to improve this form of pump have been in the form of the blades. All agree that these must be curved—the form of the curve varies with the ideas of the different makers. At the trial at the Exhibition of 1851 the Appold pump with curved arms of the form shown in Fig. 5 have a

FIG.5



maximum duty of 0·68, while the same pump with the arms made straight and inclined at an angle of 45 deg. to the radius gave a duty of only 0·463, and when the vanes were made straight and radial this duty was further reduced to 0·243. This pump had a 12in. fan with internal width of 3in. in two divisions of 1½in. each. The central opening for the admission of the water on each side of the fan was 6in. in diameter. The quantity of water discharged was 2100 gallons per minute at a height of 8·20ft., and 681 gallons at a height of 27·60ft., the fan making 828 revolutions in the former case, and 876 in the latter.

The pumps having horizontal spindles, from the ease with which they can be fixed, are eminently adapted for temporary purposes or for drainage in places where it is not considered desirable to cut through a river bank. For small drainage areas pumps of this type are preferable to those which are submerged, owing to the greater facility of access to the fan should it become choked with weeds, ropes, or other matter liable to be twisted round the blades. Substances which escape through the protecting gratings, which will readily pass through the openings in large pumps, frequently get wrapped round the fans and spindle of the smaller pumps; and if not actually bringing the pump to a standstill, seriously affect the efficiency and throw a greater strain on the engine. The action of a small centrifugal pump has been known to be completely stopped by eels which had become twisted round the spindle. To remove these impediments without taking the case to pieces a hand-hole is frequently left in the cover, and so fixed on with screws as to be readily removable. Pumps of this description require charging with water before they can be started. This can be done by a small donkey pump, or by exhausting the air by a steam jet. In the latter case the end of the outlet pipes is provided with a foot valve, which in all cases is necessary to prevent the back-flow water when pumping is stopped. In the former case a valve opening inwards is placed on the inlet, which has also a perforated rose bucket or rose at its termination to prevent, as far as possible, the entrance of foreign substances. In some of the drainage pumps a special air pump is provided for charging the pump. In order to avoid unnecessary lifting of the water the discharge pipe is carried down below the lowest level of the water on the outer side. The lift is then not greater than the difference of level of the inner and outer channels.

THE INSTITUTION OF NAVAL ARCHITECTS.

In our last impression we brought our report of the proceedings of the Institution of Naval Architects down to Thursday night. On Friday morning the first paper read was that by Mr. Biles, which we published last week. We then also dealt with the discussion. The second paper read on Friday was by Professor Jenkins on

The Shifting of Cargoes.

This paper was an investigation of the limiting angles of refuse or grain. The determination of the limiting angle for the different species of grain or other homogeneous cargo occupies but little time or labour. Quite recently the author made some measurements of the angle of repose of three kinds of bulk cargo, in the Queen's Dock, Glasgow, with the following results:—Wheat, 23¼ deg.; Indian corn, first kind, 26½ deg.; Indian corn, second kind, 28½ deg.; peas and beans mixed, 27½ deg. It will thus be seen that the angle of repose for grain cargoes is not greater than the angle many of H.M. ships of war have been found by careful observation to roll through, and hence on board such vessels grain having a free surface would shift from inclination alone. But probably steam vessels which have but little stability, when laden with cargoes such as the above, seldom roll through such large angles as would involve shifting, if shifting were governed by the inclination solely as in still water; and if this be so, the shifting that so frequently takes place must be due to some cause or causes that combine with the tendency which gravity creates to enable the surface particles to roll down hill before the inclination is reached which limits their motion when under the action of no forces but those which gravity and frictional resistance to motion supply. The author then proceeded to give an elaborate mathematical investigation of the effect of the motion of a ship on grain cargoes.

The discussion which followed was of little interest or importance. Mr. John said it was a paper of value, and that the behaviour of grain cargoes did no doubt justify the Board of Trade policy in the matter of shifting boards. Mr. Martell pointed out that since cargo steamers had been built of greater beam in proportion to their depth than was at one time customary, there had been a great reduction in the number of losses at sea. Shifting boards should extend from deck to kelson, because grain cargoes will shift bodily. It was a curious fact that large heavy bodies lying loose on a deck would in the course of a voyage work up through the grain, so as to be found lying on the top or under the upper deck beams when she came to be discharged. After a few remarks from other speakers, a paper was read by Mr. A. Denny on

The Practical Application of Stability Calculations.

It would be very difficult to make this paper intelligible without large diagrams. The gist of it is that Messrs. Denny supply to the owners of ships built by them a number of diagrams on which are marked numerous curves, these curves being calculated for each ship, as a result of inclination experiments made before the ship leaves the hands of the firm. A species of long heavy pendulum or clinometer is provided and secured to one of the deck beams; the suitable diagram having been selected is secured on a board at the back of the pendulum. If the ship having a certain cargo in her is then inclined again, by filling one or more boats on the chocks, the captain has only to note the place where the straight edge on the pendulum cuts a curve on the diagram, to know how far his stowage is proceeding properly—that is to say, whether he wants more dead weight below or above, so as to combine the greatest safety with ease of rolling. In practice, for a steamer of about 5000 tons gross, it was found sufficient to use two 30ft. lifeboats on each side; this gave an inclining moment to either side of about 224 foot-tons. It having been decided to perform an inclining experiment, the captain rigs up his pendulum and affixes his diagram to the board. He then sees that all his moorings are slack, all gangways, barges, &c., free of his ship, and finally—and this is the most important condition—that there is no free water in the bottom or bilges of the ship. He then, unless the initial list is serious, say more than 2 deg. or 3 deg., adjusts the pendulum frame by means of the quadrant until the wooden baton coincides with the middle vertical line on the diagram. The boats are filled on the one side, and the point to which the baton moves on the board is marked on a horizontal line corresponding to the mean draught of the steamer; the boats are then emptied on the one side and filled on the other, and the point to which the pendulum moves again marked; finally, the boats are emptied, and it is observed whether the pendulum comes back to the vertical, as of course it should. During the whole of the inclining experiment no moving of weight or pumping operations must be allowed, and if many people are on board they should be instructed to remain still and in the same place all the time. In one case cited, the steamer was fitted with water ballast, and it was found that 300 tons of this ballast could have been removed with safety. The captain, however, from reasons altogether apart from stability, preferred to retain the ballast; had it been otherwise, and the ballast been removed, a distinct gain in the economy of working the steamer would have resulted. This steamer, when inclined, had a metacentric height of 1·45ft., and has since completed her voyage to the colonies successfully.

Mr. Martell, in opening the discussion which followed, said that this system supplied a want which had been felt for years. Many ships were lost because of the ignorance of their captains as to the proper mode of stowage. It was true that curves of stability had been supplied to captains, but it was quite unfair to them to expect them to spare the time necessary to use them. Mr. Benjamin feared that the diagrams would prove just as troublesome and misleading as anything which had been used before. He thought a Taylor's clinometer would answer every purpose just as well. The next paper read was one of more importance, "On the Performance of some Recent High-Speed Screws," by Mr. Linnington. We give this paper in full on another page.

The discussion was opened by Mr. Blackmore, who stated that he had for years used twin-screws, one a little in advance of the other, and of such dimensions that the paths of the blades overlapped a little. Small screws worked well, however, because they got their water freely, being well away from the dead wood. The overlap helped steering, because the water was thrown better against the rudder. Mr. John said the twin-screw system was yet in its infancy, and data concerning it being wanted, Mr. Linnington's paper was specially valuable. As to pitch, he knew of a case where the pitch was as much as 1·5 times the diameter, and that was increased with great advantage in two small boats. He did not know why it was that a large pitch did better with twin-screws than with a single propeller. In the Iris, great as the success had been, he would like to see a screw of still greater pitch tried. Admiral De Horsey said that results obtained in calm water were no criterion of the results to be had in a heavy head sea. There must be something against them in this way which kept the mercantile marine from using them. Mr. Spyer held that each ship should have her propeller designed for her of the best diameter, pitch, and number of revolutions, and that the engines should then be designed to fit the propeller. In men-of-war the engine speeds were much greater than would be tolerated by shipowners, and consequently the twin system, demanding a small screw, it had a much better chance of success in the Navy than in the mercantile marine. The position of a screw had a great deal to do with its efficiency. In the case of H.M.S. Invincible, moving her screws further aft by a short distance had given her half a knot extra speed. It was a curious fact that there was a difference of nearly a knot an hour between the Nelson and the Northampton, although they were nearly alike in most respects. He knew of a case in which a 48ft. pinnace had her twin-screws shifted further aft only 7in. With 10 per cent. less horse-power, she then went 0·3 knot faster. Mr. Barnaby asked if, in designing a pair of screws to transmit, say, 8000-horse power, each screw would be made of the same size as a single screw intended to transmit 4000-horse power? The smaller the screw the quicker its pitch might be. Thus, in torpedo boats it was as much as 1·64 of the diameter. The plates of the hulls right over the twin-screws of ships were found to be pitted and corroded in a curious way. How was this explained? Was it that the screws drew down air, which attacked the plates?

Mr. Hill said that as managing owner of a line of very large steamers fitted with twin screws, they might like to hear something of his experience. The ships he alluded to were the Ludgate Hill, the Richmond Hill, and the Tower Hill. They were 4000-ton ships, of 2500-H.P. each, and they had been a great success. He had built two large tug boats, the Game Cock and the Storm Cock, and it was needless to say how high a reputation they had. He was glad to hear that the four great Atlantic liners just ordered would all have twin screws. As to the difficulty of coming in and going out of dock, about which much had been said, there was really nothing in it. It was forgotten that the twin screw ship was so handy that she did not run the same risk as the single screw. As to making screws overlap and cutting a hole in the dead wood, it was quite unnecessary, and only weakened the stern frame. He found no disadvantage in running the propeller close to the dead wood. The tops of the blades in his boats only cleared it by a few inches. He had tried the experiment in the Game Cock of cutting 7in. off the length of each blade, so reducing the diameter by 14in., but he had to piece the propeller up again. The twin screw was a great advantage in passenger ships. Two of his ships had broken down, and come on with one engine. Once a cylinder was broken when a few hundred miles out, but the ship was only one day more on the voyage than she ought to have been.

Mr. W. H. White said that as to docking, the best answer to objections was that while two tugs were required for single screw ships, none was needed for vessels 420ft. by 47ft. The screws were 15ft. in diameter. In the case of vessels 65ft. beam, with 15ft. twin screws, they were fully protected.

Mr. Linnington, in reply, said that there was more power of selection of place with twin screws than with single screws, the latter being tied to position by the rudder post. Although it was true that smaller screws were fitted to the Iris than those originally tried, yet the best result was got with the original diameter, only with the blade area altered. As to pitch there was no fixed rule; excellent results had been got with a pitch as great as $d \times 2{\cdot}2$. In reply to Admiral De Horsey, he said that experience proved that the twin screw was better at sea than the single screw. As to Mr. Barnaby's question, that opened too wide a field for discussion to be answered then.

After a vote of thanks, a paper by Professor Thurston, on "Forms of Fish and of Ships," was taken as read.

Two papers, one on "New Method of Using Paper Sections for the Determination of Cross Curves of Stability," by Mr. J. H. Heck, and the other by Mr. Benjamin, on "Stability Calculations by Means of the Planimeter," were read and discussed together. The latter described a method of using the planimeter to calculate cross curves instead of the integrator.

The discussions which followed were of no popular interest. This brought the proceedings to an end at a late hour.

COMPOUND v. TRIPLE EXPANSION MARINE ENGINES.

We have repeatedly stated that the superior economy of the triple expansion as compared with the two-cylinder compound engine was due in large measure to the high pressures carried, and we have gone so far as to suggest that shipowners would do well before they embarked on a large expenditure to ascertain what higher pressures would do in the way of economising coal with two-cylinder engines.

Mr. Charles Jones, of the firm of John Jones and Sons, Liverpool, has tested the soundness of this view on a practical scale, and has courteously placed the results at our disposal. On page 287 will be found a sheet of diagrams, which will well repay careful examination. They have been taken from the engines of the cargo steamer Bentinck. The ship is 232ft. 7in. long, 29ft. 2in. beam, and 16ft. 1in. deep. On page 288 will be found a sketch showing with sufficient clearness the general arrangement. The engine is triple compound of the tandem type, the cylinders being respectively 15in., 20in., and 46⅝in. in diameter, with a stroke of 2ft. The safety valves are loaded to 160 lb. The pistons are Jones' patent, which have run in other steamers 100,000 knots on one adjustment. The high and intermediate valves are piston valves, with Mr. Jones' special arrangement for balancing by different diameters, so that the wear and tear of the excentrics and hoops is reduced to a minimum. For the last four years Mr. Jones has adopted the excellent plan of draining off the water of condensation produced in the first cylinder, instead of letting it be passed on to the

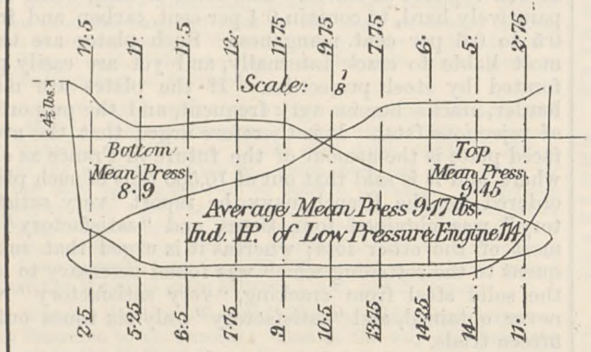
INDICATOR DIAGRAMS, S.S. BENTINCK.

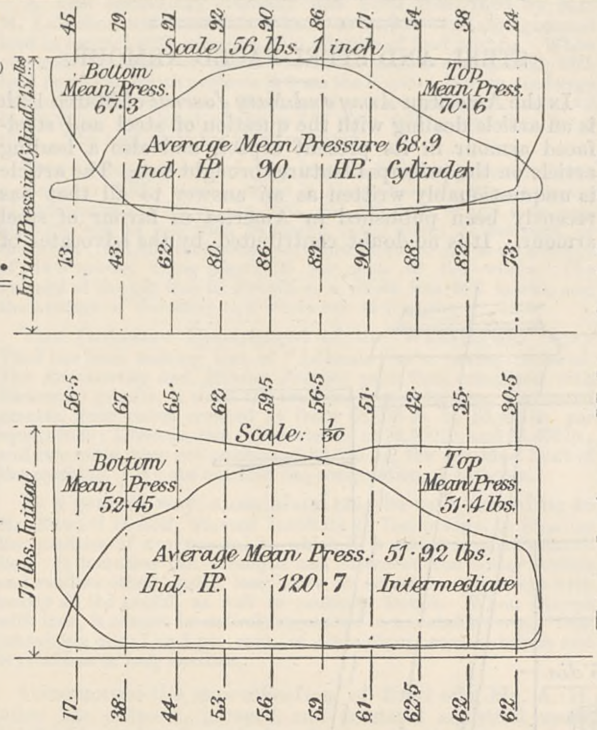
(For description see page 286.)

S.S. "BENTINCK."

Length: 232·7 Feet, Breadth: 29·2 Feet, Depth: 16·1 Feet.

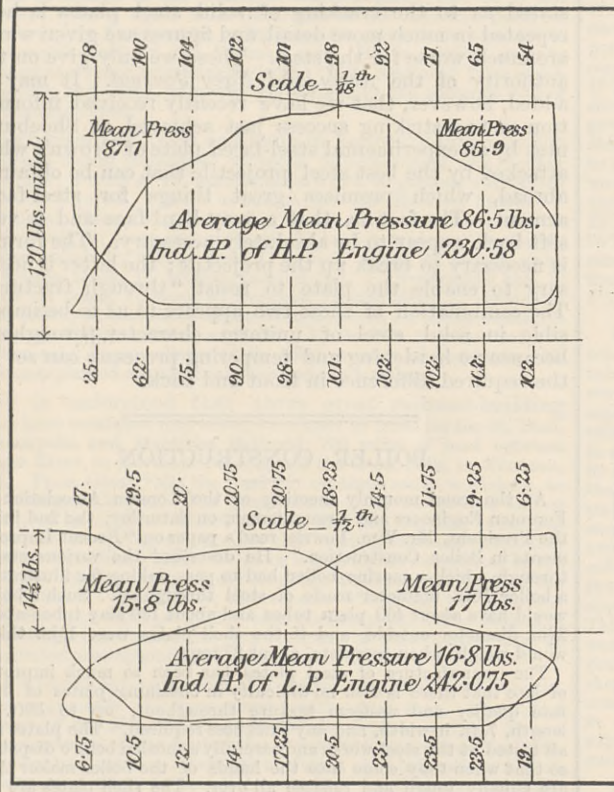
INDICATOR DIAGRAMS.



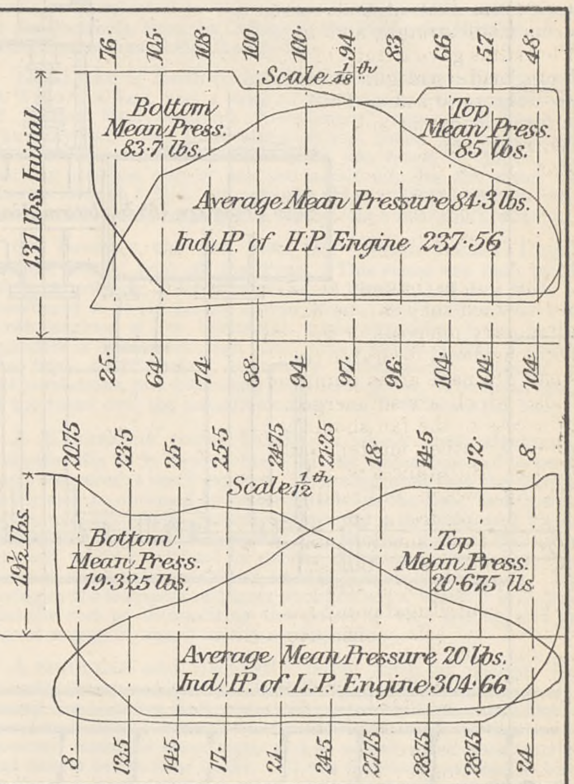


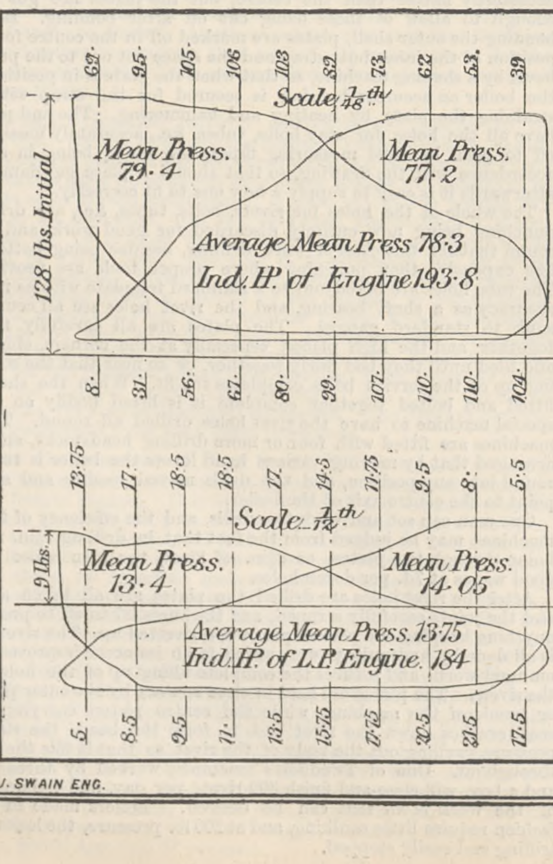
This is the Average Working Card from Rufisque to Rotterdam.

Triple Expansion	
Date	June 14th 1886
Hour	10 a.m.
Weather	Strong head wind & sea
Draft	13′ 0″ Aft 11′ 0 Forwd
Speed	8·1 Knots
Diatrs of Cylinds	15″, 20″ & 46⅜″
Stroke	2′ 0″
Revolutions	61 pr. min.
Steam Pressure	160 lbs.
Vacuum	25 inches
Expansion	Full out 15 ins.
Throttle Valve	Full open
Combined IP.	325·85 I.HP.
Coal per 24 hrs.	6 tons. 7 cwt.
Class of Coal	Welsh
Coal per Ind. HP.	1·75 lbs per hour.



July 6th 1886	Date	August 2nd 1886
10 a.m.	Hour	9·40 a.m.
Calm and Smooth Water	Weather	Light Head Wind and Sea
15′ 8″ Aft 14′ 10 Forwd	Draft	15′ 0″ Aft 10′ 0 Forwd
9·7 Knots	Speed	10·2 Knots
20″ & 46⅜″	Diatrs of Cylinders	20″ & 46⅜″
2 Feet	Stroke	2 Feet
70 per minute	Revolutions	74 per minute
130 lbs.	Steam Pressure	140 lbs.
25 inches	Vacuum	25 inches
Full out 15 ins.	Expansion	Full out 15 ins.
Full open	Throttle Valve	Full open
472·65 HP.	Combined Ind. HP.	542·2 HP.
Welsh	Class of Coal	Welsh

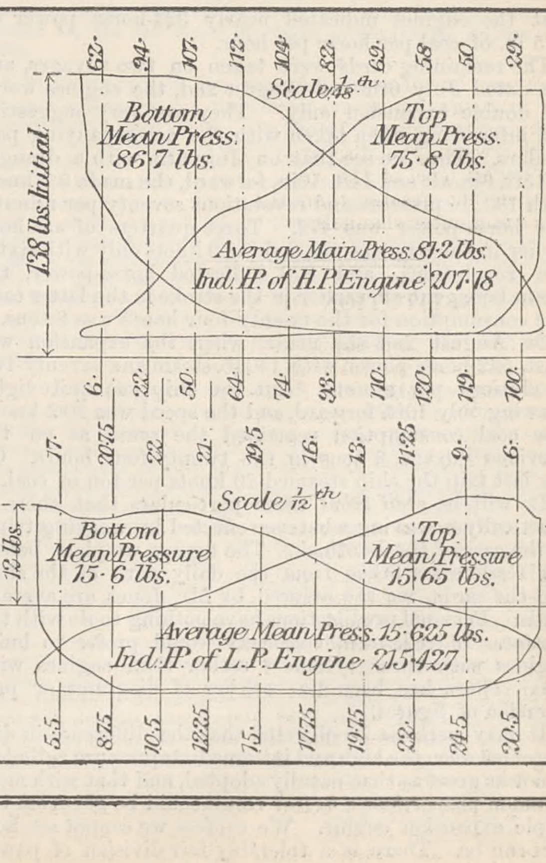




This is the Average Working Grade out.

July 6th 1886	Date	August 2nd 1886
9·15 a.m.	Hour	9·15 a.m.
Calm & Smooth Water	Weather	Light Head Wind and Sea
15′ 8″ Aft 14′ 10 Forwd	Draft	15′ 0″ Aft. 10′ 0 Forwd
9 Knots	Speed	9·2 Knots
20″ & 46⅜″	Diatrs of Cylinders	20″ & 46⅜″
2 Feet	Stroke — do. —	2 Feet
65 pr minte	Revolutions	67 pr minte
130 lbs.	Steam Press.	140 lbs.
25 ins.	Vacuum	25 ins.
11½ ins	Expansion	10 ins.
Full open	Throttle Valve	Full open
378 HP.	Combined HP.	422·6 HP.
8 Tons.	Coal pr 24 hrs	8 Tons
Welsh	Class of Coal	Welsh
2·01 lbs.	lbs. of Coal pr Ind. HP. per hour.	1·7 lbs.

This is Working Grade from Las Palmas to Marseilles



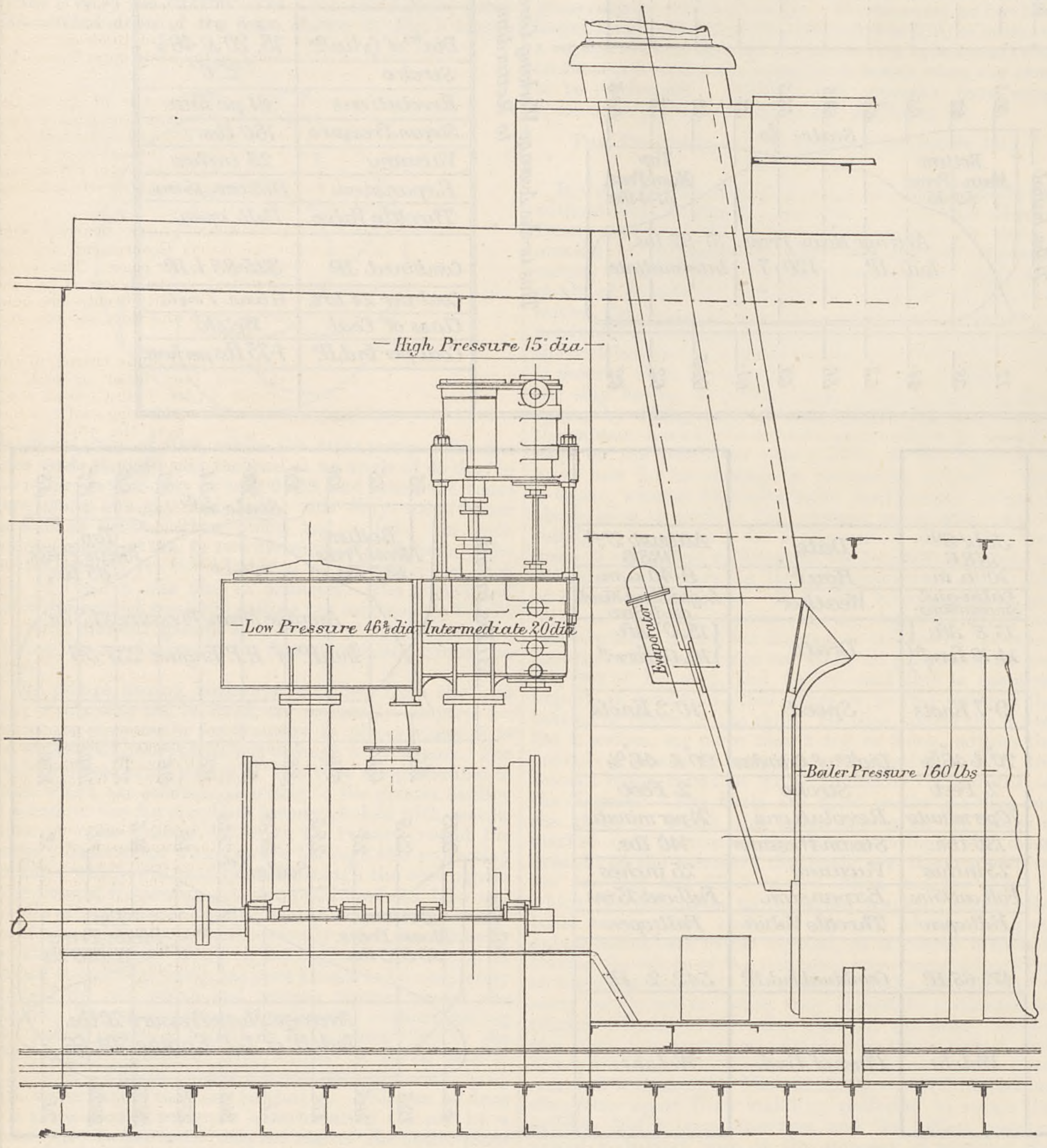
J. SWAIN ENG.

low-pressure cylinder. In the Bentinck the mechanism for effecting this is quite automatic. The water is withdrawn from the bottom of the intermediate valve casing, and conveyed straight to the hot well, with the result that the temperature of the feed-water is raised 12 deg., while dry steam is supplied to the low-pressure cylinder.

The engines of the Bentinck are so arranged that the high-pressure cylinder can be shut off from the boiler, and thus the engines can be worked either triple or double-cylinder. The ship has been worked on alternate voyages both ways for some time. The result is that when the engine is working triple, the coal per indicated horse-power is slightly reduced, as compared with the quantity needed when she is working double compound. But the knots per ton are augmented in the latter case, and this is the *only* test of economy for which the shipowner cares anything.

The first three cards have been taken when working triple expansion. All the particulars are given with the diagrams, and need not be repeated here. It will be seen between the two cylinders, and in any case the heat-trap action, for which so much is claimed, must have taken place to the fullest extent in the high-pressure cylinder.

The thanks of engineers and shipowners alike are due to Mr. Jones for carrying out this most interesting experiment. It must not be forgotten that the data obtained extend over many months and numerous voyages, and that what we have placed before our readers is nothing but a specimen of the results obtained.



GENERAL ARRANGEMENT OF ENGINES AND BOILER, S.S. BENTINCK.

that the engines indicated nearly 324-horse power on 1·75 lb. of coal per horse per hour.

The remaining cards were taken on two voyages, and are dated July 6th and August 2nd, the engines working double expansion only. They are very suggestive and interesting when taken with the accompanying particulars. Thus we see that on July 6th, with a draught of 15ft. 8in. aft and 14ft. 10in. forward, she made 9·7 knots with 130 lb. pressure and revolutions seventy per minute. The horse-power was 472. Three-quarters of an hour earlier in the day she was making 9 knots only with sixty-five revolutions, and 378 indicated horse-power, the steam being cut off earlier in the stroke in the latter case. The consumption for the twenty-four hours was 8 tons.

On August 2nd she made, when the expansion was least, 542-horse power with 140 lb. steam and seventy-two revolutions per minute. But the ship was quite light, drawing only 10ft. forward, and the speed was 10·2 knots. The coal consumption remained the same as on the previous voyage, 8 tons in the twenty-four hours. On her last trip the ship steamed 29 knots per ton of coal.

It will be seen from these particulars that there is practically no saving whatever effected by working triple in the case of the Bentinck. The figures we place before our readers are taken from the daily work of the ship, and the cards, we are assured by Mr. Jones, are average cards. Personal predilections have nothing to do with the matter. Indeed, most engineers would prefer to build engines with three cylinders rather than engines with two. There has been no cooking of diagrams or preparation of figures.

It may perhaps be objected that the difference in diameter between the high and intermediate pressure cylinders is not as great as that usually adopted, and that with more common proportions a better result could be got from the triple expansion engine. We confess we cannot see how this can be. There is a tolerably fair division of power

STEEL AND STEEL-FACED ARMOUR.

In the American *Army and Navy Journal* of March 12th is an article dealing with the question of steel and steel-faced armour in its present aspect, and also a leading article on the principal features brought out. The article is unquestionably written as an answer to all that has recently been published in America in favour of steel armour. It is no doubt contributed by the advocates of steel-faced armour, and must be regarded as putting that side of the question forward. We may be glad to get this, however, after the course of articles we had written on the opposite side. The main value, however, of all such contributions depends on the facts brought to our notice—facts such as can be definitely contradicted or made good on further investigation. The article referred to gives the processes of manufacture of solid steel armour, which, it seems, are as follows:—(1) Running off from a Siemens furnace; (2) heating in gas furnace and forging under an 80-ton block hammer; (3) shaping by hammering, or hydraulic pressure and annealing. (4) trimming; (5) oil tempering; (6) finishing by planing. It is stated that the first contract for forged steel plates made by the French Government with Creusot bears date July 19th, 1880, and was for the Terrible. Since then the armour for the Furieuse, Admiral Baudin, Formidable, Grenade, and Fusié has been ordered from Creusot, as well as various plates for the trial of projectiles. The ninety plates for the Terrible were delivered in five lots, weighing in all 1700 tons. Each lot was tried at Gâvre, and reported on as follows:—1st lot, "very satisfactory;" 2nd, passable; 3rd, "very satisfactory;" 4th, passable; 5th, passable. There were, however, eighteen plates rejected for cracks ("tassures"). Of the first lot, two broke when just going to be fixed on the ship's side at Brest; of the 2nd lot, one cracked at Brest and three at Creusot; 3rd lot, one cracked at Brest and five at Creusot; 4th lot, four cracked in course of manufacture; 5th lot, one plate cracked at Brest and one at at Creusot. Owing to the dismay caused by the discovery that the plates were liable to have internal cracks of which there was but little indication at the surface, the "fall test" was instituted, which consists in dropping each plate 2½ m. on a cast iron floor. This caused the rejection of several, without giving absolute security. To avoid this evil the plates were then made much softer, consequently the projectiles penetrated them more easily, and they only obtained the verdicts of satisfactory enough and just passable, and many rejections still occurred. Later on harder plates were made to test projectiles. These are only passed if one of them taken from a lot of 150 or 200 passes without fracture through a forged steel plate, whose thickness is at least equal to the diameter of the projectile.

On December 8th, 1884, out of five plates 30 cm. and five plates 25 cm. thick, four plates were rejected on the dropping test, and the verdict on firing was only "middling." On July 6th, 1885, out of nine plates, three were rejected for cracks in working, and two after the fall test. These were replaced, but on firing the plate was rejected. The eight plates were then by special permission re-worked and tempered, but three were rejected on the fall test. Thus nine plates were rejected out of a lot which began as nine; the remainder arising from the additions stood over as doubtful. On March 1st, 1886, out of seven plates 55 cm. thick, four had been rejected for cracks, but the firing test plate had not yet been selected, and the fall test had not been finished. On March 8th, 1886, two plates 12 cm. thick, three plates 16 cm., and two plates 20 cm. thick, were submitted. They were more free from cracks, but the test plate fired at was rejected at Gâvre. The steel is said, when comparatively hard, to contain 0·4 per cent. carbon and from 0·5 to 0·6 per cent. manganese. Such plates are those most liable to crack internally, and yet are easily perforated by steel projectiles. If the plates are made harder, cracks become very frequent, and the proportion of rejections fatal. It is therefore urged that the steel-faced plate is the armour of the future in France as elsewhere, and it is said that out of 16,500 tons of such plates ordered for the French navy the report "very satisfactory" was obtained four times, and "satisfactory" to most of the other lots; whereas it is urged that subsequent to the softening which was found necessary to save the solid steel from cracking, "very satisfactory" was never obtained, and "satisfactory" only six times out of fifteen trials.

We have given in the above the main facts in the article referred to. It will be seen that what we have stated as to the cracking of solid steel plates is here repeated in much more detail, and figures are given which are much worse for the steel. These we only give on the authority of the *Army and Navy Journal*. It may be added, however, that we have recently received information as to a striking success just achieved at Shoeburyness by an experimental steel-faced plate of Brown's when attacked by the best steel projectile that can be obtained abroad, which promises great things for steel-faced armour. The fact is, that a very hard face and a very soft back appear to be absolutely necessary. The former is necessary to break up the projectile; the latter is necessary to enable the plate to resist "through fracture." The combination of these two appears to us to be impossible in solid steel of uniform character throughout, because no hardening and tempering processes can set up the required difference in front and back.

BOILER CONSTRUCTION.

At the usual monthly meeting of the London Association of Foremen Engineers and Draughtsmen, on Saturday, the 2nd inst., the President, Mr. Wm. Powrie, read a paper on "Recent Improvements in Boiler Construction." He described the various stages through which a marine boiler had to pass, taking for illustration a boiler 16ft. diameter made of steel throughout. Such a boiler would have about 460 plain tubes and about 180 stay tubes about 2⅝in. diameter outside, and if the shell plates were 1⅛in. thick, would weigh, when complete, about 27 tons.

The manufacture of steel plates has been so much improved of late that there is now no difficulty in obtaining plates of first-rate quality and uniform texture throughout, up to 30ft. in length, 7½ft. in width, and any thickness required. The plates are all tested at the steel works and carefully annealed before dispatch, so that when they come into the hands of the boiler maker they are equally tough and reliable all over. The shell plates are not heated at all after shaping, and are bent cold to the exact curve by a powerful set of vertical rolls. A short piece at each end is necessarily flatter than the centre, but the plates are got long enough to allow of these being cut off after bending. Before bending the outer shell, plates are marked off in the centre for the position of the inner butt strap and the space cut out to the proper bevel by a shaping machine, so that when the plate is in position on the boiler an accurate housing is secured for the strap without straining the plate by heating and hammering. The end plates have all the holes for stay bolts, tubes, &c., accurately measured off to $\frac{1}{64}$in. by steel measuring tapes, the whole being in strict accordance with the drawing, so that should a plate get damaged afterwards it is easy to supply a new one to fit correctly.

The whole of the holes for rivets, bolts, tubes, &c., are drilled, punching being now entirely discarded for good work, and it is found that for this class of work drilling, besides being better, is less expensive than punching where proper tools are provided. The tube holes are bored out to a standard template with as much accuracy as a shaft bearing, and the rivet holes are all countersunk to standard gauges. The plates are all carefully fitted together, and the high places, especially at the corners, chipped and filed until they bed fairly together, or so near that the screwing up of the service bolts completes the fit. When the shell is fitted and bolted together complete it is lifted bodily on to a special machine to have the rivet holes drilled all round. These machines are fitted with four or more drilling headstocks, and so arranged that by moving various hand levers the boiler is turned round into any position, and the drills moved readily and set to point to the centre axis of the boiler.

One man can set and work two drills, and the efficiency of these machines may be judged from the fact that in drilling 1⅛in. rivet holes through two plates, or 2¼in. of steel, the men make very good wages at 7d. per dozen holes.

After the rivet holes are drilled the plates are all taken apart and the joints carefully scraped, and the burrs taken off to prevent anything keeping the plates apart when rivetted up. The rivetting is all done by hydraulic power, which is an immense improvement on hand work, and secures the complete filling up of the holes by the rivets. The plates are held in close contact by the outer piston or trunk of the machine, while the centre piston carrying the snap crushes down the rivet end to form the head, the steady pressure swelling out the body of the rivet so that it fills the hole throughout. One of Tweddell's machines, worked by three men and a boy, will close and finish 300 rivets per day, and the quality of the work is all that can be desired. Boilers made in this fashion require little caulking, and at 200 lb. pressure, the leaks are trifling and easily stopped.

RAILWAY MATTERS.

THE new Midland line doubling the road between Lancaster and Newcastle has been completed, and will, it is expected, soon be in use.

THE Canadian Pacific Railway Company propose to erect a cable road under some of the worst spots in the Rocky Mountains to prevent interruption of the service by snowslides.

A propos of the more than usually frequent bridge failures in the States recently, the *New York Sun* gives the following:—"Chairman of the Board: 'The master mechanic reports the Deep River bridge unsafe.' Directors—without a dissenting voice—'Give it a new coat of paint.'"

IN March the railway and canal companies brought into the metropolis 669,297 tons of coal, against 702,729 tons in the corresponding month of last year. For the three months of the current year there is a decrease of 26,257 tons in the total quantity carried as compared with last year's corresponding figures.

THE death is recorded of Mr. S. J. Claye, railway wagon builder, of Long Eaton. He was originally in the service of the Midland Railway Company, after leaving which he started a wagon works at Long Eaton in the Erewash Valley. He also established works at Barrow-in-Furness when trade was good about 1872-3.

ALTHOUGH a good deal of interest is shown in the proposed new line of railway to Ashbourne and Dovedale, and it is hoped that the active sympathy of the landowners, as well as one of the railway companies, will be given to the scheme, it will probably be opposed by Ruskinism, because it is a charming district and has been the haunt of some of the most celebrated English writers in times gone by. When a journey to the Highlands was a feat, Boswell said, "He who has seen Dovedale has no need to visit the Highlands of Scotland."

FOR the Oxford and Cambridge race, the London and South-Western Railway Company last year carried 6900 passengers from Waterloo, and this year 11,400 went down, making a difference in the receipts of £155 8s., which does not seem much for carrying 5500 passengers even so short a distance. Twenty-one ordinary specials were run and two to Barnes Bridge, the latter conveying 850 passengers. This was in addition to the usual extra trains run on Saturdays, and also exclusive of the through booking from Cannon-street. At least 23,000 people must have passed through the Waterloo gates between 1 p.m. and 2.30 p.m.

A WRITER in the *Sheffield Weekly Telegraph* says:—"San Francisco to St. Pancras! That is the way the American can book by the Midland line. He does not even ask for an insurance ticket for this little trip of 7000 miles. His luggage is taken in charge at the American starting place, and he is not troubled with it again until he arrives at his objective point in England. At Liverpool he walks from his cabin in the steamer to his sleeping berth in the Pullman cars. He is whirled away to London at a speed unattainable in the 'fast' continent from which he comes, and steps from the platform into the entrance hall of St. Pancras Hotel."

THE record of train accidents in February given by the *Railroad Gazette* includes 57 collisions, 67 derailments, and 8 other accidents; a total of 132 accidents, in which 55 persons were killed and 106 injured. These accidents are classified as follows:—Collisions: Rear, 24; butting, 31; crossing, 2. Derailments: Broken rail, 9; loose or spread rail, 2; broken bridge or trestle, 4; broken switch, 2; broken frog, 1; broken wheel, 4; broken axle, 5; broken truck, 1; broken parallel rod, 1; overloaded car, 1; cattle on track, 1; snow, 3; washout, 3; land slide, 1; accidental obstruction, 5; malicious obstruction, 2; wind, 5; unexplained, 17. Other accidents: Boiler explosion, 1; broken parallel rod, 1; broken axle, 1; miscellaneous, 5; total number of accidents, 132. The unexplained are as usual very large in number.

IT is understood that three great railroad-building firms have combined and taken a contract to build for the St. Paul, Minneapolis, and Manitoba Railroad, 700 miles of road between Mouse River, in Northern Dakota, and the Great Falls, in Montana, U.S. From Great Falls the road will continue south to Helena, as the Montana Central. The construction is to be pushed as few lines ever have been—50,000 men, if they can be had, being put on as soon as spring opens. As this road operates in connection with the Canadian Pacific, it will be a formidable competitor of the Northern Pacific, for not only Montana business, but that of the Pacific Coast. Practically, this scheme will bring the Montana ranchmen into close proximity with the sheep and cattle dealers in Manitoba, from whence the vast resources of that country may be distributed throughout the Dominion.

WE never can tell, says the American *Railroad Gazette*, what arguments will have weight with some men. The latest number of the *Memoires de la Société des Ingénieurs Civils* gives a long discussion of the project for a metropolitan railroad in Paris, and the most serious reason given for an elevated rather than an underground route is that "the people of London are very different from those of Paris. In London, for two-thirds of the year, the climate is gloomy, cold, and unwholesome, above as well as underground; the streets are almost always muddy, and these reasons which make the underground way quite endurable there do not apply to Paris." Another speaker reasoned that Parisians "would rather be swallows than moles." It would be well for the promoters of the New York underground railroad to stop and think of these things.

SEVERAL Spanish railway contracts are about to be given out. On the 14th inst. the Board of Public Works at Madrid will place the contract for the construction of a railway from Ferrol to Betanzos; the Government guarantees 303,054,813 pesetas to be paid in eight annual instalments. A sum of 145,260 pesetas will have to be deposited. On the 20th inst., also at Madrid, a concession will be granted for the construction of a railway in the Island of Porto Rica. The cost it is estimated will be about 9,929,000 pesetas. Likewise, on the 20th, tenders will be received at the Colonial Office in Madrid for the building of the following lines of railway:—From San Juan de Puerto Rica to Mayaquez, *viâ* Arecibo and Aquadilla, length 195 kilometres; from Rio Piedras to Humacao, length 96 kilometres; from Ponce to Mayaquez, *viâ* San German, length 90 kilometres; from Ponce to Humacao, *viâ* Arroyo, length 125 kilometres; and from Caguas to Humacao, *viâ* Juncos, length 50 kilometres. The Spanish Government guarantees 8 per cent. upon these lines.

THE Government of New South Wales are advertising in the United States for tenders for sixteen passenger and twenty-eight freight engines. It is reported that all the locomotive works are full of orders. Up to the end of the fiscal year, June 30th, 1886, the United States had sent 125 locomotives to Australia and New Zealand, but nearly all the orders have been obtained during slack times, as American makers cannot compete in price with England during average times. Commenting on this, the *Railway News* says the total American exports of locomotives for the last twelve years have been:—1875, 79 locomotives, value 996,639 dols.; 1876, 44, 561,559 dols.; 1877, 53, 568,302 dols.; 1878, 98, 1,016,97 4dols.; 1879, 73, 567,802 dols.; 1880, 60, 466,313 dols.; 1881, 99, 893,123 dols.; 1882, 133, 1,455,717 dols.; 1883, 219, 2,219,081 dols.; 1884, 282, 2,819,946 dols.; 1885, 85, 732,403 dols.; 1886, 52, 633,393 dols.; total number of locomotives, 1277; total value, 12,631,252 dols. In addition to the above, locomotives have been exported to Mexico and Canada, for which no returns have been made to the Bureau of Statistics. The locomotives have been distributed about as follows:—To Russia, 4 per cent.; England and all English colonies, 29 per cent.; Spain and Cuba, 10 per cent.; Mexico, 14 per cent.; South America, 37 per cent.

NOTES AND MEMORANDA.

THE number of tons of wrought iron made in Spain in 1886 was 1909.

The production of pig iron in Germany during 1886 has been returned at 3,339,803 tons, as compared with 3,751,775 tons in 1885. The make of 1886 was thus less than that of 1885 by 411,972 tons. This is the first time for many years that there has been a decrease in the production of pig iron in Germany.

A NEW secondary element has been described by Mr. M. Kalischer, which consists of iron—or carbon—and amalgamated lead in contact with mercury, in a solution of lead nitrate. When charged, the iron—or anode—becomes passive and coated with lead peroxide, which protects it from the liquid. During discharge the peroxide is reduced. Electromotive force on open circuit = 2 to 2·5 volts; on closed circuit = 1·8 volts, falling slightly after a time. The lead plate has to be renewed.

THE average price of pig iron in Germany varies from a minimum of 32·8 marks per ton in Alsace-Lorraine to a maximum of 50·8 marks in Silesia. In 1885, 851,126 tons of pig were produced to sell at less than 34 marks, being about 24 per cent. of the whole; 902,654 tons more were produced to sell at an average of 44·9 marks, being about 25 per cent. of the whole. The average of the pig iron of Prussia as a whole was 46·1 marks, and the average of Germany as a whole was 44·8 marks.

THE Ordnance Department of the Washington Navy Yard has been making test of "Lithonia" as a paving material. The *Engineering and Mining Journal* says that, compared with Richmond granite, it stood the crushing test as follows: Richmond granite, four cubes crushed at from 68,275 lb. to 83,900 lb. per square inch; Lithonia, two cubes crushed at 76,800 lb. and 83,400 lb., and two more were not crushed at 85,000 lb., the practical limit of the machine. We are not told the composition of Lithonia.

IN a general way, aluminium may be said, according to Mr. Edward D. Self, Stevens Institute of Technology, to improve the qualities of every metal to which it is added in small quantities. It increases the strength and lustre of the softer metals and renders others much less liable to corrosion. It alloys with nearly all the useful, as well as precious, metals. When alloyed with iron, it cannot be entirely separated in a metallic form. Iron containing over 7 or 8 per cent. of aluminium becomes brittle and crystallises in long needles.

CONCERNING the saponification of fixed oils, Mr. A. H. Allen has collected, grouped, and tabulated analytical results obtained by various investigators in the examination of a large variety of fatty substances by Kœttstorfer's saponification method. Oils consisting of olein mixed with comparatively small quantities of stearin or palmitin, whether of animal or vegetable origin, neutralise about the same quantity of potash—from 18·93 to 19·66 per cent. Oils from crucifertus plants require 17·02 to 17·9 per cent. of potash to neutralise them. Vegetable drying oils require 18·7 to 19·6 per cent. These numbers are not characteristic, but show that linoleic acid must have a higher atomic weight than is generally supposed. With marine animal oils, also, the numbers obtained are not characteristic, varying from 18·51 in cod-liver oil to 21·88 in porpoise oil, which contains much valeric acid; marine waxes, however, require only from 12·30 to 14·74, much less than the marine oils. The butter class contains—butter fat requiring 22·15 to 23·24, cocoa-nut oil 24·62 to 26·84, palm-nut oil 22·00 to 24·76 per cent. of potash. The various mixtures of palmitin, stearin, and olein require from 19 to 20 per cent. of potash for their neutralisation. Beeswax requires 9·2 to 9·7, Chinese wax 6·5, castor oil 17 6 to 18·15, Japan wax 21·01 to 22·25.

PROFESSOR HELMHOLTZ recently demonstrated the great cohesion of an air-free column of water. A syphon-shaped glass tube, the longer leg of which was closed and the shorter one open, was filled with quicksilver, and above the quicksilver there was superposed a small quantity of distilled water. If the filling was effected without admission of air, then, on the tube being placed in an upright position, the water adhered to the closed end, and its adhesion supported the quicksilver column, which was longer than the barometer height. The speaker now brought the open end of the syphon tube into communication with an air pump, and caused to be pumped out as much as down to 2 mm. pressure, but even then the cohesion of the water supported the quicksilver column. Only by shaking was the water column shattered, and the quicksilver immediately sank. If there was no shaking, the apparatus continued for an unlimited length of time unchanged. This contrivance should serve the purpose of electrolysing air-free water and ascertaining the strength of the current under which gas bubbles developed themselves by electrolysis. The experiment showed that on the transmission of a current of 2 volts the water continued adherent. The depression of the quicksilver column in consequence of gas development occurred, however, in an experiment with a current of 2·15 volts, and in another with a current of 2·18 volts.

IN a report on the influence of the ferrous oxide in basic cinder on the growth of plants, Mr. J. M. H. Munro describes experiments supplementary to those which formed the subject of a note some time since. Seeds of various sorts—barley, white turnips, clover, white mustard, garden cress—were sown in mixtures of garden soil with basic cinder in order to ascertain whether the large proportion of ferrous oxide in the basic cinder exercises any unfavourable influence on germination or growth. In order to put this question to the severest test, enormously exaggerated doses of basic cinder were employed, namely, 10 per cent. of the mixed soil, 25 per cent., 50 per cent., and pure basic cinder without any soil. Most of the seeds tried germinated even in the pure basic cinder, and some of the plants lived until starved for want of nitrogenous food. All the other mixtures produced plants which flowered and seeded in due course—the barley plants in the mixture of equal parts of basic cinder and garden soil were actually better than those grown in garden soil alone, and produced full ears of grain of unimpaired germinating power. Since basic cinder is an alkaline substance containing free lime, it is only natural that in the three strongest mixtures fewer seeds germinated than in the three weaker mixtures or in garden soil alone. The conclusion arrived at is that the ferrous oxide contained in basic cinder is without injurious influence on germination or growth.

THE Sonnblick Observatory, in the province of Salzburg, Austria, is the highest in Europe, being 10,177ft. above the level of the sea. It was established chiefly through the exertions of M. Rojacher, proprietor of the mines in that district, in conjunction with the German and Austrian Alpine Club, and the Austrian Meteorological Society. Observations at such elevated stations offer much that is of interest. In the *Meteorologische Zeitschrift* for February last, Dr. Hann gives an interesting account of the first three months' observations. The mean temperature in October was 25·9 deg Fah.; in November 15·3 deg., and in December 8·1 deg. In October, the decrease of temperature with height during the barometrical minima was, generally, rapid. But during the barometrical maxima it was very slow in the lower strata, up to about 5900ft.; then an increase of temperature with height frequently occurred. The periods of high pressure were generally warm intervals on the Sonnblick, and the periods of low pressure were cold intervals. It is noteworthy, however, that the change of temperature with height, in the strata between about 5900ft. and the summit, was almost independent of the conditions of weather, being nearly constant during the whole month, and amounting to about 1·3 deg. Fah. per 328ft.—100 metres—while in the lower regions, from about 1300ft. to 5900ft., it varied between 0 deg. and 1·1 deg. And, generally speaking, the same rates of decrease of temperature obtained in November and December.

MISCELLANEA.

A TRANSLATION of M. Gaston Planté's work on "The Storage of Electrical Energy," by Mr. P. B. Elwell, will shortly be published by Messrs. Whittaker and Co.

PROFESSOR A. B. W. KENNEDY, of the Engineering Laboratory, University College, London, has taken chambers at 3, Princes-street, Westminster, for increased convenience in the conduct of his professional work.

THE sale by auction on the 19th inst. and the two following days of the land and premises, and of the plant, machinery, and tools of the Monk-street Engineering and the Wreath Quay Boilerworks, Monkwearmouth, Sunderland, is announced by Messrs. Wheatley Kirk, Price, and Goulty.

THE great war ship built under the name Renown by Messrs. Armstrong, Mitchell, and Co., for the British navy, was launched on Saturday last, and named the Victoria in honour of the Queen's 50th year of reign. Her length is 340ft., breadth 70ft., mean draught 26ft. 9in., displacement 10,500 tons and horse-power 12,000.

THE "Cold Water Committee" of the Bath Town Council have recommended the borrowing of £12,500 for work in connection with the water supply. Of this sum, £8949 is for the completion of the waste water meter system, and the remainder for new mains. Mr. A. R. Binnie M. Inst. C.E., of Bradford, reports that the expenditure of this amount on the waste water system will be the most economical course.

WHILST the steam tug Mary Usher was at sea off the Tyne on Tuesday morning looking for vessels, a loose piece of wood between the engine and the paddle beam dropped to the bottom of the boat, and was then caught and forced through it by a lever of the engine, making a hole through which the water poured, and sank the tug. The crew made their escape in a boat with difficulty, and were subsequently picked up.

MESSRS. YARROW AND COMPANY have beaten, with their second torpedo boat for the Italian Government, the performance of the first, recently recorded in our pages. This second boat was tested yesterday—Thursday—in the Lower Hope, and attained a mean speed of 25·101 knots, or nearly twenty-nine miles an hour in rough squally weather; with the tide, she ran over thirty-one miles an hour past the shore.

WE mentioned some time since that some trains on the Glasgow Underground Railway had been fitted up with an automatic system of electric lighting, by Mr. T. P. Carswell, C.E., of the North British Railway Company's engineering staff. It has we understand, now been arranged to have the whole of the carriages illuminated in this manner throughout the entire length of the tunnnels, from the College to the Finnieston stations, at an initial cost of something like £5000.

THE Duke of Bedford has just established a fire brigade at Woburn Abbey, and a trial of the brigade's new engine—one of Messrs. Merryweather's "Greenwich" type—took place on Thursday last. The Duke attended and timed the proceedings. In seven minutes five seconds steam was raised to 100 lb., the working pressure, and in one and a-half minutes the water was thrown through a 1½in. jet over the abbey; 2000ft. of hose were used, and the water supply was taken from a lake 800ft. distant.

ON Tuesday, the 5th inst., the Italian cruiser Dogali had her official trial off the Tyne. This vessel was built by Sir W. G. Armstrong, Mitchell, and Co., at Elswick, and may fairly be considered to be the fastest cruiser afloat. She is fitted with twin screw engines of the horizontal triple expansion type, having cylinders of 30in., 45in., and 73in., with a stroke of 33in. During the trial they worked extremely satisfactorily, running at 154 revolutions, and indicating 7600-horse power. The mean speed of the vessel over the measured course was 19·66 knots per hour.

A BARBERTON paper thinks it likely that electricity will presently be in favour there for the transmission of power to great distances at small expense. It is suggested that the driving-power may be obtained by water-wheels on the Kaap and Queen's rivers, and electricity generated there by a dynamo, and thence transmitted by wires to motors in the various parts of the fields, where it would be utilised for driving gravitating stamps and other forms of machinery erected as near as possible to the reefs. The saving in the transport of quartz would be large, whilst it is claimed that the cost of transmitting the power is very trifling, and the loss of energy in transit hardly appreciable.

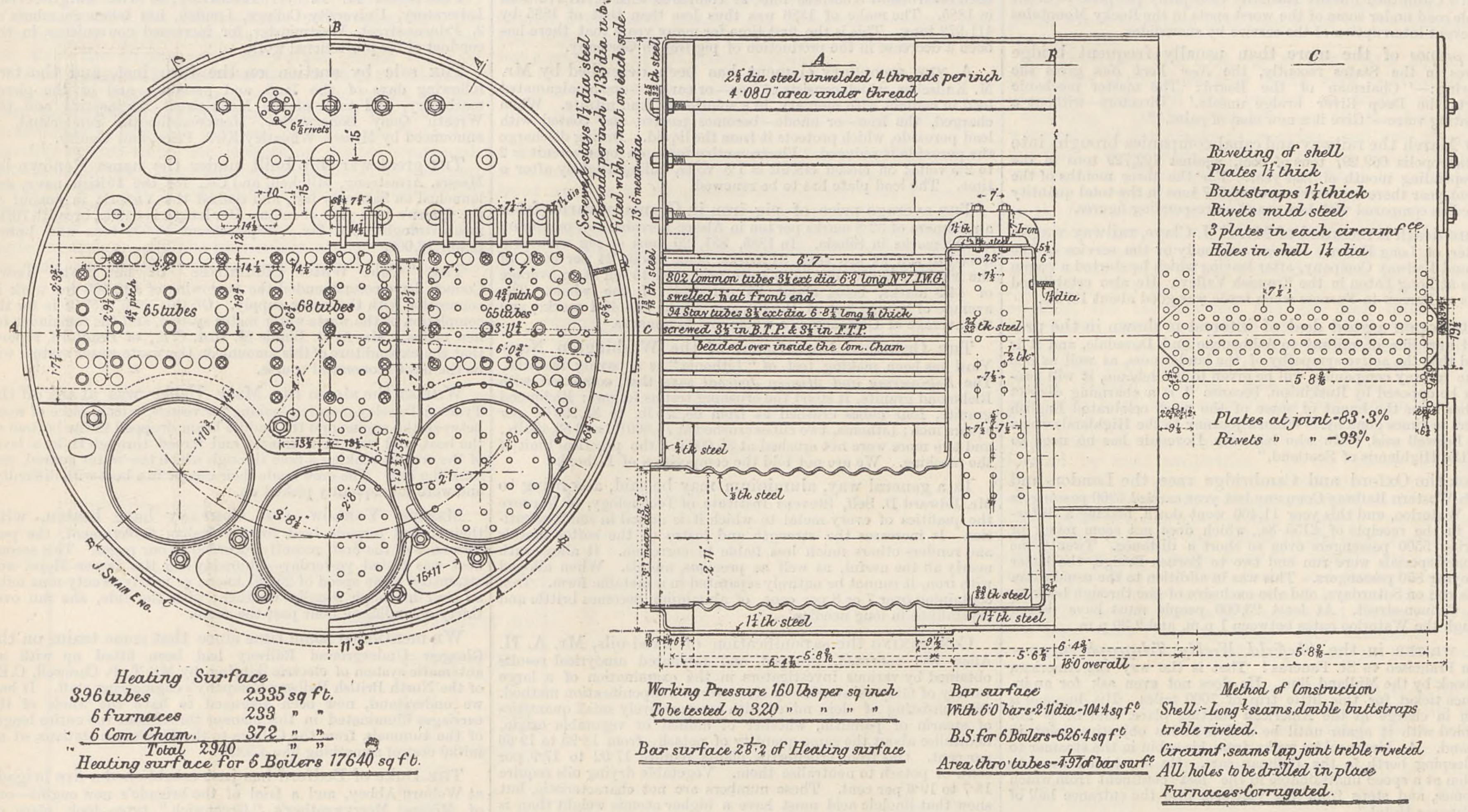
A SINGULAR and decidedly novel form of danger has recently threatened the Mersey Railway. Some weeks ago a ship named the Locksley Hall, while making for the Birkenhead Docks, foundered in mid-stream. A considerable length of the masts, however, remained above water and so caused a serious obstruction and danger to the river traffic. It was therefore proposed to blow up the ship by dynamite or other explosive, but it was found that the vessel had sunk exactly over the Mersey Railway tunnel, and that an explosion could only be made at grave risk to the tunnel. That method was accordingly abandoned, and the common-place plan of unloading the ship by divers, and then hoisting her, was resorted to, the tall masts of course continuing to impede the traffic.

A PLAN proposed for transporting natural gas long distances substitutes for the forcing process an exhaust at low pressure and in large mains. The *Engineering News* says:—"Fans would be located ten to forty miles apart according to the undulations of the line. These would be about 16ft. in diameter, and be boxed into the conduit; a 20-horse power engine would drive this fan at about thirty to fifty revolutions per minute. The pipes would be sheet iron and 5ft. in diameter. A syphon is also proposed in which two lines of pipe would be used; in ascending a hill the lower pipe would be provided with burners to heat and rarefy the gas; and after the summit was passed an upper pipe would discharge a spray of water over the gas mains and thus condense the gas. The risk of explosion and scarcity of water on hill-tops would probably interfere with the carrying out of this latter scheme."

THE following are the chief particulars of the new graving dock at Esquimalt, the English naval station, near Victoria in British Coulmbia, which has been under construction for some years past and is now nearly completed. Length on coping, inside, from gate to head of dock, 450ft.; length on floor, 430ft.; width on coping, inside, 90ft.; width on floor, 41ft.; width on coping, inside, of outer invert entrance, 69ft.; width on coping, inside, of inner invert entrance, 65ft.; depth from coping to inverts, 33ft. 6in.; depth from coping to floor, 36ft. 6in.; depth from coping to floor of caisson-berth, 36ft. 10½in.; depth from high-water level, spring tides, to inverts, 26ft. 6in.; inclination of floor, 1ft. in 400ft. The dock is built of hard sandstone, backed with Portland cement concrete. The inner abutment of caisson-berth is faced with granite. The caisson gate is of wrought iron, known as Kinipple's Patent Travelling Caisson, arranged to slide into a recess between the inner and outer inverts on one side of the dock, and is provided with a folding or lowering bridge. The masonry of the dock is completed, and the caisson gate is in course of erection on the dock floor. After completion of the latter, there will only remain the removal of the coffer dam before the structure can receive a ship for docking. The main pumping machinery consists of two lift pumps, 4ft. in diameter and 5ft. stroke, and was manufactured by Watt and Co., of Birmingham. An independent auxiliary engine operates a small drainage pump and hauls the caisson back and forth.

BOILERS OF THE S.S. OROYA.

THE BARROW SHIPBUILDING COMPANY, ENGINEERS.



THE S.S. OROYA.

We give above engravings of one of the boilers of the s.s. Oroya, which explain themselves. A double-page engraving of the ship appeared in our impression for March 25th.

RAILWAY ACCIDENTS IN AMERICA.

Here is another example of the beauty and perfection of American railway engineering. In explanation of the following extract from a railway newspaper published in New York, it may be noted that the Rio accident referred to occurred to a limited express train running between Chicago and Minneapolis on the Chicago, Milwaukee, and St. Paul Railway. A goods train was shunted in two portions at Rio, a small station, to let the express pass. Contractor's points were used, and the goods train brakemen left one of the trailing points set for the siding instead of the main line. The only signal (?) was a small switch light set some five feet from the ground. The driver of the

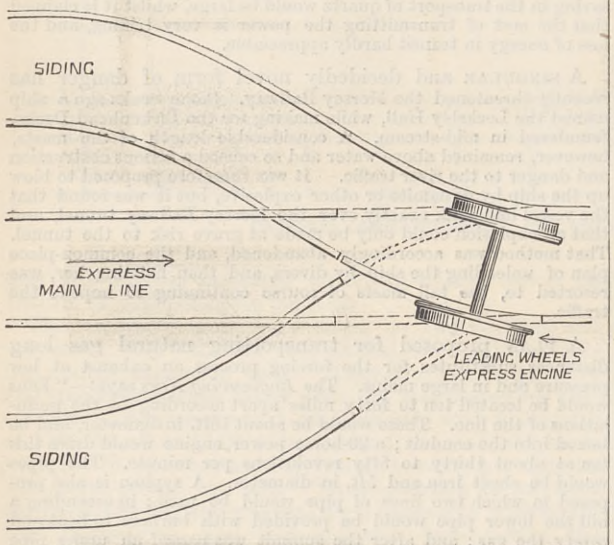
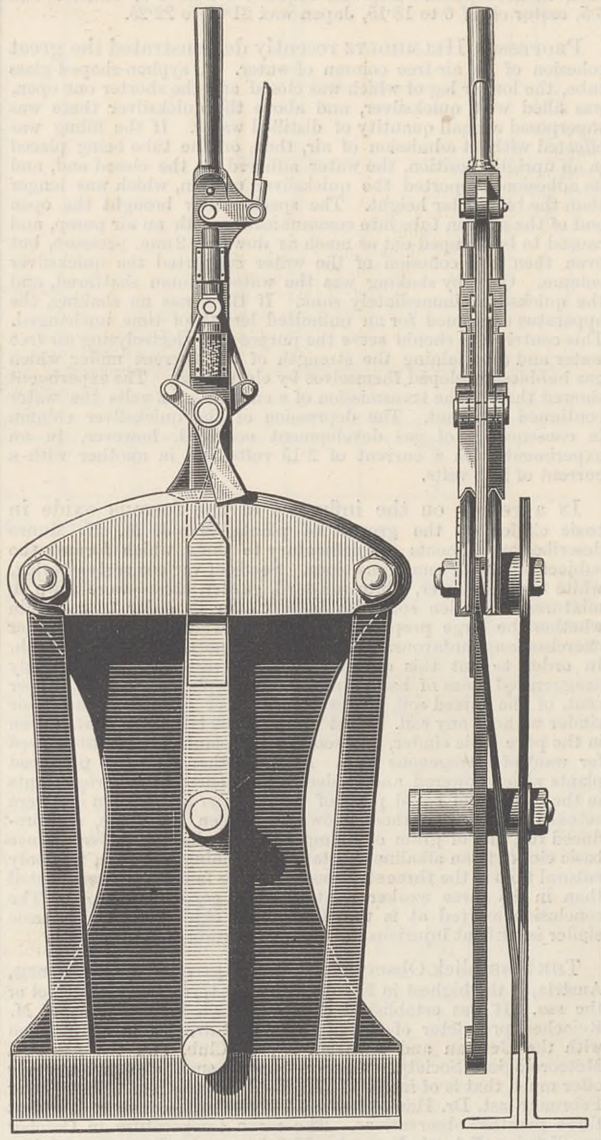


DIAGRAM OF POSITION OF CONTRACTORS' POINTS, RIO ACCIDENT.

——— Position of movable rail set for left-hand siding at time of accident.
— — — Position when set for main line.
.... Position when set for right-hand siding.

express naturally saw nothing wrong until he was within a few yards of the wretched switch, the high covered goods cars hiding the light from sight owing to the line being on a curve. The engine struck the wrongly set contractor's points, and of course left the rails and ploughed over the sandy ballast until the train came to a stand. There was, as will be seen, no collision, and the cars were not telescoped or turned over, and it was considered probable that no person was killed or even mortally injured by the shock. The stoves and lamps, however, set the cars on fire, and in less than five minutes about seventeen passengers were burnt to death. It will thus be seen that no lives would have been lost had anyone of the following ordinary precautions been observed:—(1) An elevated switch indicator clearly visible above the roofs of the high covered cars; (2) a distant, or even only a home signal interlocked with the points; (3) proper switches used, as is everywhere the practice except in the United States, where contractor's points are nearly universal; (4) the guard of the goods train seen personally that a main line switch was set right for a fast express; (5) a safer method of heating than the ordinary badly secured and brittle cast iron stove. It was freely stated at the time the accident occurred that the brakes on the train were in bad order, and were set not to work on at least one of the cars. As all ordinary precautions appear to have been neglected before the accident, it might naturally be imagined that the negligent brakeman would be punished after the event, on the principle of locking the stable door after the horse is stolen; but even that consolation is



LANGDON AND WADE'S EXCENTRIC GRIP LEVER.

denied us. An American paper states:—"The Rio accident was caused directly by the criminal carelessness of a brakeman in neglecting to close a switch. That man ought to be now in the penitentiary as a slight punishment for hurrying a crowd of human beings into eternity, and particularly as an example to other railroad men. But, instead of being in durance, he is at large, figuring as a hero. After passing through a trial that was a mockery of justice, he was set free, and was for some time exhibited in a dime museum in Milwaukee as an object of curiosity or admiration!" A "dime museum" is the American successor of Mrs. Jarley's waxworks. The price of admission is a "dime," or 10 cents.

The cheap cost per mile of American railroads need no longer be matter of surprise when a presumably first-class American railway, said to be the longest in the world under one management—5300 miles—exhibits on its main line such utter neglect of the most common and obvious precautions. The wonder is that passengers ever survive a journey, or tolerate such barbarous and reckless management. As a sequel we may add that another pin-connected railway bridge, quite new, has tumbled down, killing eight men.

LANGDON AND WADE'S EXCENTRIC GRIP LEVER.

The accompanying engraving illustrates a reversing lever for locomotives, in which the usual notched segment is dispensed with, the lever being held in place by two clutches which act like the well-known silent feed in saw mills. The engraving explains itself. The position of the lever admits of being fixed with the greatest nicety. The driver grasping the handle has only to open his hand to secure the lever in any place. The excentric grip pawls are actuated by spring bars which keep them down in the grooved cue. The arrangement has been tried with satisfactory results, and patented by Messrs. Langdon and Wade, of Hornsea, Hull.

BELGIAN STATE RAILWAY LOCOMOTIVES.

Continuing the series of types of engines used on the Belgian State Railways,[1] we this week reproduce on page 294 the drawings of two goods engines, types 28 and 29, which differ from one another chiefly in the diameter of the wheels and the weight. The wheels of No. 28, at the top of the page, are 1·45m. = 4ft. 9in. in diameter, while those of No. 29, at the bottom, are 1·3m. = 4ft. 3in. in diameter. The former weighs 32 tons empty and 35 tons in running order, while the corresponding weights of the latter are about 6 cwt. less The other leading dimensions of both engines are as follow:—

Diameter of cylinders	0·45m.	=1ft. 5¾in.
Stroke	0·6m.	=1ft. 11½in.
Diameter of boiler	1·3m.	=4ft. 3in.
Number of tubes	226	
Length of tubes	3·51m.	=11ft. 6in.
Outside diameter of tubes	0·045m.	=1¾in.
Firebox heating surface	10·92m.q.	=118 sq. ft.
Tube heating surface	98·463m.q.	=1060 sq. ft.
Capacity of boiler	5·58m.c.	=195 cu. ft.

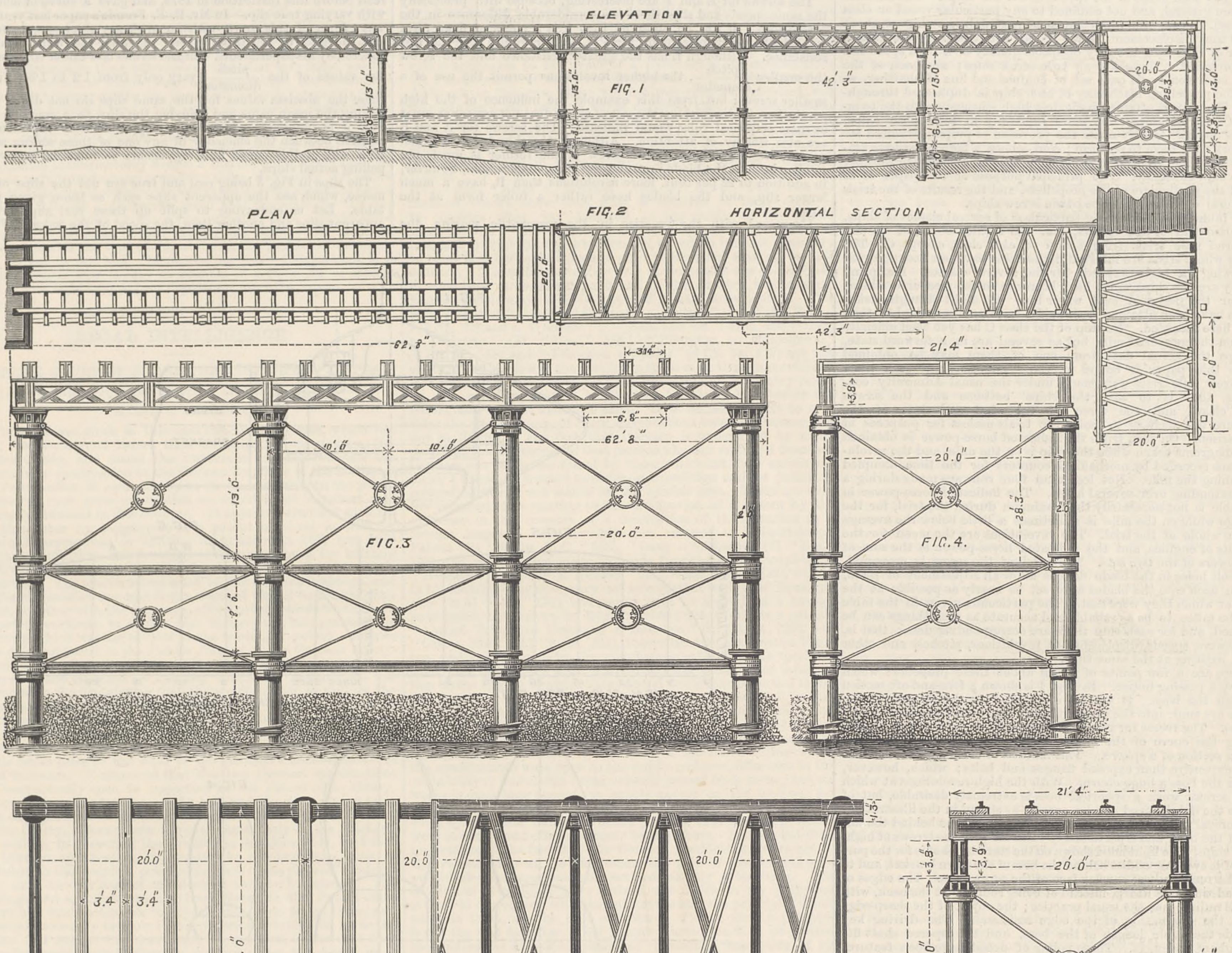
While the lighter engines are used on the level, the heavier are employed on steep gradients, easily drawing a load of 230 tons at a speed of twenty miles an hour. These engines have no brake, but are fitted with Lechatellier's apparatus for discharging water from the boiler into the chimney. This is used when descending gradients without steam, to prevent smoke and sparks from being drawn into the cylinders, owing to the draught created by the water at boiler pressure, which is converted into steam directly it leaves the boiler.

Naval Engineer Appointments.—The undernamed have been awarded medals for long service and good conduct:—T. Metcalf, engine-room artificer, of the Enchantress; C. E. Little, chief engine-room artificer, of the Egeria; S. R. Algar, chief engine-room artificer; George Baldwin, engine-room artificer. The following appointments have also been made at the Admiralty:—Elijah Tricker and John T. H. Denny, chief engineers, to the Excellent, additional, for torpedo and hydraulic course in the Vernon and Excellent, to date April 12th; Charles Allsop, engineer, to the Rupert; William C. Fincham, engineer, to the Asia, additional; William H. James, assistant-engineer, to the Tamar.

[1] See The Engineer of September 11th, 1885, page 197; April 23rd, 1886, page 320; and 8th April, 1887, p. 278.

PIER AT SALTO, ON THE RIVER URUGUAY.

MR. ALLAN WILSON, M. INST. C.E., ENGINEER.



PIER AT SALTO, ON THE RIVER URUGUAY.

THE Salto Pier is situated on the river Uruguay, and constructed by the North-Western of Uruguay Railway Company to meet the growing wants of the town of Salto, which is the terminus of the railway. It was urgently required to facilitate the landing of passengers and goods at this important town, and it is said to be the finest in the Uruguay Republic. The shape of the pier is that of the letter T. The superstructure consists of lattice girders of nearly 42ft. each in length, and 8ft. 9½in. in depth. The bracing had to be of the most substantial description to meet the heavy stresses that occur when the pier is sometimes submerged to a depth of 15ft. during floods, with a rapid current. The designs were those of Mr. Allan Wilson, M. Inst. C.E., and the works were carried out by Mr. J. J. Gardiner, the company's resident engineer. Although some difficulties had to be contended with, the works nevertheless were carried out with rapidity, and the finished pier has given every satisfaction. The superstructures of the pier, and a bridge built under the same engineer near by at the same time, were erected in the different yards under the supervision of Mr. H. Conradi, London.

The pier is carried upon cast iron columns, braced together with wrought iron rolled joists, wrought iron stays, and tie-rods, with screws on the latter to tighten the bracing when required. The lower lengths of the columns are screwed into the substratum. The columns are 2ft. in diameter, with suitable caps, and 42ft. apart from centre to centre longitudinally and 20ft. transversely. They are made up in corresponding lengths of 12ft. and 6ft., with external flanges, face-jointed and bolted together. The columns are filled with concrete. The general features and dimensions will be readily gathered from the above engravings. The erecting was done day work, and the total cost of the pier was about £5000; the wrought iron being about 183 tons, cost £3000; cast iron, 65 tons, £500; erecting the 248 tons, £1040; concrete, planking, turntables, &c., £460. These figures are approximate only, but they give some idea of the cost of such work made in England and erected in Uruguay.

SOME RECENT HIGH-SPEED TWIN-SCREWS.[1]

By Mr. E. A. Linnington.

One of the most interesting and valuable features in the development of naval construction in recent years is the great advance which has been made in the speeds of our war ships. This advance has been general, and not confined to any particular vessel or class of vessel. From the first-class armoured fighting ship of about 10,000 tons displacement, down to the comparatively diminutive cruiser of 1500 tons, the very desirable quality of a high speed has been provided. These are all twin-screw ships; and each of the twins is driven by its own set of engines and line of shafting, so that the propelling machinery of each ship is duplicated throughout. The speeds attained indicate a high efficiency with the twin-screws. In all ships, but more especially in high-speed ships, success depends largely upon the provision of propellers suited for the work they have to perform; and where a high propulsive efficiency has been secured there is no doubt the screws are working with a high efficiency. The principal purpose of this paper is to record the particulars of the propellers, and the results of the trials of several of these high-speed twin-screw ships.

The table gives the leading particulars of several classes of ships, the particulars of the screws, and the results obtained on the measured mile trials from a ship of each class, except C. The vessels whose trials are inserted in the table have not been selected as showing the highest speeds for the several classes. Excepting C, they are the ships which have been run on the measured mile at or near the designed load water line. On light draught trials speeds have been attained from half a knot to a knot higher than those here recorded. No ship of the class C has yet been officially tried on the measured mile, but as several are in a forward state, perhaps the actual data from one of them may be obtained before this paper is bound in the "Transactions." All these measured mile trials were made under the usual Admiralty conditions, that is to say, the ships' bottoms and the screws were clean, and the force of the wind and state of the sea were not such as to make the trials useless for purposes of comparison. On such trials the indicated horse-power is obtained from diagrams taken while the ship is on the mile, and the revolutions are recorded by mechanical counters for the time occupied in running the mile. Not less than four runs are made during a trial extending over several hours. The indicated horse-power in the table is not necessarily the maximum during the trial, for the average while on the mile is sometimes a little below the average for the whole of the trial. The revolutions are the mean for the two sets of engines, and the indicated horse-power is the sum of the powers of the two sets. The pitch of the screw is measured. The bolt holes in the blade flanges allow an adjustment of pitch, but in each case the blades were set as nearly as possible at the pitch at which they were cast. The particulars given in the table may be taken to be as reliable and accurate as such things can be obtained, and for each ship there are corresponding data; that is, the powers, speeds, displacements, revolutions, pitches, and other items, existing at the same time.

There are a few points of detail about these propellers which deserve a passing notice. In Fig. 1 is shown a fore-and-aft section through the boss. It will be observed that the flanges of the blades are sunk into the boss, and that the bolts are sunk into the flanges. The recess for the bolt heads is covered with a thin plate having the curve of the flange, so that the flanges and the boss form a section of a sphere. This method of construction is a little more expensive than exposed flanges and bolts; which, however, render the boss a huge churn. With the high revolutions at which these screws work a spherical boss is extremely desirable, but of course the details need not be exactly as shown in the illustration. The conical tail is fitted to prevent loss with eddies behind the flat end of the boss, and is particularly valuable with the screws of high-speed ships. The light hood shown on the stern bracket is for the purpose of preventing eddies behind the boss of the stern bracket, and to save the resistance of the flat face of the screw boss. The edges of the blades are cast sharp, instead of being rounded at the back, with a small radius, as in the usual practice; the object of the sharp edge being the diminution of the edge resistance. The driving key extends the whole length of the boss, and the tapered shaft fits throughout its length. These points of detail have been features of all Admiralty screws for some years.

The frictional resistance of screw propellers is always a fruitful source of inefficiency. With a given screw the loss due to friction may be taken to vary approximately as the square of the speed. This is not to say that the frictional resistance is greater in proportion to the thrust at high than at low speeds. The blades of screws for any speed should be as smooth and clean as possible, but for high speed screws the absolute saving of friction may be considerable with an improvement of the surface. There is no permanent advantage in polishing the blades. No doubt there is some advantage for a little time, and probably better results may thereby be secured on trial, but the blades soon become rough, and shell-fish and weed appear to grow as rapidly on recently polished blades as on an ordinary surface. These screws are of gun-metal: they were fitted to the ships in the condition in which they left the foundry.

It appears that within certain limits mere shape of blade does not affect the efficiency of the screw, but with a given number of blades and a given disc, the possible variations in the form or distribution of a given area are such that different results may be realised. The shapes of the blades of these propellers are shown in Figs. 2, 3, 4. It will be seen the shapes are not exactly the same for all the screws, but the differences do not call for much remark. Fig. 2 shows the blades for the A screw; C and D have the same form. Fig. 3 shows in full lines the blades of the B screw, and though very narrow at the tips, they, like A, are after the Griffith pattern. The blades of E and F are of a similar shape, as shown in Fig. 4, and approach an oval form rather than the Griffith pattern.

The particulars of these propellers would be considered incomplete without some reference to their positions with respect to the hulls. When deciding the positions of twin screws, there is room for variation, vertically, longitudinally, and transversely. For these screws the immersions inserted in the table give the vertical positions. The immersion in A is 9ft., showing what may be done in a deep-draught ship with a small screw. Whatever the value of deep immersion may be in smooth water, there can be no question that it is much enhanced in a seaway. The longitudinal positions are such that the centre of the screw is about one-fifth of the diameter forward of the aft side of the rudder post. The positions may, perhaps, differ somewhat from this rule without appreciably affecting the performance; but if any alteration be made it would probably be better to put the screws a little further aft than forward. The forward edges of the blades are from 2ft. to 3ft. clear of the legs of the bracket which carries the after bearing. The transverse positions are decided to some extent by the distance between the fore and aft centre lines of the engines. As regards propulsive efficiency it would appear that the nearer the screws are to the middle line, the less is the resistance due to the shaft tubes and brackets, and the greater is the gain from the wake in the screw efficiency; but, on the other hand, the greater is the augment of the ship's resistance due to the action of the screws. Further, the nearer the screws are to the hull the less are they exposed; but experience is not wanting to show that the vibration may be troublesome when the blades come within a few inches of the hull. Instead of balancing these considerations, it is more satisfactory to state that the average of the clearances between the tips of the blades and the respective hulls is about one-eighth of the diameter of the screw. An interesting and noteworthy fact in connection with these propellers is the wide differences in the pitches and revolutions, though the products of the two do not greatly vary. Such differences are extremely rare in the mercantile marine for similar speeds, but in war ships they are inseparable from the conditions of the engine design. As a general rule, with (revolutions × pitch) a constant, an increase of revolutions and the consequent decrease of pitch allow a diminution of disc and of blade area; other modifying conditions, such as the thrust, slip, number, and pattern of blades being the same.

The screws for E and F are interesting, because with practically the same speeds and slips there is a considerable difference in the revolutions. It will be observed that F is a vessel of finer form and a little less displacement than E, and therefore has the less resistance. Although E has the greater resistance and the screw the smaller $\frac{\text{pitch}}{\text{diameter}}$, the higher revolutions permit the use of a smaller screw; but from this example the influence of the high revolutions in diminishing the size of screw does not appear so great as some empirical rules would indicate. The screws for A and B are also worthy of attention. Although the ship A has a much greater resistance than B, the screw of the former is much the smaller both in the blade area and the disc. A's screws, however, in addition to 22 per cent. more revolutions than B, have a much larger slip, and the blades have rather a fuller form at the tips.

Compared with the practice in the mercantile marine, the revolutions of these screws are very high, and from the foregoing remarks it may appear that much larger screws would be required for a merchant ship than for a war-ship of the same displacement and speed. There would, however, be several items favourable to the use of small screws. For a given displacement, the resistance would be less in the mercantile ship, and with the lower revolutions the proportion of blade area to the disc could be increased without impairing the efficiency. Thus in passing from the war vessel to a merchant ship of the same displacement, there are the lower revolutions favourable to a larger screw, but on the other hand, the smaller resistance, larger proportion of blade area, and the coarser pitch, are favourable to a diminution of the screw. The ship B has a very large screw at 88 revolutions, but the tips are very narrow. If the blade were as dotted for a diameter of 16ft., the same work could be done with the same revolutions, but with a little coarser pitch and a little more slip.

There is something to be said for large screws with a small proportion of blade area to disc. For instance, two-bladed screws have frequently given better results than four-bladed screws of smaller diameter, neglecting, of course, the question of vibrations. Twin screws, however, should as a rule be made as small as possible in diameter without loss of efficiency. The advantages of small twin screws are the shorter shaft tubes and stern brackets, deeper immersion, and less exposure as compared with large screws. The exposure of the screws is usually considered an objection, but perhaps too much has been made of it, for those well qualified to speak on the subject consider that careful handling of the ship would, in most cases, prevent damage to the screws, and that where the exposure is unusually great, effectual protection by portable protectors presents no insuperable difficulty.

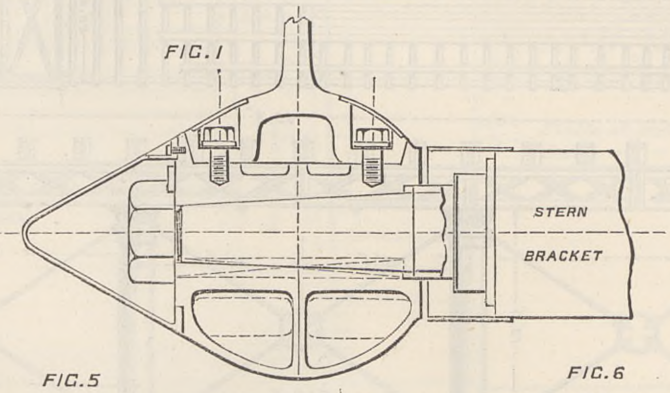
The slips of these screws vary from 10 to 17½ per cent., which is certainly not an extensive range, considering the widely different working conditions. Slip as an indication of the efficiency of the screw is not only an interesting subject but it is often one of importance. In these ships, however, there is nothing about the slips which would give rise to any doubts as to the fitness of the screws for their work. I should like to say a few words upon this slip question, though an adequate treatment of it would require a separate paper of considerable length. The ancient fallacy that small slip meant a high screw efficiency was supported by the great authority of the late Professor Rankine. Experience proved that considerable slips and efficient screws were companions. The late Mr. Froude offered an explanation of this general rule in a paper read before this Institution in 1878, and gave a curve of efficiency with varying true slip. In Mr. R. E. Froude's paper last year there was a form of this curve, with an arbitrary abscissa scale for the slip, devised to illustrate in one diagram the wide conditions covered by his experiments. In the screws now under consideration the values of the $\frac{\text{pitch}}{\text{diameter}}$ vary only from 1·2 to 1·34, and for these the abscissa values for the same slips do not differ much. Taking the mean value and bringing the slips to a common scale, Fig. 5 is obtained, which would approximately represent the relation between the efficiency of any one of these screws and its true slip, if this curve were applicable to full-sized screws propelling actual ships.

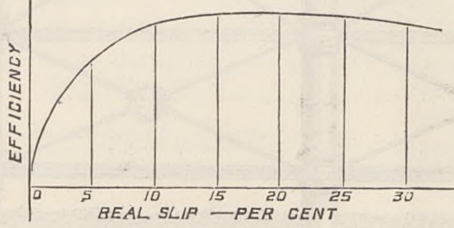
The slips in Fig. 5 being real and true are not the slips of commerce, which are the apparent slips such as those given in the table. Let us endeavour to split up these real slips into the apparent slips and another item, the speed of the wake. We then at once meet with the difficulty that the wake in which the screw works has not a uniform motion. Complex, however, as are the motions of the wake, the screw may be assumed to work in a cylinder of water having such a uniform forward velocity as will produce the same effect as the actual wake on the thrust of the screw. It is then readily seen that the real slip is the sum of the apparent slip and the speed of the hypothetical wake. To make this clear, let V be the speed of the ship, V_s the speed of the screw, *i.e.*, revolutions × pitch, and V_w the speed of the wake; then—

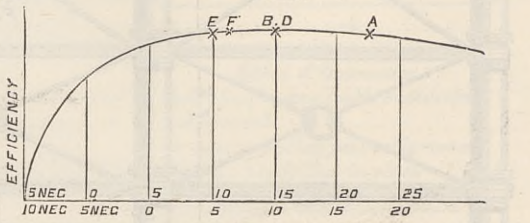
Apparent slip $= V_s - V$.
Real slip $= V_s -$ speed of ship with respect to the wake.
,, $= V_s - (V - V_w) = (V_s - V) + V_w$.
,, $=$ Apparent slip + speed of the wake.

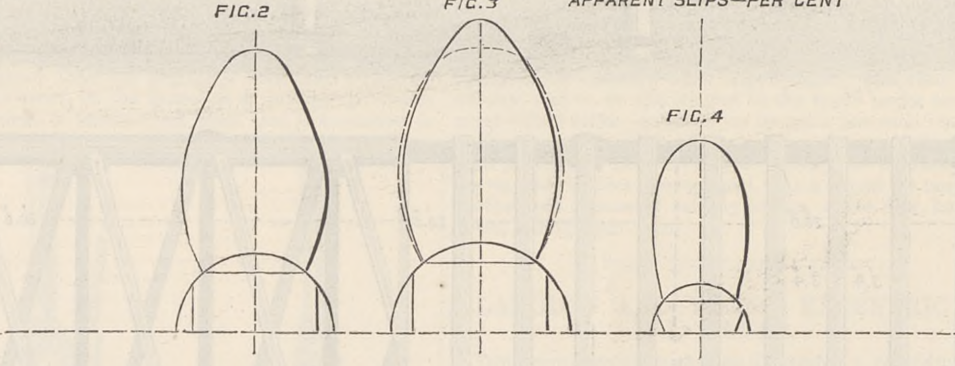
If the apparent slip be zero, the real slip is the speed of the wake; and if the apparent slip be negative, the real slip is less than the speed of the wake. The real slip is greater than the apparent slip, and can never be a negative quantity.

From Mr. Froude's model experiments it appears that this speed of wake for the A class of ship amounts to about 10 per cent. of the speed of the A screw. If this value is correct, then the real slip is (10 + 17·6) per cent., or 27·6 per cent. This is shown in Fig. 6, where O is the point of no slip, being 17·64 from the point of real slip. Slips to the right of O are positive apparent slips, slips to the left are negative apparent slips. The vessel F would certainly have a wake with a speed considerably less than that of A's wake. From the model experiments the wake for F is about one-half that for the A class, or roughly 5 per cent. of the speed of the screw. For ship F, O' is the point of no apparent slip, and the real slip is (5 + 11·4) or 16·4 per cent. For E, the point of real slip is approximately the same as for F. For B, and D, the positions on the curve would be about the same. The ship B has a higher speed of wake than D, but the screw D has the greater apparent slip. The influence of the number of blades on the scale for the slip has been neglected. If this efficiency curve were applicable to full-sized screws propelling actual ships, and if the determination of the wakes were beyond question, then we should have a proof that our screws were at or near the maximum efficiency. But as









Particulars of some Recent High-speed Twin Screws.

Ship	A.	B.	C.	D.	E.	F.
Length, feet	325	315	300	300	220	250
Breadth, feet	68	61	56	46	34	32½
Draught on trial } Forward	26ft. 2in.	24ft. 6in.	—	15ft. 6in.	12ft. 10in.	13ft. 1in.
Draught on trial } Aft	27ft. 3in.	25ft. 6in.	—	19ft. 9in.	15ft. 2in.	14ft. 7in.
Displacement, tons	9690	7645	5000	3584	1560	1544
I.M.S., square feet	1560	1287	1000	744	438	392
Speed of ship, knots	16·92	17·21	18·75	18·18	16·91	17
I.H.P.	11,610	10,180	8500	6160	3115	3045
Revolutions per minute	107·2	88	120	122·6	150·4	132·1
Pitch of screw	19ft. 5in.	22ft.	18ft. 9in.	17ft. 6in.	12ft. 7½in.	14ft. 9in
Slip, per cent.	17·6	10	—	14·2	9·7	11·4
Diameter of screw	15ft. 6in.	18ft.	14ft. 6in.	13ft.	10ft. 6in.	11ft.
Diameter of boss	4ft. 4in.	4ft. 11in.	3ft. 9in.	3ft. 5in.	2ft. 9in.	2ft. 10in.
Number of blades	4	4	3	3	3	3
Blade area of one screw	72	87	60	47	24	24
Shape of blade	Fig. 2	Fig. 3.	Fig. 2	Fig. 2	Fig. 4	Fig. 4
$\frac{\text{Pitch}}{\text{Diameter}}$	1·25	1·22	1·3	1·34	1·2	1·34
$\frac{\text{Disc}}{\text{Blade area}}$	2·62	2·92	2·75	2·82	3·6	3·96
Immersion of screw	9ft.	5ft. 3in.	—	4ft. 4in.	2ft. 9in.	1ft. 10in.

[1] Read at the Twenty-eighth Session of the Institution of Naval Architects.

we know from the total propulsive efficiencies that the screws have high and not widely different efficiencies on these ships, we may argue the other way, and say that there is good reason to consider that at least the upper part of the curve agrees with experience obtained from actual ships.

Now take Fig. 6 and consider the general laws there represented. Take the speed of the wake as 10 per cent. of the speed of the screw, which is probably an average of widely different conditions, including many single as well as twin-screw ships. Then this curve shows that considerable negative slips mean inefficient screws; that screws may have very different positive slips without any appreciable difference in their efficiencies; and that very large positive slips and inefficient screws may be companions; for instance, a screw with a large positive slip in smooth water is frequently inefficient at sea against a head wind, which increases the resistance and necessitates an increase of slip. I venture to say that these statements, taken in a general manner, are not at variance with experience obtained from the performances of screw ships. Before it is possible to satisfactorily decide if this curve applies in a general manner to full-sized screws propelling ships, we require the results of trials of various ships where the screws are working about the region of no slip. Model experiments teach that the scale for the slip varies with the design of the screw, and that with a given screw the speed of the wake—which decides the point of no apparent slip—varies with the type of ship and with the position of the screw with respect to the hull. Remembering these disturbances, it is not improbable that it may be possible to account for or explain what at first sight may appear departures from the curve.

LEGAL INTELLIGENCE.

SUPREME COURT OF JUDICATURE.—COURT OF APPEAL.

(*Before* LORDS JUSTICES COTTON, LINDLEY, *and* LOPES.)

HARRIS *v.* ROTHWELL.

JUDGMENT was given in this case last Tuesday week, which has been recently argued before their lordships on appeal from Mr. Justice Chitty, and raised the important question whether the deposit of a specification in the German language in the library of the Patent-office in such a way as to be accessible to the public constituted such prior publication as would avoid a patent subsequently obtained in this country. It appeared that the plaintiff was the owner by assignment of a patent obtained in 1880 for certain improvements in knitting machines. In 1877 and 1879 certain specifications and drawings of German patents for knitting machines were deposited in the London Patent-office for public inspection. The specifications were in the German language, and for the purposes of the case it was assumed that if in English they would, together with the drawings, afford sufficient information to a competent workman to enable him to carry out into practice the invention which was the subject of the plaintiff's patent. Entries were duly published in the *Patents Journal* of the German specifications among those in the list of foreign patents, and they were referred to and classified as knitting machines. A foot-note was appended to the list, stating that the specifications, as well as the list of applications, might be consulted at the free public library of the Patent-office. The question for the opinion of the Court was whether, under these circumstances, there was sufficient evidence, if not rebutted, to prove the publication of the German specifications in this realm prior to the date of the plaintiff's patent, so as to avoid the same. It appeared that the two German specifications had been actually open to inspection in the Patent-office library, the one during some two years and a-half, and the other during some forty days previous to the date of the plaintiff's application. Mr. Justice Chitty, before whom the case came early in the Michaelmas sittings, in answering the question in the affirmative, held that the German specification had, under the circumstances, been so published in this country, prior to the date of the plaintiff's patent, as to have become part of the stock of common knowledge. The drawings and specifications had been placed in the Patent-office library and made accessible to anyone who chose to go there, and it was not necessary to show that any person actually did go to the library and inspect the documents in question. The fact that these documents were in German did not affect the result, as it could not be assumed that the information was given in a language which was unintelligible to the public. From that decision the plaintiff had appealed.

Mr. Aston, Q.C., and Mr. W. R. Bousfield appeared in support of the appeal; Mr. Romer, Q.C., and Mr. T. M. Goodeve for the respondent.

Lord Justice COTTON stated that as he had had the opportunity of seeing, and entirely concurred in, the judgment which had been prepared by Lord Justice Lindley, he did not propose to deliver a formal judgment.

Lord Justice LINDLEY read the following judgment:—The question in this case is in substance whether, under the circumstances stated in the special case, the plaintiff's assignor was the true and first inventor of the patented invention claimed by the plaintiff. The plaintiff establishes a *primâ facie* case by proving the patents, and he thus throws the burden of proof on the defendant, and it is for him to prove, if he can, some prior use of the invention in this country, or some prior publication, in his country, of some intelligible description of the plaintiff's invention. This point was settled in "Anory *v.* Brown"—L.R., 8 Eq., 663—and, indeed, long before. In the present case prior use is not alleged. Prior publication is what is relied upon. The special case states in effect that before the date of the plaintiff's patent there existed in the library of the Patent-office two copies of two German specifications, each of which, with the drawings annexed, contained a description of the plaintiff's invention. One of these specifications had been in the library more than a year; the other had been there about six weeks. The existence in the library of these German specifications was not only known to the librarian, but attention had been called to the fact of their existence in the library by the publication in the *Journal* of English translations of their titles. Moreover, the specifications themselves were in their proper places in the library, and anybody wanting to use them could have done so. Whether any one other than the librarian did in fact ever see them is not known. It appears to me that on this evidence the burden of showing that the English patentee was the first inventor in this country is again cast upon the plaintiff; and that unless he can show that the German specifications were not, in fact, seen by any one who could understand them, the defendant is entitled to succeed. If the case were being tried by a jury, I am not sure that the Judge might not direct them to find for the defendant on the issue that the patentee was the true and first inventor. But on the present occasion it is unnecessary to decide this, and, without going so far as to say that the Judge ought to give such a direction I am clearly of opinion that the Judge ought at least to tell the jury to find for the defendant on the issue that the patentee was the true and first inventor, if they thought that the German specifications had been so published in this country as to have become known to any one here; and to guide the jury on this point the Judge ought to tell the jury that the invention having been laid before the public in this country in the way and for the time mentioned in the special case, the invention ought to be presumed to have become known in this country in the absence of all proof to the contrary. Even if the case had turned solely on the publication of the second of the two German specifications, I should not be prepared to say it would be wrong to direct a verdict for the defendant. But the only question, assuming that it would not be right to go so far, which could be properly left to them would be whether in their opinion the German specification had been published in this country long enough before the plaintiff's patent to have become known here. But this question really admits of but one answer, and I cannot suppose that any jury would find that six weeks were not long enough for such a purpose. If the two German specifications had been in the English language I have no doubt that the defendant would be entitled to succeed. It is familiar law that proof of the description in English of an invention in a book published in this country is fatal to the validity of a subsequent patent for the same invention. In such a case no evidence is necessary to show that the book was in fact read or referred to. Proof that it had not been sold or circulated might no doubt be given, and if such proof were given the publication would not be fatal to the patent. This was pointed out by the then Master of the Rolls (Sir G. Jessel) in "Plimpton *v.* Malcolmson" (3 Ch. Div., 559). The same rule is applicable to the proof of a publication—by enrolment in the Patent-office—of an earlier specification of the same invention. Although in this case there are not many copies published, but only one copy, still proof is never required that the specification has been actually seen by the public. No doubt specifications of patents are open to the observation that they stand on peculiar grounds; and that the second of two patents for the same invention must be bad in point of law. But the cases of "Oxley *v.* Holden" (8 C.B., N.S., 666), "Bush *v.* Fox" (5 H. L. C., 707), and "Betts *v.* Menzies" (10 H. L. C., 117), not to mention others, show that what is material in these cases is to consider what was disclosed to the public in the earlier specifications. In order to show that a patentee is not the true and first inventor of his patented invention it is not necessary to show that he learnt it from a prior publication existing in this country. It is sufficient to show that the invention was so described in some book or document published in this country, as that some English people may be fairly supposed to have known of it. This is the result of "Househill Company *v.* Neilson" (1 "Webs. P. C.," 718 N), "Stead *v.* Williams" (7 "Man. and Gr.," 818), and "Lang *v.* Gisborne" (31 "Bea.," 133.) "Plimpton *v.* Malcolmson" (3 Ch. D., 531) and "Plimpton *v.* Spiller" (6 Ch. D., 412) are not opposed to this view of the law, for in those cases there was evidence which satisfied the Court that the one copy in this country relied on as a prior publication had not, in fact, been laid before the public, and was not known to exist. It is necessary next to consider the effect, if any, of these specifications being in German and not in English. The fact that German is understood by many people in this country, and that persons who can read and translate German can easily be found by those who want their assistance, must, I think, be treated as common knowledge and be judicially noticed, although not stated in the special case. There are very few reported cases relating to the anticipation of a patent by the existence in this country of a description of the invention in a foreign language. His lordship then referred to "Heurteloop's Patent" (1 "Webs. P. C.," 553), "Lang *v.* Gisborne" (31 "Bea," 133), the observations made by Lords Brougham and Campbell in "Househill Company *v.* Neilson" (1 "Webs. P.C.," 733), which, in his lordship's opinion, were not inconsistent with Lord Romilly's view (in 31 "Bea," 133), but merely went to show that a foreign publication not known in England would not invalidate a patent, "United Telephone Company *v.* Harrison" (21 Ch. D., 720), and "Otto *v.* Steel" (31 Ch. D., 341), before the late Mr. Justice Pearson, and proceeded:—In the case before us the German specifications were in the very place where every one in search of information on the subject to which they related would expect to find them, and to which he would go for information. It may well be that some person in this country may have seen these specifications and have obtained information from them which he is entitled to use; and in my opinion it would not be right to assume that there is no such person. No doubt the difference in the times during which the specifications were open to the public makes a difference in the probability of knowledge being actually gained from them; but six weeks is quite long enough to enable people on the look-out for information to acquire it, especially when they are told, as they were by the lists published in the journal, that the specifications were in the Patent-office and could be seen there. I attach but little importance to the fact that the German specifications were not in the Patent-office at the time when the lists in the journal were published—the specifications arrived shortly afterwards. The conclusion at which I have arrived, and which in my judgment is most in accordance with the authorities and the principles which underlie them, may be thus expressed. *Primâ facie*, a patentee is not the first inventor of his patented invention if it be proved that before the date of his patent an intelligible description of his invention, either in English or in any other language commonly known in this country, was known to exist in this country, either in the Patent-office or in any other library to which the public are admitted, and to which persons in search of information on the subject to which the patent relates would naturally go for information. But if, as in the "Plimpton" cases and in "Otto *v.* Steel," it be proved that the foreign publication, although in a public library, was not, in fact, known to be there, the unknown existence of the publication in this country is not fatal to the patent. The plaintiff cannot prove what under the admitted circumstances he must prove in order to sustain his patent. The decision appealed from was therefore right, and the appeal must be dismissed.

Lord Justice LOPES said he had arrived at the same conclusion as the rest of the Court, but not by the same process of reasoning. I think the existence of these German specifications in the library of the Patent-office, where they were unreservedly accessible to every one, was in itself conclusive evidence of a prior publication. The Patent-office is open to the public, and anyone of the public might have seen these specifications. Whether they were proved to have done so or not, in my opinion, is immaterial. If a previous complete specification for the same invention is proved to have been enrolled in the Patent-office, that in itself, without any proof that any one had ever seen or heard of it, is conclusive evidence of prior publication. I presume on the ground that a document describing the invention has been filed in the Patent-office, a document accessible to all, and therefore the public could not be precluded from using information which they already possessed. In "Hindmarch on Patents," p. 33 (first edition), it is laid down that "if the public once becomes possessed of an invention by any means whatever, no subsequent patent for it can be granted either to the true or first inventor himself or any other person, for the public cannot be deprived of the right to use the invention, and a patentee for the invention could not give any consideration to the public for the grant, the public possessing everything he could give." This, in my opinion, is a correct statement of the law and applicable to this case. I do not attach any importance to the fact that the specifications were in the German language. I agree with what has been said by Lord Justice Lindley on this point. The appeal must be dismissed.

NOTES ON THE PANAMA CANAL.[1]

By R. NELSON BOYD, M. INST. C.E.

THE following paper does not purpose to be an exhaustive description of the Panama Canal. I only submit a few notes, gathered on the spot, which therefore may have some importance at the present time, when any trustworthy information regarding the progress of the Canal has especial interest.

Before entering on the description of the works, it may not be out of place to remind the meeting of the origin of this great undertaking. The Panama Canal—or, to give it the official title, "La Compagnie Universelle du Canal Interocéanique"—was constituted in March, 1881, with a capital of 1,200,000,000f., or say £48,000,000 sterling, and the works were at once commenced, and have been carried on without cessation up to the present time. The idea, however, of piercing the Isthmus of Panama is by no means a recent one. The early Spanish discoverers proposed to cut through the narrow tongue of land which separates the two oceans; and Cortez had the subject investigated, and proposed to make a canal at Tehuantepec. This was about the year 1525. Many years afterwards, 1780, King Charles III. of Spain had the ground explored, with a view to making a canal. In 1804 Baron Humboldt advocated piercing the Isthmus; and in 1825 a concession was actually granted to Baron Thierry, who, however, did not bring it to any practical result. In 1830 a report on the possibility of constructing the canal was made by Messrs. Lloyd, an English engineer, and Fallmare, a Swede, and published by the Royal Society of London. This report was, however, not as detailed as it might have been; and, moreover, it was asserted that a difference of level existed between the two oceans of over 9ft., which has since been found to be fallacious. The error was no doubt caused by the difference in the rise and fall of the tides, which is a great deal more than 9ft.

Some years after this report was published—namely, in 1843-44—a French engineer, Napoleon Garella, made an exact survey of the Isthmus, with the view of constructing either a railway or a canal. But his labours had no practical result. By this time the idea of cutting through the Isthmus, or of constructing a railway, had been taken up by a number of people. Prince Louis Napoleon Bonaparte, then a prisoner in the fortress of Ham, beguiled his time with the study of a canal through Lake Nicaragua and the river San Juan. This project was, however, never brought to a practical issue. In fact, although the French engineers and capitalists had been turning their attention for some years to the question of constructing a canal or railway across the Isthmus, their projects came to nothing; and eventually an American company got a concession and started the present Panama Railroad. The question of a canal then fell aside until the Suez Canal had been successfully opened. The United States Government were the first to take the matter up, and in 1871 sent a strong staff of engineers to Panama to survey and report. However, no serious attempt to grapple with the subject was made until the meeting of the Geographical Congress of 1871, held at Antwerp, when the possibility of constructing a canal across the Isthmus was much discussed. The question was again considered at the next congress in 1875. The immediate consequence of these important discussions was the formation, in 1876, of a French committee for the study of a canal across the Isthmus, with M. de Lesseps at the head of it. About this time Mr. Napoleon Wyse formed a company to defray the expenses of an exploration and survey of the ground, and went out at the head of an expedition for this purpose, and ended by obtaining a concession from the Columbian Government. This concession was then submitted to the French committee, who called together a congress for the special consideration of the different projects and schemes for constructing a canal. The congress was composed of 136 members, of different nationalities, and their labours were considerable, for they had no less than fourteen different projects submitted to them for consideration. After much deliberation, this congress selected the project of Mr. Wyse for a canal, without locks, from Colon to Panama, estimated to cost 1,070,000,000f., or, allowing interest on money during construction, 1,200,000,000f.

M. de Lesseps undertook to form a company, and the works were commenced in 1881. The ground was accurateiy surveyed, and the general plan and sections definitely fixed. The canal is to be 74 kilos. long from end to end, including 5 kilos. of dredging through the shallow estuary at the Panama end. The width of the canal at bottom is 22 metres, at top water 40 metres, and the depth of water is 9 metres. The slopes are nominally 1 to 1. From the Colon end it follows the valley of the Chagres river almost to the watershed at Culevra, a distance of over 50 kilom. But in order to do so, the river Chagres has to be deviated over a length of about 30 kilom. This is one of the great difficulties of the canal. The river Chagres drains a very large area, and during the rainy season is subject to sudden and considerable floods. This is natural with a rainfall of 3 metres per annum. It is on record that in one day of twenty-four hours, in November, the rainfall was 165 mm., or 6½ English inches. With such a rainfall over the great drainage area of the Chagres river, it is not surprising that the river at times rises 8 metres in the course of a few hours. The usual flow of the Chagres is 13 metres per second in dry weather; but during the rainy season it rises up to 134 metres, even during storms to 600 metres.

The deviation of the Chagres is a difficulty apparently not foreseen, and an expense not provided for by the early surveyors. It is in reality a necessity for the preservation of the canal, as the new bed will act like a huge ditch, and receive the surface drainage during the rains, which otherwise would rush into the canal—to say nothing of the trees, rocks and silt brought down by these floods. The new bed of the river is to be 40 metres wide by 5 metres deep. In order to deal more effectually with these excessive floods, it had been proposed to dam up the valley at the head of the Chagres, and thus form an immense reservoir. This project is for the time abandoned. It would involve a dam about 1445 metres long by 45 metres in height, with a cube of about 10,000,000 metres; and this would have to be constructed in the face of the floods rushing down the upper valley of the Chagres, unless the whole dam were constructed during one dry season, which is scarcely possible. At this point, known as Gamboa, the canal leaves the valley of the Chagres and crosses the watershed at Culevra. From the Culevra on to the Pacific Ocean no special difficulties have to be overcome. On this side of the watershed the river Obisbo and its confluents are regulated and deviated to form a ditch, just as the river Chagres is on the Atlantic slope. In fact, the deviations of these and other rivers and their tributaries are so arranged as to form two continuous smaller canals on each side of the main ship canal, and this may be considered as indispensable for its safety.

For some kilometres before reaching the Pacific ocean the canal runs through swampy ground very little above sea-level and eventually joins the sea at La Boca or mouth of the river Grande. Unfortunately the water is very shallow here, and the last five kilometres have to be dredged through a bed of sand forming a wide bar at the mouth of the river Grande. Although the work has been commenced all along the line, not one length of the canal is anything like near completion. I had the opportunity of visiting most of the sections, and with the exception of the Colon end and a short length at Gorgona, where the canal follows the present bed of the river Chagres, not one of the cuttings is down even to water-level, and many have merely had the surface removed. At Colon the entrance to the canal has been constructed by making an embankment which protects it from the north winds, and has reclaimed ground, formerly a swamp, on which the pleasant little settlement called "Cristophe Colomb" has been built. From the entrance the canal has been dredged to a depth of 6 metres for a length of 4½ kilom., and is open for small steamers. Three very powerful steam dredges are now at work deepening the canal down to 9 metres. After this comes a length of ground almost untouched, owing to disputes with the contractors. Then comes a length of 6 kilom. on the old bed of the Chagres, where dredges are at work deepening. These dredges have a power of 180-H.P., and raise about 3000 cubic metres in the twenty-four hours. This seemed to me to be the best conducted work on the canal.

From this on, all the earth in the cuttings is moved by hand labour, with the narrow gauge railway known as the "Decauville," or by the steam navvy or excavator, with full-sized railway wagons. The engineers advocate the latter, because they can get more work done; but some of the contractors prefer the former method. The steam navvy Osgood at work on the Tavernilla section moves 300 to 360 cubic metres in ten hours; this section is almost level. At Soldado a hill of about 65 metres in height is being removed by immense blasts of dynamite.

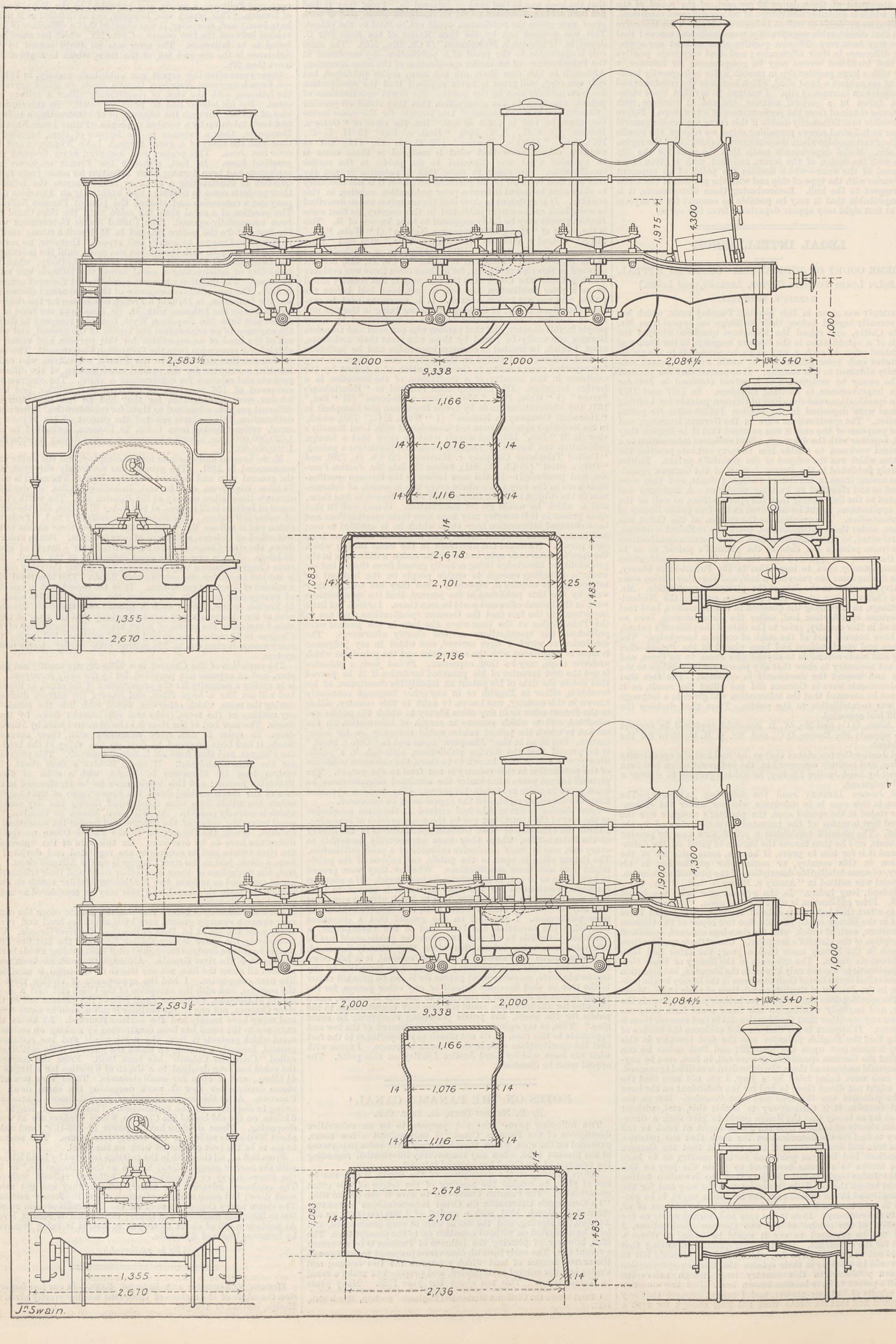
(*To be continued.*)

[1] Read before the Civil and Mechanical Engineers' Society, March 30th, 1887.

HODGES' EXHAUSTING AND BLOWING FANS.—In our last impression the name of the makers of these fans was incorrectly given as Hodge, instead of Hodges.

TYPES OF BELGIAN STATE RAILWAY LOCOMOTIVES.

(*For description see page 290.*)



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CONTENTS.

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J. R.—*Consult the indexes which you will find at your disposal in the Patent-office Library.*

EARLY STANDARD GAS THREADS.

(To the Editor of The Engineer.)

SIR,—Can any reader tell me what was the standard gas thread before Whitworth's came into use? J. W.

Manchester, April 14th.

STEEL RUST.

(To the Editor of The Engineer.)

SIR,—Could any one of your correspondents kindly inform me, through the medium of THE ENGINEER, what will stop the rusting of a Siemens-Martin steel pan, which I have made for a customer of mine to boil clean water in? When it is boiled it is entirely useless through discoloration by rust. ANTI-CORROSION.

Halifax, April 10th.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS, 25, Great George-street, Westminster, S.W.—Session 1886-87. Tuesday, April 19th, at 8 p.m.: Ordinary meeting. Paper to be read with a view to discussion:—"Water Supply from Wells," in the London Basin, at Bushey (Herts), in Leicestershire, and at Southampton, by Messrs. Grover, Fox, Stooke, and Matthews respectively.

SOCIETY OF ARTS, John-street, Adelphi, London, W.C. — Tuesday, April 19th, at 8 p.m. Foreign and Colonial Section: "South Africa," by Major-General Sir Charles Warren, G.C.M.G. Wednesday, April 20th, at 8 p.m.: Ordinary meeting. "Electric Locomotion," by A. Reckenzaun: W. H. Preece, F.R.S., will preside.

METEOROLOGICAL SOCIETY.—Wednesday, 20th instant, at 7 p.m., by permission of the Council of the Institution of Civil Engineers, at 25, Great George-street, Westminster: Ordinary meeting. Papers to be read:—"The Storm and Low Barometer of December 8th and 9th, 1886," by Charles Harding, F.R. Met. Soc.; "Report of the Wind Force Committee," drawn up by G. Chatterton, M.A., M. Inst. C.E., F.R. Met. Soc.; "A New Form of Velocity Anemometer," by W. H. Dines, B.A., F.R. Met. Soc.; "Description of Two Maximum Pressure Registering Anemometers," by G. M. Whipple, B.Sc., F.R. Met. Soc.

SOCIETY OF ARCHITECTS.—Tuesday, April 19th, at the Freemasons' Tavern, Great Queen-street, W.C., at 7 o'clock p.m.: Ordinary meeting. Paper to be read:—"Law Affecting Architects in Relation to their General Duties," by C. H. Robertson, solicitor to the Society.

DEATHS.

On the 8th inst., at Maura, Bournemouth, ALEXANDER BASSETT, Mem. Inst. C.E., of Baynton House, Llandaff, Glamorganshire, aged sixty-two years.

On the 21st March, on the voyage home, on board the s.s. Assam, HENRY DANGERFIELD, M.I.C.E., manager and engineer-in-chief P.W.D. of the Bhownagar Gondal Railway, Kattiawar, in his forty-third year. Indian papers, please copy.

THE ENGINEER.

APRIL 15, 1887.

EDUCATION AND PATENTS.

ABOUT 16,000 inventions now find their way every year to the Great Seal Patent-office. This is over 300 per week, or, say, fifty per day. A great many of these are little more than crude ideas, never getting beyond the provisional protection stage; others are not very new. Eliminating these inventions which have no pretension to vitality, we shall not be far wrong if we say that at least 3000 patents are granted every year in Great Britain and Ireland for inventions which are, or appear to be, so important that considerable sums of money are spent on their development. What comes of these inventions? The answer must be, we think, that nothing comes of them. We venture to say that the number of patents being worked at all—we shall not say at a profit, but being worked—is very much smaller than most people imagine. If a census could be taken, it would be found, we think, that there are not altogether 3000 patents worked, and that the number worked at a profit is possibly not 500. The steam engine is an excellent test. Notwithstanding the vast host of patents which have been taken out for improvements in it, we shall not be far from the truth if we say that not more than about thirty patents are really being worked. There are five different high-speed engines, all the subjects of patents, in moderate use. There are about half a dozen patents in connection with locomotives in use, and perhaps as many, principally relating to valve gear, concern the marine engine. Some of these refer to stationary engines as well. There are three or four patent pistons in use, and the same may be said of valves, and that is about all. In pumping engines there are perhaps a dozen more, which we do not include under the head of steam engines. There are hundreds, if not thousands, of patents in existence for boilers and boiler furnaces. The number in use is under a score. What is true of the steam engine is true of most other things. It is quite possible for any engineer, manufacturer, railway company, shipowner, &c., to carry on business or trade with perfect success without using a single patented invention. Why is it that so much energy is wasted in inventions which are useless? Before going further it is well that our meaning should be made perfectly clear. When we say that there is but a limited number of patented inventions in use, it must be understood that by "patented invention" we mean an invention the patent for which is in force. There are a great many things in use which were at one time patented, but the patents for which have lapsed either by flux or time or for some other cause. If we assume that there are twenty patents for steam engines in force this year, and that there will be the same number in force in fourteen years from this date, then it is clear that these last cannot be the same as those in existence now. The fact remains that although a very few new inventions come into use every year, the whole number is probably pretty constant. As new inventions are born old ones die; but the infantile mortality among patents is something enormous. It is worth while to consider to what it is due.

A careful examination of the facts proves that the reason why so many patents are taken out lies in the ignorance of the inventor. We mean nothing invidious, but no other word than ignorance will so plainly express that idea which we wish to convey. A man of, we may suppose, considerable natural talent and well educated as an engineer makes an invention. The chances are a hundred to one that the invention produced by such a man will be new. He turns the thing over in his mind for some time, anticipates objections and difficulties, and provides as far as possible for them. As soon as he has got thus far he takes out either provisional protection or a complete patent. Now be it observed that up to this point he is ignorant whether the invention will be mechanically a success or not. This ignorance is due to the circumstance that the thing patented being new, no direct experience of any kind is available concerning it. The patent secured, the inventor proceeds to educate himself—that is to say, he has the thing made and tried, and then he finds, to his surprise and disgust, that it will not work at all; something has been forgotten or overlooked, or a new fact is discovered, and the patent is of no use. Then begins the struggle of the inventor to overcome the obstacles which stand in his way. Patent follows patent as he progresses, and at last the finished result is ready to bring before the world, and is probably extremely unlike the original. All the earlier patents are valueless lumber; they are allowed to drop, and not unfrequently the inventor would be well satisfied if the earth would open and swallow them up. Here, then, we have an instance of the way in which ignorance influences the numbers of patents taken out. There is nothing like an illustration for making a meaning clear. Here is one, which came under our own notice. A novel and extremely elegant method of working the slide valves of steam engines was devised. It was based upon a well-known principle of mechanics, applied in this direction for the first time. Into details we cannot enter, for the inventor is still working in the same field. It will suffice to say that it appeared to be as certain that the slide valves could be worked in the way suggested as that the sun will rise to-morrow morning. The inventor was a cautious man. "This thing," said he, "is too good to be true. To sweep away excentrics, link motions, &c. &c., at one blow is more than I have a right to expect. Let us try it on a small scale." It was tried accordingly on a model of reasonable dimensions. The results were quite disappointing, and in a way not anticipated. Certain statements made in text-books, and on which the invention was based, were only true under conditions which do not obtain in steam engines. This was virtually a new discovery, and opened up an entirely new path for research, interesting enough from one point of view, but certainly not from that of the inventor. If he had taken out a patent, that would have gone to swell the list of examples of wasted energy. Now, every year large numbers of patents are taken out by men on a much more slender basis than that which the cautious man just referred to had to go upon. As a rule, inventors are always prophets. Nothing short of the prophetic spirit could induce them to believe as they do in the future of their inventions. But it cannot be too often repeated that no one should prophecy unless he knows. If, then, the inventor would take the trouble to try his invention before he patents it, there would be fewer inventions taken out. It may be urged, of course, that the inventor has no facilities for trying it until it is patented. This is occasionally quite true, but it is not always, not nearly always, true. This makes no difference. The moment a thorough-going inventor has had an inspiration he rushes off to the Patent-office. He never stops to think that the chance that any one else will hit on precisely the same thing is about as strong as that two men in a crowd will be identical in features. He is in a fever until he has made himself safe. That done, he can begin to try to find out whether the idea which he has spent less or more money in patenting is worth anything. In nine hundred and ninety-nine cases out of a thousand it is valueless. But it would be too much to expect him to wait as much as a week to find this out.

Even when a good thing has been invented and patented it may not prove a commercial success, and this for reasons which are, we think, little understood by either inventors or the public. The consideration, however, of this aspect of the question we must postpone for the present. Our object will be served at this moment if we can succeed in inducing inventors to believe that ignorance may be the cause of waste of time, money, and energy; and that in all cases it is bad policy to be too precipitate in taking out a patent. A great deal has been heard about "racing for the seal," the more recent "value of a date," and so on. Our readers may rest assured that these things apply only to very special cases, and that the general public of inventors have nothing whatever to do with them.

METROPOLITAN SEWAGE DISPOSAL.

TWENTY-TWO years have elapsed since Sir Joseph Bazalgette—not then possessing the title which he now so deservedly enjoys—read a paper before the Institution of Civil Engineers, descriptive of the great main drainage works of the metropolis. The whole of the main drainage scheme was then complete, with the exception of the northern low-level sewer, which was being formed in conjunction with the Thames Embankment and the new street to the Mansion House. At that time and subsequently, keen discussion arose as to the proper destination of the London sewage, and projects for the utilisation of the vast discharge pouring from the outfalls at Barking and Crossness were ardently pressed upon the notice of the public. The names of Mr. Thomas Ellis and Colonel Hope will be remembered in connection with the era when irrigation was popular, followed by those of Messrs. W. and R. Sillar, when chemical treatment was espoused. Now we arrive at another phase of the subject. A Royal Commission under Lord Bramwell has made sundry recommendations as to the measures required for delivering the Thames from the pollution caused by the discharge of the London sewage at the outfalls, and the Metropolitan Board has resolved on carrying out a plan which partly corresponds to the proposals of the Commissioners, but which nevertheless departs from those proposals in an important particular. The project adopted by the Board, and the works designed in connection with it, have been described at considerable length in our columns. The sewage is to be treated chemically at the outfalls, the effluent is there to be discharged into the river, and the solid residuum is to be carried away beyond the Nore in steamships constructed for the purpose. On the other hand, Mr. J. Bailey-Denton and Lieut.-Colonel Jones, V.C., have for some time past been pressing on the attention of the Home Secretary and the Metropolitan Board a plan which they have devised for conveying the whole of the sewage to Canvey Island, a low-lying tract on the Essex shore between Thames Haven and Southend, the distance of the latter place from the island being four and a-half miles. In defence of the scheme of the Metropolitan Board, a paper has been recently read at the Institution of Civil Engineers by Mr. W. J. Dibdin, the Board's chemist; the reading of the paper and the subsequent discussion occupying four weekly meetings. The title of Mr. Dibdin's paper was "The Disposal of Sewage Sludge," but the treatment of the subject involved considerations touching the whole sewage problem. Following this, we have now a lecture of considerable length and much ability delivered a few days ago by Mr. J. Bailey-Denton at a meeting held at the Parkes Museum of Hygiene, Professor Corfield occupying the chair. "Metropolitan Sewage Disposal" formed the title of the lecture, which may be looked upon as a rejoinder to the paper read a short time previously by Mr. Dibdin at Great George-street. The rival plans are thus brought before us in a very complete and authoritative manner.

To enter into all the details of this controversy would involve far too large a demand upon the limits of our space and the patience of our readers. We can but touch upon a few salient points, leaving those who are disposed for the enterprise to wade through the various documents devoted to the subject. Mr. Bailey-Denton objects to the scheme of the Metropolitan Board as placing insuperable obstacles in the way of any future plan for turning to account the "reproductive properties of the London sewage." This declaration seems a little too absolute. It would not be impossible to divert the sewage effluent from the outfalls, and deliver it on the land a few miles distant. There would be extra cost, of course, but this is the method by which Mr. Bailey-Denton himself proposes to deal with the effluent at Canvey Island, supposing the farmers in the neighbourhood were willing to receive it. Canvey Island is described by him as affording remarkable facilities, first, for the deposition or treatment of the sewage solids on its surface without nuisance of any kind, or any occasion for removal from the site of deposition; and, secondly, for the utilisation of the liquid sewage by irrigation on the island, or on lands in Essex and Kent. The area of Canvey Island is stated to be 4383 acres. Two-thirds would be appropriated to the deposition of the solid matter, leaving therefore only 1460 acres for the purpose of sewage irrigation, or little more than one acre for the sewage of 3000 of the present population. Accordingly, if the sewage is to be utilised, it must have a wider area of distribution than the island affords. Whatever manurial value there is in the solid residuum will be capable of preservation at Barking and Crossness as well as at Canvey Island, though in the latter instance there will be the advantage of being farther from town. Mr. Bailey-Denton still believes in the agricultural value of sewage, but contends that an expert is required in the practice of sewage farming, and adheres strongly to the opinion that intermittent filtration should always be combined with wide irrigation as a safeguard. Sound as this theory may be, the enormous volume of the London sewage and the unwillingness of farmers to employ sewage as a fertiliser, are considerations which have induced the Metropolitan Board to shape its plans without reference to agriculture. It is quite possible that if Mr. Bailey-Denton had all the London sewage conveyed to Canvey Island, he would find that what he could not make use of himself he would have to cast into the river. It was Colonel Hope's theory that his great main sewer, which was to lead down to the Maplin Sands, should be tapped on the way to supply contiguous farms. But nothing ever occurred to show that the farmers were likely to become his customers.

Mr. Bailey-Denton is unsparing in his ridicule of the idea that the pollution of the Thames by the discharge at the outfalls can be prevented by subjecting the metropolitan sewage to "homœopathic doses of 3·7 grains of lime and 1 grain of sulphate of iron, with a sprinkle of permanganate of soda per gallon." The lime, it should be observed, is to be applied in a state of solution, and experience gained at Leicester is considered favourable to Mr. Dibdin's plan. The precise quantity of 3·7 grains per gallon is, of course, obtained by calculation from a larger volume, and is based on an average. A very serious point in Mr. Bailey-Denton's lecture is where he makes it appear that Sir Joseph Bazalgette is dissatisfied with the chemical formula, and has given evidence condemnatory of the scheme adopted by the Board. This curious view of the case is derived from the report of the proceedings before the Select Committee appointed by the House of Commons in February last year, to inquire into the condition of the river Lea. Yet on referring to the Blue-book, we find that Sir J. Bazalgette gives evidence quite in the contrary direction to that signified by Mr. Bailey-Denton. Sir Henry Roscoe, interrogating Sir J. Bazalgette, said: "I believe you have had a purification system lately adopted by the Metropolitan Board under your care?" To this question Sir Joseph Bazalgette replied in the affirmative; whereupon Sir H. Roscoe inquired—"May I ask whether you are satisfied with the results of the experiments on the 9,000,000 gallons that are now in operation?" Sir Joseph replied—"Yes, I think they have been very satisfactory." Yet Mr. Bailey-Denton says in his lecture that at the time of the Lea inquiry, "the tentative proceedings" of the Board in reference to the London sewage "evidently did not satisfy Sir Joseph W. Bazalgette, who had taken part in the whole of the proceedings of 1884-5." This singular contradiction between the views ascribed to Sir J. Bazalgette and those which he actually expressed arises from a lack of discrimination in dealing with his evidence. Sir Joseph drew a broad line of distinction between the Lea and the Thames. He said: "I cannot bring myself to believe that a river whose flow depends upon effluent sewage, preserved, you may say, by manganate of soda, can be a desirable thing to live near, or can be a state of things that can exist without serious complaint arising." But the Thames is not a river "whose flow depends upon effluent sewage preserved by manganate of soda." Sir Joseph states that at each ebb tide 2500 millions of cubic feet of water pass the outfalls on the Thames. But the Lea he describes as a river "which has little or no water flowing down it," and he insists on a "vast distinction between turning the effluent into the river Thames and turning the effluent into the river Lea." The fact that this distinction governs the evidence of Sir Joseph Bazalgette has been overlooked by Mr. Bailey-Denton, so as to make the engineer to the Metropolitan Board appear as condemning a plan to which his own name is attached, and with which he is practically identified. An argument on which Mr. Bailey-Denton lays some stress is, that the Metropolitan Board does not possess the necessary qualifications for deciding on such a question as the treatment of the London sewage. No doubt on such a subject the Board ought to seek for the best professional advice. On the one hand there is Sir J. Bazalgette, and on the other, Mr. Bailey-Denton. So far as chemistry is concerned, there is Mr. Dibdin and Dr. Dupré, supported by Sir F. Abel, Professor Odling, and Professor Williamson, the last-named having been a member of the Royal Commission under Lord Bramwell. Against these, Mr. Bailey-Denton puts Dr. Frankland, Dr. Alder Wright, Professor Attfield, Professor Dewar, and Mr. Bernard Dyer. The general opinion among the chemists on Mr. Bailey-Denton's side is that Mr. Dibdin's chemical scheme is "inadequate." With such admirable authorities ranged in opposition, it is perhaps pardonable for the members of the Board to resolve on deciding for themselves what they shall do. The point in dispute is mainly as to the chemical process. If that treatment is sufficient to rescue the Thames from pollution there is no need to dispute the matter any further. If it is not sufficient, and if no reasonable modification will make it adequate, then the case for the Board breaks down. So far as engineering goes, there is no doubt that Sir J. Bazalgette's pumps and tanks will work correctly; neither need we doubt the engineering excellence of the Canvey Island scheme. It is when we get into the realm of chemistry that controversy rages most fiercely, and with the least prospect of reaching a satisfactory conclusion.

Connected alike with engineering and chemistry there is yet another element, namely, finance, which cannot be entirely excluded from view. Mr. Bailey-Denton contends that his plan will prove to be the cheapest; but that depends in a great measure on the quantity of chemicals considered necessary for purifying the sewage. If we take Mr. Dibdin's present estimate, or anything approaching it, the cost of his plan appears much less than the Canvey Island scheme. Mr. Bailey-Denton and Lieut.-Colonel Jones have made a formal offer to undertake the purification of the sewage at Canvey Island for an annual payment of £110,000, without any advance of capital by the Board, the freehold of the entire island to become the property of the Board at the expiration of fifty years. But certain conditions are specified, including one of considerable weight, namely, that the Board shall be at the cost of delivering the sewage into the island at a height of 13½ft. above the surface of the ground. When estimating the expense of conveying the sewage of the metropolis to Thames Haven, Sir J. Bazalgette calculated the cost at £3,366,000, adding thereto an annual charge of £37,400 for pumping. Reckoning 3½ per cent. on the capital outlay, we get a further item of £117,810. Thus, if we take Thames Haven as equivalent to Canvey Island, and add together the subsidy, the pumping, and the interest on capital for conveying the sewage down the river, the total annual cost to the Metropolitan Board for the Canvey Island scheme becomes £265,210. That we are not very far wrong in this reckoning is indicated by the fact that Mr. Bailey-Denton himself has estimated the entire cost of the Canvey Island scheme at £198,000 per annum, including interest on capital. On the other hand, the Board estimate the cost of their scheme at £118,000 per annum, including everything; and it is an argument with Mr. Dibdin that if, after the lapse of some twenty or thirty years, the Board felt compelled to carry the effluent to a point lower down the river, the saving effected in the interval by the cheaper plan would defray the extra cost ultimately incurred. Obviously, if there were any serious expectation of carrying the outfalls further, it would be the better plan to do so at once. Amid all the objections urged against the chemical process, it is satisfactory to know that the solid portion of the sewage is to be kept out of the river. This cannot fail to produce some improvement in the state of the stream. The permanganate is intended to deal further with the effluent. If the chemical dose now contemplated is really too small, there is a considerable margin—as between the two schemes—on which to draw for a further supply of chemical materials. We can only regret that Mr. Bailey-Denton and his colleague should have bestowed so much labour thus far in vain. In the face of the ratepayers, we can hardly see how the Metropolitan Board can go to Canvey Island, or even to Thames Haven, while there is any reasonable chance of success at Barking and Crossness. The Board has to guard the public purse as well as the public health, and while the latter consideration is imperative, the former has still to be remembered. Mr. Dibdin himself has owned that if Canvey Island were close to the outfalls he would be glad to use it; but it is far away, and the cost of getting to it is very considerable. Mr. Bailey-Denton endeavours to show that the Board's scheme is bad. This is hard to prove. He can more readily show that his own scheme is good; but it is relatively dear, and that is a fact which most people can appreciate.

RECENT ADVANCES IN DOMESTIC DRAINAGE.

The letter of a correspondent who recently asked for advice in the laying of earthenware drain pipes gives us an opportunity of making a few remarks upon the rapid change of ideas which is taking place among sanitary experts with regard to the materials to be employed for domestic drainage. It is now many years since Sir Robert Rawlinson advocated the use of cast iron drain pipes, at least in the case of London houses, where it is often necessary to lay the drain through the basement. His views have been confirmed not only by the experience of those who have adopted the system, but by the pressure and direction of recent methods of testing, which, if carried out to their logical issues, will render earthenware drain pipes and brick-built manholes of the usual form altogether obsolete.

The necessity for some rapid and efficient means of testing the soundness of drains and their connections when laid through houses, has led within the last three or four years to the use of water as a test, instead of strongly smelling essences or smoke. The *modus operandi* consists in simply plugging the drain at the point nearest to its outfall towards the street sewer, which may be accessible from a manhole or from the trench itself before being filled in, and filling the drain with water. This test has done more than anything else to insure not only a high standard of workmanship in the laying and jointing of the drain, but also in the quality of the materials used, including the cement. It provides no assurance, however, that the joints are clean, and that no obstructing ridges of cement have been allowed to adhere to their interior edges; nor does it in any way anticipate the contingency of destructive settlement in the ground. It has already proved a powerful weapon in the hands of unscrupulous builders, who find it an easy task to test an old drain by plugging it, and work upon the fears of the householder to incur an expense which is frequently out of all proportion to the necessities of the case. As a matter of fact, there are very few drains in London which, even if originally laid in the most conscientious manner before this test came into fashion, could now stand it if it were applied with any head of water in the soil pipes.

There is not the least prospect of this ordeal of hydraulic pressure being relaxed in any way in the future, and we see no reason why it should be. On the contrary, we think there is every reason to suppose that a test which is so essentially efficient will have a wider application, and that those modifications which are now applied to soil pipes, manholes, and manhole covers, will soon be looked upon as obsolete. We believe the hydraulic test, made very much more severe by having the head of water carried up the soil pipe, will soon be applied to the drainage as a whole, including manholes and everything immediately connected with the drains, such as the manhole covers. If this is to be the future of domestic sanitation, the purists who have not realised these probabilities, and are at present contenting themselves with a number of details that cannot stand the test which they already apply to the drain itself, are only advising their clients to adopt arrangements which will soon be looked upon as equally defective with a drain which cannot hold water.

This question is not likely to remain much longer in abeyance. Now that cast iron pipes have received the sanction of the highest authority, and have been largely and successfully adopted in practice, there is no reason why the material should not be applied throughout. At present the rule is to lay the cast iron drain up to the point at which it passes through an inspection chamber, when it is carried on in half-channel pipes made of glazed earthenware set in cement. At this point the continuity of the material is not only broken, but another material is introduced in the form of bricks, of which the manhole is constructed, when again a return is made to cast iron in the cover, which is rarely, if ever, subjected to a hydraulic test at all. This incongruity of materials leads to a modification of the test to meet the deficiencies of the different parts, but this method of squaring the test to the circumstances is not likely to be looked upon very favourably when contrasted with a system in which the entire arrangements are carried out in the more efficient material and to which the severest form of test may be applied throughout.

We believe it will be found in practice that this complete cast iron system is in every way more convenient and satisfactory, while the additional expense is small. An opportunity is afforded for having the whole drainage system of a house constructed accurately to drawings, as is usual in other engineering constructions, and of homogeneous materials, instead of being laid piecemeal, and of heterogeneous materials dependent upon a great many contingencies for their efficiency. The inspection chambers being all cast from patterns modified to the particular requirements of each case, fall into their places, and are connected without the necessity for any greater skill than is required in the laying of street mains, and when the work is finished it can be subjected to a test which would burst a brick manhole into fragments. The arrangement accordingly also provides a much better current of air through the drain for ventilation, and has the additional advantage of being more expeditiously carried out. This is obvious when the comparatively small number of parts are ready to put into their places before the ground is disturbed. We know of a case in which operations were commenced in a house of an average size on a Monday at noon, and completed upon the following Friday. As the work included the removal of the old drains and the substitution of a complete new iron system, together with new soil pipes, closet apparatus, ventilating pipes, &c., the advantage in point of time as compared with the old method, which under ordinary circumstances would have taken about three weeks for its completion, is self-evident. Not only is there a saving in house rent, but frequently in the heavy cost of a household having to live at an hotel or in apartments while the work is being carried out. With regard to the efficiency of the complete system, the water standing in the soil pipes to the level of the first or second floors, and filling all the drains, including the inspection chamber, is a guarantee which speaks for itself.

The Foundling Hospital, which has recently had its sanitary arrangements remodelled by Mr. Scott-Moncrieff, is an interesting illustration of how cast iron drainage, in addition to its other advantages, can be applied so as to take advantage of existing sewers; and we have little doubt that within a comparatively short period the complete systems of homogeneous materials to which we have referred will be looked upon as being no more than is necessary to comply with the obvious requirements of domestic sanitation.

THE NEW NORTHUMBERLAND RAILWAY.

We believe that a section of the Alnwick and Cornhill branch of the North-Eastern Railway will be opened for part traffic in the course of the next few weeks. The line has been described by us in outline some months ago; but it may be desirable to add a few later facts as to it. Up to the end of 1886 there had been expended on the line £353,126 12s.; and it is thus the most costly of the works in course of construction that the North-Eastern Railway has in hand. In the current half-year the expenditure was at the rate of £3400 monthly, as estimated; and after the end of this half-year a further expenditure is contemplated of about £10,000; so that it will be seen that the total cost of the line, accomplished and expectant, is about £394,000. And very naturally there is the desire to bring a part of the line into use as early as possible, for goods traffic at least, and thus to allow that traffic to commence the slow growth which is usual with lines through agricultural districts. The line, it may be remembered, is the outcome of a struggle for the possession of the northern part of the centre of Northumberland; it starts at Alnwick, rising to a considerable height above the sea level at the top of Alnwick Moor. There are some deep cuttings in the southern part of the line, and between Lemmington and the Cheviots there are some very pretty glimpses of scenery. But it remains to be seen whether the line will develope a remunerative traffic, for, between the two termini, there is no town of importance, nor any large population. It may be expected that there will be a considerable agricultural traffic during the coming summer; and it may certainly be a wise policy to open it, so as to secure, if possible, the full extent of the benefit which may be reaped from the coming Royal Show at Newcastle. And, in some future time, the line might become a section in another route from the north-east to the west of Scotland; but at present its promise is that of a local branch only.

STRING RAILWAY BRAKES.

It will be remembered that on more than one occasion string has caused the failure of the vacuum brake by getting into the leak-off hole in the piston. There are, indeed, various reasons—some of them, no doubt, based on prejudice—which induce railway men to regard with dislike the use of string about a railway train as a means of securing the safety of passengers. We are ashamed to say that we are ourselves not exempt from this weakness, and we therefore object to the instructions which have just been issued to drivers on the Manchester, Sheffield, and Lincolnshire Railway:—

Manchester, Sheffield, and Lincolnshire Railway,
Locomotive and Carriage Department.
Office of Superintendent,
March 22, 1887.

NOTICE TO DRIVERS.

So long as it is found necessary to use a tricoupling to form a brake connection between the engine or tender and the front vehicle of the train, it will be your duty to see it is effectually secured by string or otherwise, so as to prevent the possibility of the coupling working loose and becoming disconnected.

You are given to understand that for the future I will accept no excuse whatever for such failure. (Signed) THOMAS PARKER.

We do not know what "otherwise" is intended to mean, but it has at least the merit of not rendering the use of string imperative. There is thus a certain latitude left to drivers, who can use, say, a handful of waste wedged between the pipes; or a shoe-string might be employed at a pinch, or a foot or two of lamp-wick. On the whole, perhaps, some small strips of calico and a paste-pot would be best; once the paste dried, which it would quickly do when running rapidly through the air, the joint would be hermetically sealed.

LITERATURE.

Mechanics of the Girder. By J. D. CREHORE. New York: John Wiley and Sons. London: Trübner and Co. 1886.

In the full title of this book, "A Treatise on Bridges and Roofs, in which the necessary and sufficient Weight of the Structure is calculated, and not assumed; and the number of Panels and height of Girder which render the Bridge Weight least, for a given Span, Live Load, and Wind Pressure, are determined," the author claims for his book the solution of problems of which the importance will at once be apparent to those who desire to be guided in every step of their work by the rigorous application of mathematical laws. Exact methods for the determination of the stresses produced in a given structure by any combination of loads are not indeed wanting; but their application is rendered unsatisfactory by the fact that the weight of the structure itself, which in large spans is no inconsiderable part of the total load, has to be guessed at, or at best derived by analogy from the weight of similar structures; and a suitable example is often difficult to find in the case of bridges of large span or novel design. In determining the form and proportions of the structure itself, the designer is still more dependent upon experience and judgment.

From the nature of the problem it can hardly be expected that a perfect solution by practical methods, and of universal application, will ever be obtained; but a partial solution, if based on sound principles and correct reasoning, must be of considerable value as an aid to the establishment of general laws of economic design. Such a solution at least we have in Mr. Crehore's work; and as such it is worthy of careful examination by those interested in the design of bridges. The degree in which reliance can be placed upon the formulæ proposed must be a matter for individual judgment, as engineers are by no means agreed upon the data which are indispensable for the construction of any formula for obtaining the weight of a structure, and which depend upon the design of the parts and their connections, and even more upon the choice of a uniform or variable working stress.

Apart from the solution of these problems, there is much valuable matter in Mr. Crehore's book. In order to obtain general formulæ with a common notation and applicable to all classes of girders, the author has—in the introductory chapters I.-VII.—dealt with the theory of external force, stress, and strain, from the beginning. The statical problems relating to forces acting in one plane, the nature of moments, and the means of measuring them, are first investigated, and then applied to the particular case of beams; and the thorough and searching nature of the author's treatment becomes evident in the manner in which every possible case of each general equation is separately expressed in a convenient tabular form—a feature which will render the book especially convenient for reference. The relation between the external forces applied to a structure and the strain developed in its parts is next investigated. Consistently with the systematic nature of the work, but contrary to the very general practice, framed structures of the most complex kind are studied before solid beams and plate girders; as in reality affording a more simple determination of the relation between external forces and the resistance of the material. In determining the stresses on framed girders, the method of moments is principally used, and is shown to be preferable for variable loads to that of shearing forces, since with the latter method every change of load necessitates a recomputation from the beginning. Expressions for determining the stresses in every member by both methods are, however, given for each of the twelve classes into which all framed girders, or trusses, are divided by the author. These classes are illustrated by diagrams of about seventy different forms, among which the diagrams of the bowstring and crescent girders—Figs. 48 and 62—are unfortunately misplaced, and owing to their position at the head of their respective classes, are somewhat apt to mislead the reader. The examples include several forms of roof truss which might with advantage have been omitted; as the specific treatment required by roof trusses, on account of the inclined wind forces to which they are subject, is not dealt with, and the general formulæ are for this reason not applicable to them. In dealing with the internal resistance of solid beams, the author assumes that the neutral axis coincides with the centre of gravity of the cross section, and introduces the modulus of rupture, or ultimate unit resistance of the material to cross breaking, for which experimental values are given, in order to obtain the moment of resistance of the section. This, although a satisfactory practical solution for the forms of beam in general use, has the disadvantage of requiring special experimental values of the modulus in the case of beams of unsymmetrical section. In a chapter devoted to an elaborate investigation of deflection problems a useful approximation is given for the deflection of girders of varying height—such as the bowstring—the author finding from numerous examples that for open girders of the same central height the total deflection is nearly in the inverse ratio of the areas of figure of the girders. For the strength of struts, the author derives from the equation to the curve of the bending strut, formulæ for the breaking weight of the general form:—

$$p = \frac{c}{1 + \dfrac{l^2}{a\,r^2}}$$

in which a and c are constants and l and r the length of the strut and radius of gyration of its cross section; and it will be interesting to those who have followed the recent train of thought on this subject, to note that the term unity in the denominator in this well-known form, arises from the assumption that the direct or axial pressure due to the load reduces the effective resistance of the cross section to bending.

Having thus dealt with the preliminary problems, the author proceeds to investigate the determination of the weight of a bridge to carry a given live load, the height and number of panels being assumed. By means of the formulæ already established the weight of each member is expressed, in terms of the total panel dead load W, and the live panel load L. Summing these expressions, the weight of the girders themselves is obtained in the form:

$$\text{Weight of girders} = G = a\,W + b,$$

in which a is the sum of the reduced numerical values of the coefficients of the unknown dead load W, and b is the reduced numerical equivalent of the weight resulting from the known live load L. From this and the weight of the floor, wind system, &c., computed in the ordinary way, the weight of the girders is obtained by a simple equation. In order to determine the best number of panels and best height, the author obtains a similar expression, in terms of powers of an unknown value of the height h, for the bridge weight corresponding to a series of different panel lengths; and by differentiating each of these equations with respect to h, obtains, for each panel length, that value of h which renders the bridge weight least. Introducing this value of h, the minimum weight for each panel length is obtained, and by comparing these the most economical proportions for the girder are determined.

Simple and conclusive as this process may appear in the abstract, it is, as the examples show, exceedingly laborious in practice, and has its weak points. These, although not essentially fatal to its utility, demand careful consideration, and the introduction where necessary of special coefficients. For instance, the whole of the material required for joints, attachments, excess of practical over required section of bars, and the like, is covered by a general addition; which is, in the earlier examples, taken as from 2 to 2½ per cent. of the imposed dead load only, while the excess on the girders themselves is entirely neglected. The author also assumes for all the verticals in a bridge a common ratio of length to radius of gyration—a condition generally incompatible with good design of the parts. It may also be objected that as the stresses arising from dead and live load are necessarily kept apart in summing the expressions for the weight of the girder, the saving in weight of web members due to the neutralisation of live load counter stresses by dead load main stresses is neglected. But the author, while admitting this, justifies it on the ground that it is usual to insert more counters than theory requires; and it will be found, on examining any ordinary example, that the error involved is relatively small, amounting in bridges of moderate span to about 5 per cent. of the weight of the diagonals, or, say, 1 per cent. of the total weight of the girders. On the other hand, some of the most serious difficulties which attend the solution of the problem are successfully dealt with. Proper allowance is made for the increase of the weight of the longitudinal joists or stringers with the panel length, and also for the increase in the weight of the wind system as the height of the girders is increased, and the total weight of the transverse beams in a given span is shown to diminish with the number of panels, not only because a greater proportion of the load is directly carried by the abutments, owing to the increased length of the end panels, but also because the greater load on a single beam permits of greater depth—assuming the beams to be equally well proportioned.

Sufficient has been said to give a general outline of the author's method, as seen in the preliminary examples given in Chapter IX. The remaining two chapters form the commencement of an elaborate application of these principles to the twelve classes of girders, left in an unfinished condition at the author's death in 1884. The value of the book depends, however, upon the method itself, and its capabilities for extended application according to individual requirements; and, having regard to the progressive nature of the knowledge of the resistance of materials upon which the data for examples depend, the editors appear to have acted wisely in presenting it to the public in its present form. Evidently designed only for the use of practical engineers who are already well acquainted with the general features of the subject, the book is remarkably free from extraneous matter, and is throughout illustrated by numerous examples fully worked out, which materially assist the reader in following the formulæ, which are often complex, and necessarily involve the use of the calculus. Viewed as a whole, it exemplifies in a striking manner the effect of the American system of competitive designs, and the lesson it teaches of the exhaustive study of the causes which produce economy in design, is not to be disregarded if this competition is to become general.

A Manual of Lithology. By E. H. Williams, Jr. New York: Wiley. London: Trübner. 1886.

This is probably the smallest text-book on the subject of rock structure that has yet appeared. By the use of small type and a careful selection of matter, the author has contrived to compress within 125 pages of 3in. by 5in. effective surface an account of the composition and structural character of the principal classes of rocks, according to the definitions current in this branch of knowledge at the present day. The main object of the book being to enable students to identify rocks without elaborate means of investigation, all allusion to microscopic structure is avoided, so that it cannot be put in comparison with such manuals as those of Rutley and Jannetaz, and still less with the more elaborate works of Rosenbuch and Fouqué; but for its own limited purpose it is likely to prove very useful.

THE MANCHESTER ROYAL EXHIBITION.

The holding of an Exhibition in Manchester was first suggested about five years ago. It was thought, in view of the great success of the Art Treasures Exhibition in 1857, and as that was the only Exhibition partaking of an international character that had been held in Manchester, that something might be done to give an impetus to trade, which was then, as it is now, not in a very flourishing condition. The proposal, however, fell flat, as it was felt that although successful Exhibitions had been held in London, Edinburgh, and other places, Manchester was not quite in the same position in respect of general holiday attractions, and these considerations explain to a considerable extent the failure of the efforts which were then put forward. The various Jubilee celebrations in one form or another recently projected all over the country again brought the proposal to the front, to be this time crowned with so large a measure of success that even the most sanguine amongst the promoters of the present Exhibition could scarcely have anticipated. The project was first revived by letters addressed to the editors of the local journals, and on the 11th of June a largely attended public meeting was held in the Town Hall, when it was resolved that it was desirable to consider the advisability of holding a National Exhibition of Arts, Science, and Industry to commemorate the Jubilee year of the reign of her Majesty the Queen, and a committee was appointed to make the fullest inquiries as to the feasibility of the proposal and to report to a future meeting. The committee set to work with a determination not to enter upon the project rashly, but no time was lost, and on the 19th of July a second public meeting was held in the Town Hall, when the committee presented a report, and a detailed scheme prepared by Sir Joseph C. Lee as the suggested basis of operations. This report was distinctly favourable to the holding of an Exhibition, and the scheme proposed was divided into seven sections:—(1) Industrial design, as shown in textile fabrics, pottery, metal work, &c., original drawings for manufactures of various kinds, examples of ancient fabrics and designs, and architectural designs. (2) Industrial processes, such as textile machinery, engineering, and general plant, and machinery in motion. (3) Chemical and collateral industries. (4) Handicrafts—workers in brass, iron, wood, ivory, needlework, &c. (5) Representation of Old Manchester and Salford, in which the handicraft work of Section 4 was to be performed, and a model of the proposed Manchester Ship Canal, showing docks, locks, waterways, &c. (6) Fine arts. (7) A botanical section. The original idea was that the Exhibition should be confined to a radius of fifty miles round Manchester, but in the end wiser counsels prevailed, and ultimately it was decided that it should be held on a scale that had never previously been attempted in the provinces. A guarantee fund, amounting to about £130,000, was very quickly secured, and the next step was to appoint a thoroughly representative committee, with Sir Joseph C. Lee at its head, Mr. C. P. Scott, the editor of the *Manchester Guardian*, as hon. secretary, Mr. A. A. Gillies as the acting secretary, and Mr. Lee Bapty, who had acted in a similar capacity in connection with the Liverpool Exhibition, as general manager. The site selected was a vacant space of land adjoining the Manchester Botanical Gardens, and competitive designs were obtained for the Exhibition building. At a meeting of the guarantors, held on August 13th, the design of Messrs. Maxwell and Tuke, of Manchester, was accepted for the main buildings, and that of Messrs. Darbyshire and Smith, of Manchester, was afterwards accepted for the Old Manchester and Salford section of the Exhibition. For the Exhibition buildings the selected plans, whilst providing for a structure of effective ornamental design, were exceedingly simple and compact in their arrangement, the ground plan taking the form of a Latin cross with lofty nave and transepts and low buildings supporting it on each side. The general outline of the main building may be given as consisting of a central nave 1022ft. long and 56ft. high, with a transept across the centre 370ft. long and the same height, and two lower transepts near the ends of the nave 60ft. wide. At the intersection of the nave with the central transepts is a dome 90ft. diameter and 140ft. high, and at the intersection of the nave with the low transepts are square pavilions of a lower altitude, the spaces between the nave and the arms of the cross being filled with exhibition courts in bays 30ft. wide. The contract for the erection of the buildings was let early in September, to Messrs. R. Neill and Sons, of Manchester—whose tender of a little over £44,000 was the lowest sent in—the land to be covered according to the contract being $8\frac{1}{2}$ acres. Since then, however, a considerable enlargement of the first plans has been found absolutely imperative, and the further extensions which have been deemed necessary have probably pretty nearly doubled the original estimate. Perhaps in no section of the Exhibition has the pressure for increased space been more felt than in that devoted to engineering. In so important an engineering centre as Manchester it was of course expected that this branch of industry would be strongly represented, and the committee set out by providing 6400 square yards of covered space. It was, however, very soon seen that they had altogether underestimated the importance of this particular section of the Exhibition; they had to more than double the space originally allotted, the area of the building now set apart for engineering exhibits and machinery in motion, together with the boiler house and the electric lighting department, being not less than 168,000 square feet, which is the largest covered space that has been set apart in any previous Exhibition for this special branch of trade, and even with all the increased accommodation that has been provided, the applications sent in by exhibitors have been far in excess of the space which the committee have had at their disposal. This has necessarily led to numerous complaints, as not only have many important engineering firms been unable to get the space they have applied for, but a very considerable number of applicants have been unable to obtain any space at all. Under such conditions as these a committee is, of course, placed in a very difficult position, but they have endeavoured to give the preference to exhibits presenting some new features which would illustrate the progress that is being made in the various branches of engineering. For this section of the Exhibition an entirely separate building, 510ft. in length and 210ft. broad, with a gallery running round, from which visitors can obtain a bird's-eye view of all that is being shown, has been devoted to machinery in motion, whilst an adjoining building, 180ft. by 180ft., will accommodate machinery of a stationary character. In this portion of the Exhibition very rapid progress is being made, and it is in a more advanced stage than, perhaps, any other section. Already a considerable number of heavy exhibits have been got into position. Messrs. Craven Bros. have erected at one end of the larger building a 21-ton crane, which is being used to unload the boilers and other machinery as they are delivered at the railway siding, and the boiler-house is being fitted with ten of Messrs. Galloway's boilers, each 30ft. by 8ft. Close to the boiler-house is a building in which the dynamos are put down, and these, which will supply electric illumination for the whole of the buildings and grounds, are to be worked by twelve powerful engines. Gas is also being laid down, but this is only to be used for pilot services or for some special or local purpose. Another important section which has been added to the Exhibition is that devoted to Irish industries, for which a special building covering 40,000 square feet, and adjoining the main structure, has been provided. The whole Exhibition now embraces about 11 acres of covered buildings and about 13 acres of land, in addition to the adjoining laid-out gardens of the Botanical Society, which are included as a portion, and form a very attractive feature of the Exhibition grounds. In this portion the representation of old Manchester and Salford is being erected, and a large fountain for the display of the electric light, similar to the fountains which were so important an element at the London Exhibitions, is being laid out. We have dealt specially with those portions of the Exhibition with which the interests of our readers are most closely identified; but in the various other sections the Manchester Exhibition will assume an importance which will surpass anything that has been attempted in previous provincial efforts of the kind, and the art section will probably be the most valuable that has ever yet been brought together in any single collection. The building operations have been somewhat impeded by unfavourable weather, but very satisfactory progress has been made, and with the exception of a few minor details, the Exhibition buildings themselves may now be said to be practically finished. The main portions have been ready for the reception of exhibits for some time past, and the engineering and machinery section is in a very forward state. Most of the heavy exhibits have been got into position, and although it is more than probable that some firms who are preparing special exhibits may not be able to comply with the committee's professedly stringent requirement that everything of a heavy character shall be in position by the 15th of the present month, after which date the open spaces in the walls which have been left open for the reception of such exhibits it is announced are to be bricked up, there is every prospect that before the formal opening next month by the Prince of Wales the Exhibition will be in a condition which may be described as practically thoroughly complete.

At the Reschitza Iron and Steel Works, already described and illustrated in The Engineer, the puddling furnaces and rolling mills are now electrically lighted. A department is being added for the production of steel plates, and a new shop is being put up on the left bank of the Berazva for large iron bridges as well as a new boiler shop. The Pieler safety lamp is now used in the collieries for making exact observations of the disengagement of fire-damp.

THE COLONIAL AND INDIAN EXHIBITION REPORTS.

If the English and the Indian and Colonial manufacturers and producers allow themselves again to be wheedled into providing all that is necessary to constitute a splendid exhibition for the benefit of a South Kensington clique, it will not be because they have not been sufficiently warned that if they do so it will be at their cost and for the showmen's gain. The main chance of any solid benefit to be derived from the last Exhibition lay in complete reports which, distributed broadcast or sold at cost price, would have placed every importer, every user of Colonial and Indian products, in possession of information as to their occurrence, properties, and cost. This was in fact acknowledged when in the preparation of "the scheme for the Colonial and Indian Exhibition, which was approved by H.R.H. the Prince of Wales, there was included a provision for the preparation of reports on the exhibits of the various colonies." This is a quotation from the "Reports on the Colonial Sections of the Exhibition" just published by Messrs. Clowes, whose names have been associated with the publication of the catalogues of the Exhibitions, and from which a great loss resulted, according to the statement made in the accounts published by the "staff."

With the exception of but a few inventions, the reports are confined to the colonies, India not being specially included. It was evidently seen, when the scheme for the Exhibition was being drawn up, that reports which would have placed new information in the hands of importers and manufacturers, and told them what materials there were to be had, and given some hints as to how and for what they were or could be used, would recommend themselves to the exhibitor classes, and hence they were told that a "provision for the preparation of reports" had been made. It is not clear whether the Prince of Wales "approved" the scheme of the Exhibition, or the "provision" in principle, or the "provision" of a handsome sum likely to make it possible to place in the hands of the leaders in British commercial and manufacturing industries much very valuable information. Whatever he approved, the result is the same. The reports are a disgrace to the authorities, and an insult to the Colonies. Here into less than 500 pages is crowded all that could be said concerning the products of all the Colonies of the British Empire. Into this number of octavo pages is all that South Kensington has to tell the British trading and manufacturing communities of the products which the colonists all over the world sent in profusion, and at enormous cost, to provide us with evidence of what they have to place at the disposal of the world. The vast mineral wealth of Canada, New South Wales, Victoria, Queensland, South Australia, Western Australia, New Zealand, Cape of Good Hope, Natal, Ceylon, Straits Settlements, West Indies, Gold Coast, &c., everything that is to be said of the present state of the mining industries, and of the prospective mining operations, all is comprised in about fifty pages, and without one map or illustration of any kind. This report is well done, what there is of it; but the author being confined to the space of a pamphlet, and denied any engravings, could not possibly do justice to the subject, or make his report really valuable in the United Kingdom, or of any importance, from a business point of view, to the Colonies. Provision for reports, forsooth! a fine provision that did not provide for a single necessary engraving!

The reports on the timbers are very little more than catalogues. The author, Mr. T. Laslett, has already published much of it in his book on "Timber and Timber Trees." The provision for reports did not include provision for one experimental fact concerning the strength and weight of the timbers described. A second report on this subject is by Mr. Allan Ransome, who in some measure repeats Mr. Laslett, describes the result of cutting up some of the woods and timbers with his machines in his works, and adds some useful figures concerning the shrinkage of wood dried by the cool air process. Mr. W. Anderson wrote the report on the machinery, but instead of the report which Mr. Anderson would have liked to have prepared, it is only a bare abstract of it. Fourteen and a-half pages comprises all that the Commission, with the assistance of the Council of the Society of Arts, thought it necessary to say of the machinery and implements of the British Colonial Empire. There was altogether a large quantity of machinery and implements in the Exhibition as made by colonial makers for colonial markets and users. Of agricultural machinery alone there was enough to have demanded the very careful attention of a specialist for a considerable time, and his report, even if sparingly illustrated, would have occupied half the pages of this whole volume. There was much that the English eye disapproved, and it was for the reporter to show why the colonists in different parts of the world liked this and that machine and this and that implement better than the similar things usually made in England and not liked in the colonies. In the report on machinery there is not even a diagram, and the author has to attempt to convey in a dozen words a notion of the peculiar bevel epicycloidal gear of the mowing machine exhibited amongst many other things by the Massey Manufacturing Company of Canada; and in half-a-dozen lines the very clever differential velocity gear of the shaping machine shown by Messrs. McKechnie and Bertram, of Canada.

The High Commissioner for Canada specially asked that a report on the musical instruments shown in the Exhibition should be included. This fact is mentioned in the introduction to the reports. The report thus specially asked for, and for which presumably "provision" was made by the High Commissioner of England's oldest colony, occupies less than two pages at the end of all; and out of this three lines are used by the author to say, "I much regret that, owing to the late period at which I was called upon to make a report, all the more important instruments exhibited by this firm had been sold or removed." Thus under the shadow of the South Kensington Education department, aided by a special Commission and the machinery of State, that which was to be learned from the gathering together of England's colonists from all over the world has been lost. Not one penny was spent to secure the information which was to be obtained from the materials our colonists lavishly laid at our feet—information they wished us to gather, and for which our manufacturers and merchants ask. After the colonists had made the show, South Kensington thought little of promises; the promise of "provision for the preparation of reports" had obtained what was wanted, but the fulfilment of the promise would no doubt have conflicted with the liberality of the clique to itself. Nothing was left. The products of the world were taken to South Kensington, but the showmen can give no account of their stewardship. And yet a few profess to wonder that the Imperial Institute makes so little headway.

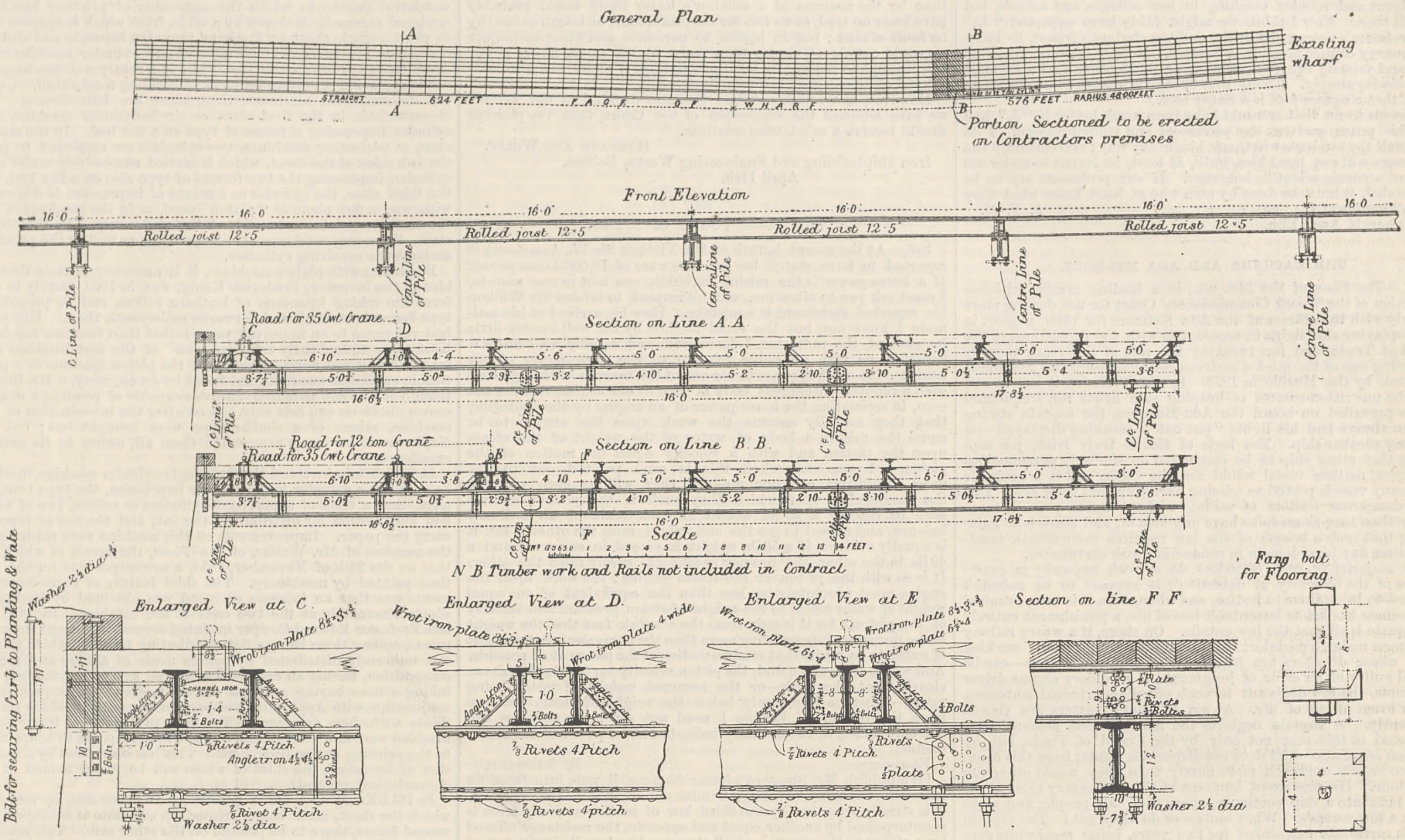
KURRACHEE HARBOUR BOARD.—SHIP WHARF EXTENSION.—GIRDERS AND JOISTS.

The work carried out under this contract was the supplying and delivery on board ship in one of the ports named in the form of tender, 225 main girders, and 918 floor girders, with flitch plates, joint plates, stays, bolts, rivets, and other fastenings, as described below, to form the superstructure of a screw pile wharf 1200ft. long, of which 624ft. is straight, and 576ft. is on a curve of 4800ft. radius. The following description is from the specification:—"The girders are to be rolled joists of English manufacture, and to be of good and tough iron of fibrous structure, or of steel of approved quality, and are to be subjected to the following tests:—One in every twenty of each sort to be selected by the engineer is to be supported at both ends over an opening of 15ft. 2in., and loaded in the middle, the joists of the main girders with a weight of 20 tons, and the floor girders with a weight of 12 tons, on the removal of which there shall be no permanent deflection. One of the main girders and four of the floor girders from every lot offered for shipment shall then be further weighted until they give way by crippling or fracture, and if in doing so they break or cripple with a less weight than 30 tons or 18 tons respectively, or if in doing so they give evidence of any unsoundness or other imperfection, the whole quantity offered may be rejected, the contractor to replace the broken or crippled girders. The wrought iron in flitch plates, stays, and washer plates to be of quality satisfactory to the engineer, of good fibrous structure, and capable of sustaining a tensile strain of 20 tons on the square inch under a blow struck by a heavy hammer. The straps bolts and nuts, and pins to be of the best approved scrap iron, the rivets of the best rivet iron. All the fitting and other workmanship throughout is to be done in the best and soundest manner. The main girders will be placed transversely to the wharf, and each line of three girders will rest on four pile caps 16ft. apart from centre to centre. They are to be in lengths of 16ft. $6\frac{1}{2}$in., 16ft., and 17ft. $8\frac{1}{2}$in., the ends at the face and back of the wharf are to be bolted down to the pile caps each by $1\frac{1}{4}$in. bolts as shown, and the ends which meet over the intermediate piles are to be bolted to the caps each by two similar bolts. Templates of the pile caps will be provided. The girders are to be of the section shown on the drawing, and are to consist of a rolled joist 14in. deep, 6in. wide at top and bottom, and weighing not less than 60 lb. to the lineal foot, if of iron, and of a weight giving equal strength if of steel, strengthened with flitch plates 10in. by $\frac{3}{4}$in., rivetted on the top and bottom by $\frac{7}{8}$in. rivets at distances of 4in. The rivet heads on the under sides are to be counter-sunk where the girders rest on the pile caps, and on the upper sides where the floor girders rest on the main girders, and for a distance of 4ft. from the inner ends of the outer rows of girders. There are also to be ribs or stiffeners of angle iron $4\frac{1}{2}$in. by $\frac{1}{2}$in., accurately cut to fit the form of the girder, rivetted on each side at three points on each girder, as shown on the drawing. The girders are to be fished at the junctions by plates 12in. by 11in. by $\frac{1}{2}$in., prepared to be rivetted one on either side of the ribs. These plates are to be cut and the rivet holes made in them and in the girders to one uniform pattern, so that they will be interchangeable for any position of the same form of girder. The floor girders are to be also of rolled beams, but without flitch plates. They are to be 12in. deep, 5in. wide at top and bottom, and to weigh not less than 42 lb. to the lineal foot if of iron, or of a weight giving equal strength if of steel. There are to be twelve lines in the width of the wharf, except for six bays, as shown on the drawing, where there are fifteen, and the girders are to be cut in different lengths for each line for the 576ft., which are on a curve, the line nearest the face being 16ft., and that nearest the back 15ft. 10in., the others being in proportion according to their distances from the face of the wharf. For the straight part they are all to be 16ft. The girders are to be prepared to be bolted down to the upper flitch plates of the main girders by two $\frac{3}{4}$in. bolts in each end, with heads of a form to suit the flange of the girder. The joints are to be fished, each with two plates $9\frac{1}{2}$in. by 6in. by $\frac{1}{2}$in. and eight $\frac{3}{4}$in. rivets. The floor girders are further to be stiffened at each crossing of the main girders by an angle iron stay $2\frac{1}{2}$in. by $2\frac{1}{2}$in. by $\frac{3}{8}$in., bent at the ends, as shown on the drawing, and secured to the web of the floor girders, and the upper flitch plate and flange of the main girder by a $\frac{3}{4}$in. bolt in each. The bolts are to be fitted with tapered washers to suit the slope of the under side of the flange. Five hundred wrought iron plates, 9in. by 4in. by $\frac{5}{8}$in., bent to the form shown on the drawing—enlarged view at D—and provided with two holes for the bolts which will pass through the planking to secure the inner rail of the 35-cwt. crane line, are to be provided. The ends of the plates are to be bent to suit the under sides of the flanges of the floor girders, and the central part bent upwards so as to be $\frac{1}{4}$in. below the top surface of the girders. The holes are to be $\frac{7}{8}$in. diameter, and placed at such distance apart as may be directed to suit the width of the foot of the rail. Four hundred and fifty plates, 14in. long, formed of a channel iron, 5in. by 2in. by $\frac{1}{2}$in., and bent as shown on the enlarged view at C, are to be provided for the outlet rail of the crane line except for the 96ft., on which there are to be three lines of girders, and for this portion 100 washers, $6\frac{1}{2}$in. by 4in. by $\frac{3}{4}$in. of the form shown on the enlarged view at E, are to be provided. Proper holes in each case to be punched to receive the ends of the holding-down bolts. Eight hundred and seventy wrought iron plates, $8\frac{1}{2}$in. by 3in. by $\frac{5}{8}$in., are to be provided to place under the rails of the crane lines. They are to have holes in them to receive the hook bolts on either side of the rail. One hundred similar plates, but 8in. wide and with four holes in each, are also to be provided to be placed under the joints of the crane line rails. Two thousand three hundred hook bolts for securing the rails of the crane lines, as shown on the drawing, are to be provided. The heads are to be made to fit the flanges of the rail, a template of which will be supplied.

The following bolts are to be provided for securing the timber work as shown on the enlarged view at C, viz., eighty strap bolts with nut and washer at one end to pass through wall, planking, and curb to the side of the fender; 250 bolts $\frac{5}{8}$in. diameter, $12\frac{1}{2}$in. between head and nut, with washers for bolting the above to the fender; eighty bolts each with two nuts on one end and a washer to secure wall to floor girders through head of angle iron stay horizontally; and 240 bolts 1in. diameter, and 1ft. 11in. between head and nut, each with two washers to pass through curb, planking, and wall vertically.

The portion of the wharf shown dark, on the general plan

KURRACHEE HARBOUR WORKS.—WHARF EXTENSION.



given herewith, is to be erected complete, with stays, joint plates, &c., on the contractor's premises. The parts so erected are to be made from the same patterns, templates, or models, as the corresponding parts of other portions. Before it is exposed to corrosion, the whole of the ironwork is to be coated with boiled linseed oil, applied hot, and as soon as it shall have been inspected and approved at the factory, all the parts, with the exception of the bolts and rivets, are to be scraped clean, and covered with two coats of best anti-oxide oil paint.

LETTERS TO THE EDITOR.

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

LARSSEN'S SLAG CEMENT.

SIR,—Referring to the paragraph in the letter from your correspondent from the North of England in last week's ENGINEER, on the above subject, I shall be obliged if, in justice to myself, you will be so good as to give publicity to this letter.

About twenty-two years since I made various experiments with blast furnace slag with a view to making cement. I had no pulverising apparatus, except an ordinary pestle and mortar; nevertheless I succeeded very well. I took some of the resulting product to a Mr. Francis, of Nine Elms, London, as I was then living at Battersea. He asked me to bring him a larger quantity, and to tell him how it was made, promising to reward me if he was then satisfied. I went down to Weedon, in Northamptonshire, procured some slag from some furnaces there, delivered it to Mr. Francis' works, and told him how to make it into cement. My recipe was to grind it exceedingly fine, in the proportions of one-sixth lime and five-sixths slag. Returning in a few weeks, I found the end of a building had been plastered with it in Mr. Francis's yard, and the work appeared hard and sound. I was somewhat elated at this, but Mr. Francis told me the cement was of no use to him, as it was too slow-setting, and he could pay me nothing for it. I have never seen him since.

In 1868 I came to Middlesbrough. I there met Mr. Norie, the foundry foreman at the Tees Ironworks. I told him what I had done about cement, gave him a written prescription, and made a sample for him. He showed the whole to Mr. C. Wood, manager of the same works, and the latter gentleman soon after, I believe, took out a patent for something similar. At that time Mr. Michael Croft, a plasterer, of York, was plastering the Middlesbrough Exchange, then building. I showed him some of my cement, gave him directions how to make it, and sent some slag to his place at York. He made some cement, and plastered the end of a building there. In the first letter he wrote me he said it was slow in setting; in the second that it had set very hard; and in the third that it was as hard as cast steel. In a fourth letter he said he had got some cement from Mr. Francis, of Nine Elms, that it was slow in setting, but set very hard, and he believed it was the same kind as I had sent him. I did not take any patent out.

The revolving barrel, which has been mentioned as being essential to the process, is not new. Nearly fifty years since I was working in a foundry owned by Mr. Lisle, at Cardiff, at which the machine for grinding coal dust for blacking was identically the same as that now said to be used by Mr. Larssen. A similar machine has been used for many years for grinding dry colours.

JOHN THOMAS, Sen.

369, Newport-road, Middlesbrough, April 5th.

RAILWAY ROLLING STOCK.

SIR,—Fabian, sen., who flourished about the year 220 B.C., wrote a book, which it is said was compiled entirely upon hearsay evidence, and "Fabian, jun.," your correspondent, is evidently a careful imitator of his great progenitor.

I have read "Fabian's" letter two or three times, and I must say that I can make neither top nor tail of it. I suppose he knows what he means, but certainly none of your readers will ever find this out from his description. He starts his letter with condemning what he calls my facts and finishes it with accepting them altogether. He says, 'Less railway work requiring rolling stock is now being inaugurated." But how does he know this? It may be so, but it is a moot point, and not by any means to be disposed of by a short sentence, *à la* Sir Oracle. India and South America are always prospecting new lines, and are taking an immense deal of all descriptions of rolling stock and material from this country; and I believe that owing to the wants of these and other customers the volume of trade done by the various rolling stock companies is as great as it has been almost any time this last twenty years.

Then he says, "All the large English railway companies are now making their own stock." Well, in answer to this, I shall merely remind him that two of the large English railway companies have given out large orders for carriages within the last few weeks. Then he complains "that there is too much capital invested in the manufacture of rolling stock." Yes, so there is; but has he only just found this out? It has been perfectly well known to those in the trade for many years, and those companies who were wise reduced their capital considerably, while others have gone on struggling to the present time with this millstone round their necks. And the trouble has become even more acute of late years, because time back a great deal of money was profitably employed in financing wagons, &c., on deferred purchase to private owners; but since the great railway companies have been buying up freighters' trucks this outlet for capital has been greatly curtailed. But when he asks me the question whether the capital invested for profit had not better be drawn from a failing trade, I must tell him simply, first of all, I don't admit that it is a failing trade. People must always have carriages to ride in and wagons for the conveyance of goods, and there are more carriages and wagons being built at the present time than there ever was before. So I repudiate the failing trade proposition *in toto*. "Fabian" says he maintains, and he thinks you will agree with him, that if we are to carry out the idea of the survival of the fittest, it would be absurd to throw away the so-called benefits obtained by competition; but who told "Fabian" that we are to carry out the idea of the survival of the fittest—and what does he understand by it? If he means that the ten or twelve railway carriage builders in this country are to go on working for nothing till they have ruined half their number, and that afterwards they are to re-imburse themselves by raising their profits, and rise, Phœnix-like, on the ashes of their defunct competitors, then I do not understand "Fabian," nor should I attempt to follow out such an impracticable and immoral idea. Impracticable, because he and I might be dead and buried before we had effected the destruction of the supposed weak ones; and immoral, because it is opposed to the live-and-let-live spirit of the age. But I must now give up following "Fabian" into the world of cloudland, where he seems to be so much at home, and return once more to the object of my letter of the 11th inst., which was written simply to suggest to certain G. M.'s, whose number can be counted on one's fingers, that the time seemed opportune for putting a little extra percentage on prices for new work, and thus increasing the present very small margin of GENERAL EXPENSES AND PROFIT.

Birmingham, March 30th.

PROFESSORS AND STUDENTS.

SIR,—With your permission, I should like, if possible, to ascertain what good purpose can be served by the remarks in a letter headed "Professors and Students," which appears in your last issue signed by a correspondent "J."

I read his production with some care, and tried to the best of my poor ability to discover what really was the purport of it, and to give him credit for such a case as he had made out. So far as it seems possible to elucidate a definite and connected scheme from the somewhat disjointed and irrelevant sentences which he has strung together, they appear to consist of a declamation against professors of physics and their teaching generally, and of a proposal to substitute for them and it the working result of a magnificent generalisation in physical science, which he now brings before the world for the first time, and which shall no sooner have been fully adopted than straightway the teaching of physics will become all that could be desired.

Now if this scheme of "J.'s" be feasible, we must all—more especially those who are students—prepare to incur no small debt of gratitude to him for such an admirable advancement of the educational efficiency of our country. For, be it observed, it is no small and insignificant project that "J." has proposed to himself in this calmly superior and confident manner. He aims at nothing less than entire renovation, by his way, of our present method of teaching physics, so as to render the paths of learning easier and more pleasant to tread than ever yet has been supposed possible! He states that learning physics is, after all, a very simple affair, if only it were adequately taught—taught, that is to say, as "J." himself would doubtless teach it if he had time; but that, unfortunately, it is not so taught in England, and will continue to be badly taught until teachers use a little more of the common sense of which he is presumably a fortunate possessor, and which he employs in so palpably admirable a way. And he goes on to remark that he has at length discovered the key to the whole position; so that when his views and his new method come to be adopted, our professors will be able to make up their minds to teach "all in the same way"—"J.'s" way, we must suppose—with the desirable result—which does not now obtain—that mayhap even pupils educated in physics by Tait will be able to flutter like butterflies from college to college, and pass examinations with an ease and certainty hitherto unknown to these benighted men, at least outside of their own college at Edinburgh.

Why, then, do we not rush to accept the proposals of the sagacious and altogether admirable "J."? Why do we listen to the inadequate teaching, the incoherent confusion of speech, of such men as Professor Greenhill and Professor Tait, when "J.," in his magnanimous philanthropy, waits only to show how physics is one of the simplest things on earth to learn; waits to "make our puzzles clear as the sun at noonday;" and with the aid of the new principle which he has discovered, viz., that "beyond the range of our own senses we can have no knowledge of anything," he will be happy to supply us with "the key to the mist"—as he so well puts it—"of words and formulæ under which truth is at present hidden."

Why, I repeat, are we not sitting at the feet of this great high priest of science? Who, despite his claims to the eternal homage of mankind, stoops to honour with his friendship no less than three professors of physics and engineering, notwithstanding the fact that he is dissatisfied with their teaching! Happy professors! Magnanimous "J."!

Why? Because we find that when "J."—the student's newly-found guide, philosopher, and friend, the man who poses as a very oracle of wisdom, from the infallibility of whose responses there is no appeal—comes to talk the language of physics, which to him ought to be as easy as his mother-tongue, he falls into errors so apparent, so ridiculous, so grave, that even one of Tait's poor misguided pupils, who could not pass anywhere save in Edinburgh, is able to see the absurdities of them. And on finding that "J."—from whom, if from anyone, he might have expected rigid exactness in terminology—is not even so accurate as some of the much-despised professors who teach physics thus inadequately, is reluctantly forced to acknowledge that hope has at last quite died out of his heart, and is obliged to return to the husks that Tait supplies.

Let us examine the preliminary inoculating dose of physics which has been meted out to us. "J." says there are certain broad, well-defined things about which the poor professors cannot well go astray, and he cites as an example, "the rate of acceleration due to gravity." Now it surely cannot be possible for "J." himself to go astray on such a very simple point as this, on which he says it is impossible for even professors to make a mistake. Such, however, is the case. Nothing could be more absurdly redundant than the word "rate," when placed before "acceleration" in this way. Acceleration means rate of change of velocity. When, therefore, "J." says "rate of acceleration due to gravity," he virtually says, rate of rate of change of velocity due to gravity. This surely is hardly up to "J.'s" standard of excellence?

But let us give our attention to the quite supreme effort he makes in the next sentence. He says: "But take the words acceleration of motion away from g, and we have vagueness and confusion." This is an algebraic equation pure and simple. We have: g − acceleration of motion = vagueness and confusion. Now, remembering that acceleration of motion equals mass × acceleration (= M g, say), we get: $g - \mathrm{M}\,g$ = vagueness and confusion, or $g = \frac{\text{vagueness and confusion}}{1 - \mathrm{M}}$; a new and striking expression for determining g without any recourse to experiment.

Then, again, "J." gives it as his opinion that "as far as physics are concerned, the great thing we have to deal with is energy." He appears to have forgotten what doubtless one of these wretched professors taught him in his youth—that energy is never found except in association with matter. I suppose he has not noticed that statement in "almost every text-book of physics which has been published in the last twenty years." In any case, the properties of matter form no part of "J.'s" new and improved curriculum. Assuming, then, that physics can be treated as a term synonymous with energy, "J." now goes on to enunciate the sweeping generalisation already alluded to, which is to effect a grand revolution in all the methods of teaching adopted in the schools. He declares that energy is motion! and concludes from this that when all forms of energy are treated as cases of motion we may expect to have intelligent and reliable teaching in our colleges and schools, but not till then. Now I think we might fairly have expected "J.," the professor's patron and critic, and the student's friend, to know that energy cannot possibly be motion. Energy is proportional to mass and velocity squared; motion or momentum varies as mass and velocity simply. To say that energy is motion is as absurd as to say that a square foot is a linear foot.

It seems to me that it would have been much better if "J." had held his peace, and let the professors and students alone. I do not think the students will thank him in any way; and certainly the professors will not heed him, until, at least, he learns to make use of more accurate scientific language. If our professors are to be overhauled, it must be done by men who at least know what they are talking about! J. T. N.

Edinburgh, April 12th.

THE KAPUNDA AND ADA MELMORE.

SIR,—The *Times* of the 31st ult., in a leading article, criticises the action of the Wreck Commissioners' Court for not dealing more severely with the officers of the Ada Melmore for their neglect in not displaying side lights in accordance with the regulations of the Board of Trade, and for breaking the rule of the road, thereby producing one of the most disastrous collisions since the Northfleet was sunk by the Murillo in 1873. In the evidence it was shown that the unwritten custom of keeping side lights for frequented waters prevailed on board the Ada Melmore, the captain stating that he always had his lights "put out"—meaning displayed—on sighting another ship. The logic of this is truly Irish, for supposing that other ship to be conducted on similarly parsimonious principles, neither vessel would see the other, and it is probable that many vessels posted as missing have thus met their fate. This most dangerous custom of sailing without lights prevails more widely than long-shore folks have any idea of, and there is no gainsaying that such a breach of the law requires more drastic treatment than any legerdemain in connection with certificates.

The majority of such offenders do so with impunity in consequence of the difficulty of detection; it appears to be nobody's business to bring them to justice, and when, as in this case, criminal carelessness has led to lamentable loss of life, a punishment entirely inadequate is all that the law entails. On shore, if a weary railway signalman makes a mistake; if a driver, guard, or fireman—working a line whose directors are interested in improper brakes—can be proved guilty of an error of judgment; if a colliery engine driver overwinds, the law deals out to such offenders criminal sentences, in the event of loss of life. At sea all these matters are viewed differently. A captain neglects the most obvious precautions—suggested in this case not only by the Board of Trade, but by common sense also—and does not display his lights; from this cause the two vessels approach more nearly than they would otherwise have done. His first mate, ignorant of the elementary rules of the road, luffs into a ship containing more than 300 people, and sinks her in a few seconds. What sentences do they get? The captain has his certificate suspended for two years, being meanwhile supplied with a first mate's certificate; whilst, as to the first mate, he gets off scot free.

Passing over the harrowing details of the disaster, by which most of those who perished were drowned like rats in a cage, the single women doubly locked in, unwilling martyrs in the cause of morality, without even a chance of joining in the struggle for the twelve lifebuoys which the Board of Trade considers sufficient for 300 people, we come to the question not asked by the Wreck Commissioner,—Why did the Kapunda sink so rapidly?

Lloyd's register states that the Kapunda had but one bulkhead—a collision bulkhead—placed near the bows, and intended only as a protection from the effects of an end-on collision, and of no use whatever should the vessel, as in this case, be struck aft of the bulkhead. It appears to me to be a very grave question whether emigrants—who, unlike ordinary passengers, cannot individually choose their vessels—should be shipped under any circumstances in vessels with less than three bulkheads.

Had the Kapunda been provided with three, or better, four, bulkheads, there is every reason to believe that most, if not all, the passengers could have been transferred to the Ada Melmore, and possibly no such transference would have been necessary, as the vessel would have remained afloat long enough for them to have been rescued by some other vessel.

The bulkhead question is no novelty; it has been well threshed out. The efficiency of well-constructed bulkheads is admitted, and yet here we have a case in which a vessel with only one bulkhead is chartered to convey 300 emigrants, whilst numbers of well bulkheaded vessels are to be had. The bulkheads of the Oregon kept her afloat long enough to get every passenger into the boats, and but for an obstruction which prevented the closing of a watertight door, she would be afloat at this minute.

I had hoped that other more powerful pens than mine would have dealt with the ship lights and bulkhead question; and let no one flatter himself that it is no business of his, for this is a matter which concerns every one who goes to sea. Some six years ago the technical press was largely instrumental in causing the adoption of more powerful pumping machinery on board first-class steamships. The question of lights and bulkheads remains yet to be pressed on, and it would add to the grief of those who have lost friends in the Kapunda if the disaster and its warnings should pass into oblivion without any lesson having been learnt from it.

STEPHEN H. TERRY, A. Mem. Inst. C.E.

Local Government Board, Whitehall, S.W.

EMPLOYERS' LIABILITY.

SIR,—The action of Mr. Geagh *v.* ourselves, tried last week before Judge Harrison and a special jury at the Antrim Assizes, being, we think, of more than usual interest to the engineering trades and employers generally, it has occurred to us that you might consider it worth while to give your readers a short *résumé* of the case, the more so that the ordinary newspaper reports hardly bring out the special points on our side as clearly as we imagine they deserve.

This action was brought under the Common Law, not under the Employers' Liability Act, and was for injuries undoubtedly suffered by the plaintiff through the breaking of a chain which carried a balance weight. The machine was a large self-contained drill, of which the spindle was balanced by a weight of about 9½ cwt. suspended by two ⅝ chains.

The evidence given for the plaintiff went merely to prove the fact of the breakage and its result, while no evidence whatever could be produced of negligence on our part. On our side it was proved that we employed one of the best makers in the kingdom—Messrs. Smith, Beacock, and Tannett, of Leeds—to manufacture the machine, that the chain had a factor of safety of 19, and therefore greatly in excess of all recognised rules, and that no external examination could have detected a defect in the link that broke.

The case was three times before a jury, and before fifteen judges altogether; on the first trial the jury disagreed, on the second they found a verdict for the plaintiff with £500 damages, but the judge having referred the point of law on which we relied to the full Bench the verdict was reversed, whereupon the plaintiff appealed. The Court of Appeal, through some misunderstanding of the evidence, ordered a new trial, giving us the option of taking the case into the House of Lords, and we elected for the new trial, which was the one just decided, as we considered that it would be better to have the misapprehension which some of the judges evidently had as to the facts removed by the evidence clearly given in the new trial. The result has been a clear verdict in our favour, and being as we think strictly in accordance with the evidence, should form an important and valuable precedent in all future cases where actions are brought against employers for the consequences of accidents beyond their control.

Had the plaintiff approached us at the outset in any other way than by the medium of a solicitor's letter there would probably have been no trial, as we felt for his misfortune, although caused by no fault of ours; but in justice to ourselves and other employers we could not do otherwise than resist by all means in our power the attempt to enforce by legal proceedings a claim which we considered neither legally nor morally tenable.

However, as we have now had the case decided in our favour, we have adopted the suggestion of the Court, that the plaintiff should receive a substantial solatium.

HARLAND AND WOLFF.

Iron Shipbuilding and Engineering Works, Belfast.
April 11th.

THE HORSE-POWER OF STEAM.

SIR,—At the recent launch of the Victoria Sir W. Armstrong is reported to have stated her engines were of 12,000-horse power. If a horse-power is the raising 33,000 lb. one foot in one minute, I must ask you to allow me, with all respect, to inform Sir William his reported statement is a mistake. How he arrived at his estimate I know not, but the usual method by the well-known little instrument, the indicator, I know well, and equally well know it furnishes us with no guide relative to the horse-power of our engines. It often appears to me one of the marvels of the age that such a reputed intelligent body of men as our engineers have not seen, in estimating the horse-power of an engine by the indicator, that they actually assume the work upon the engine to be equal the raising a body of water of the weight of the steam upon the piston, and with a velocity equal the motion of the piston. I am sure when this is once pointed out to the more intelligent of your readers, they will at once perceive the assumption upon which they work is the precise equivalent to placing a 50 lb. weight in each scale of an ordinary balance, and expect to see the one weight raise the other. But it is equally evident, if a 50 lb. weight is placed in one scale and a 40 lb. in the other, the heavier weight will surely raise the other. It is so with the piston of the steam engine; the work upon the engine must absolutely be less than the equivalent of an equal weight of water raised to the weight of steam pressure and velocity of the piston; for it is only from the absolute fact that the weight of the pressure of steam being more than the equivalent of the weight of water to be raised that renders motion of the piston at all possible. And when, as we often find, the piston velocity very high, this shows clearly that the work—or the assumed weight of water being raised—must be immensely below the weight of steam pressure upon the piston. I believe I need not say more to show the extreme fallacy of the ordinary indicated horse-power of the steam engine.

Eastbourne. R. SHEWARD.

[We publish Mr. Sheward's letter because it puts into force an idea entertained by very large numbers of engineers. Nevertheless, it is strictly true that by the third law of motion as every force is counterpoised by another equal and opposite, the resistance offered by a piston to the steam is at all times and under all circumstances precisely equal to the driving force. This is Pambour's well-known theorem referred to in most text-books of the steam engine. —ED. E.]

ENGINE DRIVERS' EYESIGHT.

SIR,—Your corrspondent "Mem. Inst. M.E.," page 280, last week, gives details of the "dot and wool" test, and remarks that if a driver can pass it "his sight is considered right for distance." The absurdity of a theoretical test is clearly shown by the fact that some men who fail to pass the dot and wool test can see signals at any required distance; whereas, some who have successfully passed those tests can only imperfectly see the railway signals. Within the past fortnight meetings of railway servants have been held at fully a hundred railway centres, and in every case the following or similar resolution has been passed:—"That this meeting of railway servants is of opinion that, whilst good eyesight is of the highest importance to enginemen, it believes that the only really useful test should be of a practical kind, and consist of ability to discern at long distances, by day and night, the signals they have to obey."

"Mem. Inst. M.E." in his letter states that he has known several instances of colour blindness. My experience is quite contrary, for during the past twenty years I have only met with one case of a man who could not tell the difference between the various flags and railway signals. It is most important that a driver should have good sight, but at the same time it is of great importance that the test should be practical and fair, and that it should not be employed as a means to remove certain men from their work as drivers.

CLEMENT E. STRETTON,
Consulting Engineer Amalgamated Society of Railway Servants.

Head Offices A.S.R.S., 306, City-road,
London, E.C., April 12th.

THE INSTITUTION OF CIVIL ENGINEERS.

PRINTING MACHINERY.

AT the meeting on Tuesday, the 5th of April, Mr. Edward Woods, President, in the chair, the paper read was on "Printing Machinery," by Mr. E. A. Clowes.

The universal law of development and progress in nature, with the survival of the fittest, is strikingly exemplified in the history of letter-press printing machinery. The little hand-press of four hundred years ago has developed into the huge power-press of to-day by successive and sequential stages. In the middle of the fifteenth century, printers possessed an appliance which would print on one side of a sheet of foolscap only; and at the present time they have an apparatus that prints on both sides simultaneously from reels of paper five miles long, at the rate of 100 yards per minute. The former worked at the rate of less than 200 impressions per hour; the latter gives 10,000 copies of the *Times* per hour. Yet it is possible to trace the gradual evolution of the one from the other; and it is the object of this paper to indicate how, by successive steps of improvement, a stage of perfection has been arrived at which could not have been conceived even in the wildest dreams of the first printers.

In order to estimate aright the conditions of the problem, the elements which presented themselves may be recalled. There was the surface to be printed from—one containing designs of letters or pictures in relief. This was to be covered with a pigment or ink, sufficiently thin to coat even the finest lines of the design, and sufficiently tenacious to be transferred to paper. There is, also, the apparatus by which the ink may be impressed on the paper, that is, the press or machine. The earliest representation of a press is dated 1507. There is a simple screw, with a long pin for a lever. The head of the press and the table bear the pressure between them. The type forme is laid on a "table," which is run in and out, under the platen, by means of girths or bands, a drum, and a handle. The principle involved is the use of a flat board or plate moved parallel to itself, and so brought to press on a forme of type laid on a hard flat surface. This kind of press was, with modifications, in general use for about three hundred years, and its main principles are continued up to the present day, although the pressure is obtained in various ways, as fully described in the printed introduction to this paper. Presses have, however, been superseded, for all but exceptional work, by "machines," the origin of which it is now necessary to trace.

In the chronological synopsis the various machines, whose date of origin is given, are divided into:—(*a*) Hand presses. (*b*) Machines. The word "machines" is here used in the printer's sense. Of course a press is a machine, but this word has been adopted as a concise description of a press that is more or less automatic. The wonderful degree to which the apparatus of printing has been rendered automatic is shown by a table, from which it appears that to print a single sheet by the hand press ten separate and distinct operations are necessary; on an ordinary cylinder machine with flyers these are reduced to two, while in a rotary web-machine the whole operation is performed by the self-acting mechanism. Under the denomination machines, then, there are four classes. The characteristic in the first class, or single-cylinder machine, is a cylinder impressing a forme of type on a flat bed. In the second class, or perfecting machines, two cylinders are employed to print the two sides of the sheet, which is carried successively under each cylinder, impressing the two formes of type also on a flat bed. In the third class, the cylinder as a means of impression is dispensed with, and a flat plane or "platen" used, as in the hand press, and the machine prints on one side of the paper only. In the fourth class—the rotary machines—the impressing, as well as the printing, surfaces are revolving cylinders.

Beginning with platen machines, it is necessary to state that the idea of the inventor, Frederick König, was, in 1803, merely to perform the inking by means of leathern rollers, and to propel the type-forme backwards and forwards underneath them. His ideas had reference to an improved press rather than to a new machine. König was undoubtedly the "inventor" of the first machine ever made; but it was not a success, and the platen machine as a practicable appliance was first introduced by an engineer, a Mr. Brown, though it was not patented, and was capable of printing a double-crown sheet on one side only. Soon after the introduction of this machine, others of a similar type were brought out; but the Napier machine nearly superseded them all, owing to its general excellence.

In 1811 König invented the first single-cylinder machine, in which he adopted a cylinder for giving the impression, the type being on a flat bed, a train of superposed cylinders or rollers, two of which had end motion for distributing the ink, and the use of tapes to carry the paper. Improvements on this machine were made under the auspices of Mr. Walter, of the *Times*, the result of which was that on the 28th of November, 1814, a newspaper was for the first time printed by machinery. The chief feature of these improvements was that an increase of speed was obtained by feeding in sheets alternately at the two ends of the machine. In 1818 the late Professor Edward Cowper invented several important improvements, among them being a flat distributing table, on which the ink was uniformly distributed by rollers made of a glue and treacle composition, having an end motion as well as a rotary motion, and inking rollers having a simple rotary motion. Subsequently, in conjunction with Applegath, Cowper constructed a machine for the *Times* with four cylinders. The true principles of this class of machine were now ascertained, and the next step was to adapt them to the printing of fine book-work. This has been done by a succession of inventors, the chief of whom will be found named in the chronological synopsis.

In 1814 König took out a patent for an apparatus, by means of which the sheet, after being printed on one side, is conveyed to a second forme, there to be printed on the other side. This machine resembled two single-cylinder machines placed with their cylinders towards each other. The sheet was conveyed from one cylinder to the other by means of tapes, the track of the tapes resembling an horizontal ∽, so that, in the course of its track, the sheet was turned over, and a different side presented to the second cylinder to that which encountered the first. This system has been followed in perfecting machines ever since König's time. In 1818 Cowper applied some very important improvements. At the first cylinder the sheet received the impression from the first forme, and at the second cylinder it received the impression from the second forme. In order to make register, the intermediate drums were raised or lowered by means of screws arranged for that purpose. Thus the sheet was sent in a little sooner or later as required, after printing the first side. The credit of having improved this method, by causing the cylinders to rise and fall and facilitating the making of register, is due to the late Mr. David Napier. He, in 1824, added to his machines the contrivance called "grippers," which conveyed the sheet from the laying-on board through the machine.

A rotary machine of the fourth class, which indeed foreshadowed nearly every fundamental element of the most advanced machinery of the present day, was patented in 1790 by William Nicholson, but never actually built. The first to make a rotary machine were Bacon and Donkin, who in 1813 devised an apparatus in which the types were fixed on a revolving four-sided prism, and the ink applied by an adjustable roller, the sheet of paper being wrapped on another prism so formed as to meet the irregularities of the type prism. The inking apparatus being defective, good work was not possible. The machine is noteworthy from the fact that the roller for the first time was to be clothed with glue prepared so as to lessen its tendency to become hard by exposure to the air.

(*To be continued.*)

LAUNCHES AND TRIAL TRIPS.

ON Thursday, April 7th, Messrs. Edward Withy and Co., West Hartlepool, launched the steel screw steamer Rockcliff, built to the order of George Horsley, Esq., of West Hartlepool. The dimensions of the vessel are 300ft. by 38ft. by 20ft. 3in. and she is fitted with a long raised quarter deck, poop, bridge, and top-gallant forecastle. Her deadweight carrying capacity will be very large. The main, poop, top gallant forecastle decks are of steel and iron, the bulwarks, rails, engine-room and cabin skylights, chart-house are of iron, five steel water-tight bulkheads, and she is fitted with patent improved cellular double bottom for water ballast all fore and aft. She is also fitted with four patent steam winches, windlass, two donkey boilers, Davis' combined hand and steam steering gear amidships, right and left-hand screw gear aft, and is rigged as a two-masted fore-and-aft schooner with iron pole masts. The cabin accommodation for the captain and officers is fitted up in the poop and constructed of hard wood. The steamer will be fitted with triple expansion engines by Messrs. T. Richardson and Sons, Hartlepool.

On March 23rd the sea trial trip of the steam yacht Thalatta, built by Messrs. Philips and Son, of Dartmouth, for Mr. Frank C. Capel, of London, took place, the run being from Dartmouth to Cowes, a distance of 94 knots. This yacht is of teak with oak frames, having a length of 90ft., with a beam of 17ft., the run from Dartmouth to Cowes being covered in 9½ hours in a heavy sea. It will be remembered that on the 23rd March the weather in the Channel was very boisterous, the Weymouth and Guernsey boat deeming it prudent to remain in harbour on that day, while sailing vessels were kept at their anchorages owing to the storm cone being up at all the stations on the south coast, and it says a good deal for the sea-going qualities of the Thalatta that the trip was performed in such good time, the engines never having been eased during the whole run, and while the passage was what would be called a lively one, the quantity of water that reached the deck was inconsiderable in such a sea. The engines of the Thalatta are by Messrs. Alex. Wilson and Co., London, the cylinders being 15in. and 27in. diameter by 16in. stroke, indicating 180-horse power, and are fitted with Payton and Wilson's patent circular balanced and double-ported slide valves. These valves are meeting with a great success, and as Messrs. Wilson and Co. have been using them for the last six years, they have now passed the experimental stage, and from their lightness as compared with piston valves are worthy the attention of all marine engineers, and indeed of all those using steam at a high pressure.

THE Ottawa Board of Trade has discussed the Ottawa Ship Canal scheme and warmly endorsed it. Steps are being taken to bring it before the Government.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE condition of the iron markets of this country has not materially altered in the course of the week, nor have the weaker tendencies shown on some of the principal foreign iron markets, which are here looked upon as only transitory, been able to affect it unfavourably as yet, a circumstance which, under the general aspect of affairs, must be considered satisfactory. Prices have been, generally, very firmly maintained, and from all the industrial districts a very hopeful tone is distinctly pronounced, for now that the political horizon has begun to assume a more friendly appearance it is calculated that business in the iron industry, a little sooner or a little later, must take a further upward turn. During the late political crisis, buyers were not willing to come forward and give the enhanced price which just before had been declared, but now they are gradually emerging, and in the S.W. districts, where the works are very well occupied with orders, are ready to pay an advance of M. 5 p.t. for girders and bar iron for constructive purposes. The reports from Silesia are of the same tenour. Pig iron is going off in satisfactory quantities at M. 48 p.t., and the demand for all sorts of wrought iron, as bars, girders, and plates, is very brisk. The prices for steel articles are very firm, and some sorts have gone up M. 2 p.t.—and, in fact, the enhanced prices have had the effect of quickening the general demand.

The Belgian iron market has continued unchanged and is very firm, which can especially be said of wrought iron, the receipt of the large order for Buenos Ayres, for which no less than thirty-three firms tendered, having had not a little to do with this. The base price of plates has been fixed at 130f. p.t., that is to say, the same price is now charged for plates for domestic consumption as for export, in order not to favour foreign constructive works, which was hitherto the case when export goods enjoyed the benefit of 5f. p.t. The machine shops are pretty well employed all through. The St. Leonhard Company has secured an order for four locomotives and 200 wagons of all sorts for Brazil. Steel rails have gone up in the last three months 10f. p.t., but Bessemer pig has gone up higher in proportion. The prices of pig iron vary from 40f. to 42f. p.t. Lump coal costs 19f. to 23f., and semi-bituminous small coal 5·50 to 7·50 p.t., and is very firm at these prices.

The French iron market has been quiet; the works have just enough in small orders to keep on with, but the prices are not quite satisfactory, and there is great trouble to maintain these. Bars cost 130f. to 140f., the former price only for large lots at short delivery. The tenders for 5564 t. of steel and 881 t. of wrought ironwork, estimated at 2,546,480f., for the machinery section of the Exhibition building, were to have been awarded a fortnight ago, but no decision was come to, because the prices offered exceeded the estimates. This is considered a healthy sign by the ironmasters, and hopes are now entertained that this will stop the downward tendency of prices. Old rails can be bought for 75f. p.t.

As regards Rheinland-Westphalia, both the ore and pig iron trades have remained unchanged. The demand has continued regular, and, if anything, has been rather more brisk. As a sign of increased confidence in the future, it may be noted that really serious thoughts are now entertained of blowing in fresh furnaces, though it must at the same time be said that the production covers the demand at the present time. The prices on the whole are the same as those last reported. The wrought iron business continues to show satisfactory features. The works are, as before, still well employed on bars of all sections, and since it may be said that the convention is now firmly constituted, it will not be long before the base price of M. 110 p.t. will be everywhere easily obtained from buyers, whereas at present this is only possible of attainment from those who did not cover themselves before the rise was declared. Girders are likely to advance rapidly now the building season has set in, especially as the Moselle and Saar group of works have raised their prices already M. 5 p.t., as above mentioned. In plates there is no alteration to note. Thin black sheets are at this season rather out of course, but yet the Siegerland mills are able to keep full on with them, and so no stocks are on hand. The building season is likely to cause the prices of the roofing gauges to rise. The present price is M. 135 to 140 p.t., but for later delivery by contract higher prices are demanded. The wire rod trade is slightly dull, and prices not buoyant; but as the works have orders for some time on the books, and indications of brighter prospects are not wanting, there is nothing disheartening in the condition of the business, for still there is a moderate demand from abroad, and, indeed, from home consumers as well, but buyers are rather slow in coming forward. Wire nails are noted M. 135 to 140 p.t. In steel railway material there is little new to relate. The lowest tender for 3000 tons of rails at Breslau on the 6th inst. was M. 115 p.t. Those of the Rhenish Works and of Cockerill and Co. were rather higher. It may be noted here that the International "abstention" arrangement lapsed at the end of March, so now foreign competition is again possible, much to the chagrin of the native works. The last lowest tender for steel tires was M. 202·50, whilst others ranged from 204 to 234·50 p.t. The Dortmund Union Company it is reported has received, or expects to receive, orders for 20,000 tons of rails from Japan and Buenos Ayres. From a trustworthy source it would appear that there is no truth in the near approach of an International Rail Convention, but that for months past negotiations have been going on, and that everything is so far arranged that if some principal works could be induced to join, it might at once come into existence. Up to the present time only two works—Krupp, and the Hœrde Co.—have made steel ship-plates in this country, but now the Hœsch Co., of Dortmund, is about to manufacture them, and to this end is adding Siemens-Martin furnaces and a heavy train to their present establishment. The machine and constructive shops and foundries are not well employed, as a rule, only here and there some have a good deal of work to do, but still not enough to keep all the departments going. The position of the wagon works is pretty much the same as before, except that the State has just given out an order for 550 of different kinds at Magdeburg. The brass foundries have been moderately well off for orders during the month of March, especially those which make tuyeres and the like for blast furnace purposes, which were quite busy on these articles. The prices, however, remain very low, as: M. 1·65 for phosphor bronze, 1·60 for bronze, 1·65 to 1·70 for red brass, per kilog.

It is stated that the largest cannon in the world, now being manufactured by Krupp, is to weigh 143,000 kilogs., is to have a calibre of 40 c.m., and a length of 16 m. It is to fire two sizes of shells, one of which is 1·12 m. long, weighing 740 kilogs.; the other, 1·60 m. long, weighing 1050 kilogs. The brown prismatic powder charge is to be 480 kilogs., and with this the lighter shell is to have an initial velocity of 735 m., and the heavier one of 640 m. at the muzzle. The former is to pierce a wrought iron plate of 1·142 m., and the latter one of 1·207 m. in thickness. As given, the charge and shells seem out of all proportion to the size of the gun and its assumed performance.

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

(*From our own Correspondent.*)

THIS has been the week of the quarterly meetings. The attendances have been fairly good, though iron and steel masters from distant parts of the kingdom have not been present in such numbers as on some former occasions. The fact that the meetings have fallen in the middle of Easter week has also militated somewhat against their success. Merchants from London, Liverpool, Bristol, Manchester and elsewhere were anxiously sought out by iron and steel masters waiting for orders. The favours which these buyers have distributed have not, however, been of great account, and they did not speak of having many lines of value to place just yet in any of the iron departments.

Alike at the Wolverhampton meeting yesterday and at the Birmingham meeting to-day—Thursday—however, sellers offered a fairly firm front. They were indisposed to admit that the quietude which characterised the meetings in the way of new buying must be accepted as an inevitable indication of the character of the demand which is likely shortly to appear. As the quarter wears on better things are expected. There is therefore a reluctance to fill up order-books for finished iron and steel at any prices which merchants care to offer. Sellers prefer to wait a little, and to act with caution.

The gatherings assembled in the belief that the standard quotations for raw and manufactured iron were to remain unaltered. This has proved to be the case, for all-mine pigs have been re-declared at 52s. 6d. to 55s. for hot blast sorts, and about 75s. to 80s. for cold blast sorts. Marked bars are re-announced at £7, with the customary 12s. 6d. additional as merchant's premium for the Round Oak brand of the Lord Ward house. This standard for bars has ruled since April, 1886, and is quoted by such firms as the New British Iron Company, Messrs. Wm. Barrows and Sons, Messrs. Jno. Bagnall and Co., Messrs. Noah, Hingley, and Sons, and others.

Messrs. John Bradley and Co. still price all bars above ⅝in. at £9 10s.; hoops they quote £8 10s., which is 20s. per ton above the standard of the market; and sheets and plates £10, which is 30s. advance on other best makers. Rounds and squares up to ⅝in. are quoted £8, a rise upon other firms of 20s. per ton.

Most of the business that the superior bar makers are doing is in their second-class qualities, for which the quotation remains at £6.

The mitre iron of Messrs. Philip Williams and Sons is quoted:—Bars of ⅝in., round or square, or ½in. to $\frac{9}{16}$in., round or square; and flats 1in. by ⅜in. or ¾in., £6 15s. Strips from 1½in. to 6in. broad, £7 5s.; and angle and plating bars also £7 5s.; sheets of 20 w.g. are £7 15s.; 24 g., £8 10s.; and 26 g., £9 10s. Wednesbury Oak qualities are quoted £1 less than mitre.

Makers of unmarked bars and hoops and strips reported that their order-books are getting worked up pretty closely. There has therefore been no disposition this week to shorten the usual length of the Easter holidays. At some of the mills and forges, including certain of the sheet works, operations which had been suspended on Friday and Saturday were resumed on Wednesday, but at many works nothing was done until to-day, and not a few mills will remain idle until next week. The orders which have been placed at this week's meetings, and which will be received during the next few days, will provide something for the men to begin upon. But it cannot be said that in any direction requirements bulk largely.

Prices of unmarked iron favoured buyers. Very little trace was now observable of the resolution of last February advancing prices 10s. per ton. That effort has failed in consequence of the lack of the requisite demand for the iron. The only result of it at this week's meetings was that ironmasters were in a state of some uncertainty upon the wages question. The men's claim for a 5 per cent. advance has to be argued before Sir Thomas Martineau, Mayor of Birmingham, as arbitrator to the Wages Board; but there is very little expectation that Sir Thomas will grant any advance during the present state of trade.

General merchant bars are £5 10s., and common £5. Hoops are £5 7s. 6d. easy, and strips for gas-tube making and for similar uses, £5 to £5 5s. per ton. The extras for small sizes of bars determined upon in February were re-quoted by sellers this afternoon in Birmingham, and their efforts met with some degree of success. Makers quoted:—Squares and rounds, ⅜in., an extra of 5s. per ton; $\frac{5}{16}$in., Nos. 1 and 2, 10s. extra; Nos. 3 and 4, 15s.; No. 5., 25s.; No. 6, 35s.; No. 7, 55s.; No. 8, 75s.; and No. 9, 100s. extra per ton.

Sheets, as had been expected, showed more buoyancy to-day than any other denomination. Yet there was less animation than a couple of months ago, and the contrast with the marked activity which existed at the quarterly meetings which opened the year was very conspicuous. The galvanisers have become much quieter on export account, and the orders placed with the black sheet ironmasters are a good deal curtailed. Prices, however, were steady at £6 for 20 w.g., £6 7s. 6d. to £6 10s. nominal for 24 g.; and £7 5s. for 27 g. Production is being kept pretty level with the demand, and makers have good hopes of improvement with the advance of the season.

The position of steel to-day was much better proportionately than that of iron. A brisk demand is expressed for both native and also imported makes. Plates, bars, channels and angles, sheets, billets, and blooms, all sold well. Local steel masters reported their order books better filled than for a long time past, and those from other districts spoke in high terms of the activity which they are experiencing.

Steel rail and steel sleeper prospects were reported very good, with prices advancing. Prices of native steel were strong at £5 15s. to £6 for soft blooms and billets of excellent quality, £7 to £8 for superior mild boiler plates, and £9 to £10 for soft sheets for deep stamping. Basic steel bars were £5 10s. to £6; plates, £6 10s. to £7 10s., and other sorts in proportion.

The American demand was much discussed. There was no denying that it has declined, and that our home markets are less buoyant in consequence, but the hope, in certain quarters amounting to a belief, was expressed that we shall again see a revival of American buying.

The pig iron market is without much animation. Sales of 500, and in some cases of 1000 ton lots, have been made this week in various directions, but heavy contracts have been the exception. Forward orders have been placed by some buyers, but the bulk have not been anxious to add to their existing responsibilities. Midland imported brands have shown more life than native makes, and sellers are not wholly unsuccessful in their efforts to keep up prices at the full level of the past few weeks. Compared with the prices of a couple of months ago, however, this week's figures were down all round.

Prices of pigs varied greatly, but 38s. 6d. to 39s. may be mentioned as continuing about the average for ordinary Northamptons delivered, and 39s. 6d. to 40s. for ordinary Derbyshires. Some superior Derbyshires were firm at 42s. to 42s. 6d., as also were certain Lincolnshires. For some Midland brands no quotation could be obtained by consumers, sellers being still off the market. Bessemer hematites were strong at 57s. 6d. to 60s. delivered from the West Coast. Native pig makers reported brisk deliveries at 37s. 6d. to 40s. and 42s. for part-mines, according to mixture, and 30s. to 32s. 6d. nominal for cinder sorts.

The galvanisers held a meeting this (Thursday) afternoon and resolved to make alteration in price for the ensuing quarter.

The death is announced, on 7th April, at Torquay, of Mr. William Barrows, eldest son of the late Wm. Barrows, of Himley, Staffordshire, aged 62 years. The deceased was identified with the firm of Messrs. Bradley, Barrows, and Hall, of the Bloomfield and other works at Tipton, Staffordshire. They once made 1000 tons of bars a week for the Australian markets. The firm is now known as William Barrows and Sons. At the time of his death Mr. Barrows was the proprietor of a hotel at Torquay.

The annual meeting of the South Staffordshire Institute of Iron and Steel Works' Managers was held at Dudley, on Saturday, when the president, Mr. G. B. Wright, in his inaugural address, said that the causes of the present unfavourable condition of the South Staffordshire iron trade might be looked for in a questionable fiscal policy of Government, a defective system of currency, on extortionate demand on the part of railway monopolists, or the short hours of labour in this country. These were matters of great moment, and each or all of them possibly vitally affected the trade of the district. But two matters of yet greater importance than any he had mentioned remained in their hands—economy of production and excellence of manufacture. To achieve the objects much attention should be paid to improvements in the mills and forges, and more particularly in the puddling furnaces. Mr. R. Smith-Casson, manager of the Earl of Dudley's Round Oak Works, alluded to a patent which had been taken out by Mr. A. E. Tucker and Mr. Harbord, members of the institute, for substituting basic slag for sand for the bottoms of mill furnaces. He had experimented with the new bottom at one of his own furnaces, and found that it answered remarkably well, the flue cinder making an admirable fettling, and the iron being altogether free from crystal. Other members spoke favourably of the new practice.

American competition in the door-lock trade in the Australian and New Zealand markets is increasingly severe. Certain large establishments at Willenhall, where machine plants have been put down at great expense, especially to manufacture iron locks for the colonies, are now unable to get orders to keep the machinery going. Consequently one of the chief firms—Messrs. H. and T. Vaughan—have this week despatched one of their members on a lengthened tour through Australia, New Zealand, Tasmania, and Canada, to ascertain what are the secrets of the American success, and to bring the increased capabilities of English manufacturers more prominently to the notice of these export buyers.

Considerable expectation has been aroused throughout the sword trade in Birmingham touching the contract which is to be given out by the War-office for 150,000 Enfield-Martini sword bayonets and 150,000 leather scabbards; 30,000 are required for delivery by March 31st, 1888, and the remainder to be spread over two or three years, at the discretion of the Secretary for War.

The Birmingham builders are still indisposed to resume work at the reduced wages, and they do not seem desirous of facilitating a speedy settlement by arbitration. Names have been submitted to them by the employers for selection as arbitrators, but they have been all rejected, apparently in the belief that their decisions will not be wholly disinterested.

The ironworkers of West Bromwich, Oldbury, and Smethwick districts are looking forward with confidence to the forthcoming national meeting at Manchester. They believe that, "if properly entered into, the conference will prove the foundation of prosperity for the iron trade, and will effectually establish an equality of wages in the North and in the South."

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—This has been so much a broken week owing to the holidays that it is little more than guesswork to arrive at any conclusions as to the real condition of trade so far as they can be based upon actual business operations. Engineering works and collieries have, for the most part, been closed for three days, and with the quarterly meetings following so closely upon the holidays, business has been practically at a standstill for the greater portion of the past week. So far as the quarterly meeting held at Middlesbrough on Tuesday has afforded any means of judging, the prospects of improved trade are not very encouraging, and it remains to be seen whether the Birmingham meetings will bring forward any better results. As regards the outlook here I find few who speak very hopefully of the future; there is an absence of anything tangible in the shape of actually increased trade in prospect, and although the feeling as to the future is not despondent, there is a more or less general want of confidence.

There was a moderate attendance on the Manchester iron market on Tuesday, but business had not got back into its ordinary groove after the holidays, and there was practically little or nothing doing, with quoted prices simply nominal. So far as the very limited operations could afford any means of judging, it may be said that the general aspect of trade remained extremely dull, with a continued weakness in prices. The persistent downward tendency reported from the Glasgow market, and the excessively low figures at which both Scotch and North of England warrants are quoted, has necessarily a depressing effect, and buyers are encouraged to hold out for much lower prices than makers are willing to entertain. Lancashire makers of pig iron have reduced their list rates 1s. per ton, and this has enabled them to effect a few sales to special customers; but so far as trade of anything like a general character is concerned, they are still quite out of the market, and in district brands even the minimum prices quoted by makers of Lincolnshire iron, which are considerably below what local makers are asking, fail to meet the present views of buyers. In outside brands there is continued underselling, and for Scotch iron makers' prices are gradually following the low cut prices of merchants and dealers; whilst representatives of Middlesbrough houses, although they still hold to late quotations, are more open to entertain offers.

The leading hematite makers are in most cases still holding on to late rates, but they are undersold by merchants, whilst warrants are offered at an altogether disproportionate margin below the prices quoted by producers.

In the manufactured iron trade business continues of a hand-to-mouth character; some of the forges manage to keep about fully employed, but there is a general shortness of work, and as a result of so much eagerness to secure such orders as do come upon the market, that prices are not in all cases very firmly adhered to. Quoted rates are no lower, but there is a disposition to meet buyers who have favourable specifications to offer, and to this extent prices may be said to be easier.

The returns just issued for the past month by the principal trades union organisations connected with the engineering branches of industry again show a decrease in the number of unemployed members, whilst from the various districts in most of the important industrial centres reports are sent in of a gradual improvement in the condition of trade. This is nowhere very marked, and it is only in exceptional cases where trade is yet returned as actually good; but the men seem to have got the conviction that trade is undoubtedly better, and a very uneasy feeling has sprung up with regard to wages. So far wiser counsels have prevailed, but it has only been with very great difficulty that in one or two districts the men have been restrained from setting on foot a movement for a return to the rate of wages ruling prior to the reduction which was rendered necessary by the depressed state of trade at the commencement of last year. With regard to employment, the returns of the Amalgamated Society of Engineers show a substantial reduction in the number of members in receipt of out-of-work support. In the Manchester and Salford district it is 2½ per cent. less than a couple of months back, and throughout the whole of the society there is a reduction of 2 per cent. as compared with the returns at the commencement of the year, there being now only about six per cent. of the members in receipt of out-of-work donation as compared with about 8 per cent. in January. The returns of the Steam Engine-makers' Society show a reduction of about 1 per cent. upon last month in the number of members on donation benefit, and in this society there are now only about 3½ per cent. of the members actually in receipt of out-of-work support. The Moulders' Society, in its report for the past month, also shows a reduction in the number of unemployed members. These returns are, of course, very satisfactory, but the reports which I am able to gather as to the actual state of trade do not bear out the conclusion that it is in any really much better condition, and with a few special exceptions the engineering works in the district are only indifferently off for orders. There is no doubt here and there a temporary push of work which gives an appearance of improvement in trade, but employers generally are in no really better position, and the orders they are able to get have still to be competed for at excessively low prices.

The annual report of the Boilermakers' and Iron Shipbuilders Society, of which I have obtained a copy, can scarcely be said to show very encouraging results from a trades' union point of view.

The general secretary, Mr. R. Knight, in his introductory statement, points out how the list of unemployed members "shows the terrible effect" of the depression in trade. During 1884 they had an average of 23½ per cent. unemployed members, the following year it rose to 26¾, and last year the average of unemployed members was no less than about 28 per cent. The present position of the society may be briefly stated as follows:—At the end of last year the number of members had fallen from 27,695, at which it stood at the close of 1885, to 25,341, being a decrease of 2344 members; the increase for the past year amounted to £67,839, whilst the expenditure had amounted to £84,260, being an excess of expenditure over income of £16,421, and the balance of funds in hand at the close of the year had been reduced to £21,895, one of the chief items of expenditure being £38,967 in out-of-work support to members, and it may be added that during the past three years this benefit alone has cost the society £148,245.

The first ballot for the election of general secretary to the Amalgamated Society of Engineers, in the place of Mr. John Burnett, who has accepted a post under Government in connection with the recently formed Labour Bureau, has just been completed, and Mr. Robert Austin, of Manchester, stands at the head of the list with a majority of upwards of 2000 votes over his nearest competitor, Mr. John Anderson, of London, who is acting as secretary *pro tem.* Mr. Austin has, however, not secured a sufficient majority over the whole number of votes, and a second ballot will be necessary.

I understand that the promoters of the Manchester Ship Canal are well satisfied with the result so far of the appeal they have made to the district for support; the amount of capital requisite to be subscribed in Lancashire and the surrounding district before the scheme can be financed in London has, however, not yet been promised, and the canvassing for shareholders is still being most energetically proceeded with. The mayors of the various important Lancashire towns are calling meetings at which the scheme can be publicly explained, and in this way a large measure of support is being secured, whilst the model of the proposed canal, of which I gave a description recently, and which is being shown in various places, has proved a most attractive feature.

In the coal trade, apart from the interruption which has been caused by the holidays, there is little or no change to report. There is still a fair demand generally, and with the exception of best house fire coals colliery proprietors have no great difficulty in moving away their present supplies. With the advance of the season there is the natural tendency towards weakness in prices, and although quoted rates are no lower, colliery proprietors do not allow small concessions, if they are found necessary, to stand in the way of business. At the pit mouth best coal averages 8s. 9d. to 9s.; seconds, 7s. to 7s. 6d.; common coal, 5s. 3d. to 5s. 9d.; burgy, 4s. 6d. to 4s. 9d.; good slack, 3s. 6d. to 3s. 9d.; and common, 2s. 6d. to 3s. per ton.

The shipping trade continues fairly good, with steam coal delivered at the high level, Liverpool, or the Garston Docks, averaging 7s. 3d. to 7s. 6d. per ton.

Barrow.—There is again a quieter tone in the hematite pig iron trade, and orders are offering very slowly from the sources which have represented for the past few months the chief features of the demand. Americans who have bought largely have withdrawn from the market, so far as any practical demand is concerned. It is known of course that large deliveries of pig iron have to be made during the season to America and elsewhere in respect of contracts entered into already, and there are many who share the opinion that the present will only be a lull in the demand and that in a very short time a revival will set in. It is, however, noticeable that this quieter tone is resulting in a large number of speculative sales, and as a consequence a tendency to lower prices is shown. Parcels of Bessemer iron of mixed numbers are quoted at 48s. per ton net. f.o.b., and No. 3 forge and foundry iron at 47s. per ton. Speculative sales have been done as low as 44s. 6d. net, but these are chiefly instances where needy sales have been made and where no guarantee of brand can be had. Stocks of iron are large, but not unwieldy. The make of iron has been further increased by the relighting of furnaces. Makers are justified in increasing the output by reason of the fact that they have entered into so many engagements for forward deliveries. The steel trade is well employed, and the demand is still maintained for most of the descriptions of this metal which are produced in this district. The market for rails is especially good, and orders are still offered from America, the colonies, and the Continent. Only a fair demand exists, however, on home account. The mills are busily employed night and day, and the probabilities are that throughout the remainder of the year there will be a continuance of this activity. Rails are quoted at £4 6s. per ton net, at makers' works, for parcels of ordinary sections prompt delivery. Forwards are dearer, but makers, generally speaking, are so well sold forward that they are not in a position to take many of the orders which are offering. The trade doing in bars, billets, and blooms is still good, but merchant steel is quiet, and orders are slow in offering. Shipbuilding material in steel is quiet, and shipbuilders themselves have very little to do. No new orders have been booked during the past few weeks, though several are pending. It is hoped and believed that the shipbuilding industry, which at present is the quietest branch of local trade, will show a revival in a few weeks, and that although the opening of the year has been very dull, a good year's trade will be shown at the end of December. Engineers are still in a quiet position, and are short of orders. Iron ore has still a good market, and prices are still quoted at from 10s. 6d. to 12s. 6d. per ton at mines, according to quality. Coal and coke firm and steady.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE Government are asking for tenders for exceptionally large quantities of military material—cartridges, 50,000 cases; fuses, 12,500 cases; 30,000 common shells; 12,500 steel shells; and 7500 case shot. The cartridges and fuses concern Birmingham more than Sheffield; but the shells touch a trade to which local firms are giving very close attention at present. It is no secret that the success of the Firminy and Holtzer shells has been unacceptable to Sheffield makers, who have set themselves to meet and beat the Frenchmen. A local company of high repute has solved the difficulty—not by war, but by arrangement. They have purchased the English right of reproducing Firminy shells, and are now manufacturing these projectiles for the British Government. Another company, which has been engaged in shell experiments for many years, and has a great renown for steel in one of its most important adaptations, were not content with this method of meeting the foreigner. They were invited to purchase the secret of a French shell for a large sum of money, but declined to do it, and have at last produced a steel projectile which they claim has passed a triumphant test. I am informed that a 6in. shell produced by this Sheffield company was fired at Shoeburyness under Government conditions and auspices, against a 9in. compound armour-plate, and passed through unbroken, and that it afterwards entered 3ft. of granite, where it remained embedded. On the same day a 9in. French shell, bearing a well-known name, failed to penetrate a 12in. compound plate. The Sheffield manufacturers contend that their 6in. shell fired against a 9in. plate was subjected to a much more severe test than a 9in. shell against a 12in. compound plate. Three Sheffield firms are now employed on the production of steel shells for the War-office.

The armour-plate makers, of course, are actively engaged in meeting the new conditions imposed by the increased power of steel projectiles. Messrs. Charles Cammell and Co. have produced an experimental plate which has stubbornly resisted the French shells; and Messrs. John Brown and Co. had another experimental plate fired at last Thursday by a French projectile, with the result that the projectile was broken by the blow, and failed to penetrate the plate. I am informed that it is not correct that any steel projectiles made at Sheffield on the French system have yet been tested at Shoeburyness. Those referred to as being successfully tested against compound armour were not made on the French system.

Sheffield is further interested in another speciality of war material. The War-office are now inviting Sheffield firms to tender for 150,000 sword bayonets of the Enfield-Martini pattern, 1887, and 150,000 leather scabbards. The latter concern Walsall more than the cutlery capital; but the sword bayonets revive an old and interesting question. For many years Sheffield has supplied the steel with which Birmingham artificers fabricate the sword; and it has been a matter of marvel that in a town where the delicate manipulation of steel and knowledge of its peculiarities have given it renown the world over the complete production of swords should not be a local industry. They may not be cutlery, but surely swords should come under the official definition of cutlery—"goods with a cutting edge." The manufacturers' reply has always been that Governments were so variable in their requirements. No sooner did they put down plant to make swords than another pattern was adopted, and they had their expense for their pains. The Government, by asking for 150,000 sword bayonets of a certain type, answer this observation; and it is just on the cards that Sheffield may add sword and bayonet making to her other industries. At present one large firm—Messrs. Joseph Rodgers and Sons—occasionally make fancy swords for Eastern rajahs; but as a trade it can scarcely be said to exist. The War-office intimate that they want 30,000 of these sword bayonets by 1888, and the remainder within two or three years, at the discretion of the Secretary of State for War. There is no doubt Sheffield can do the work. The question is, Will the Government pay the price? A reliable sword cannot be produced at the figure the Government has been paying at Solingen. Until this point is made plain at headquarters, good swords are out of the question.

During March last the value of cutlery and hardware exported was £257,180, against £248,632 for March of 1886; for the quarter the respective values were £700,035 and £694,533. It is interesting to note that the decreasing markets during March were confined to France, Spain and Canaries, Foreign West Indies, Brazil, and Australasia. The most gratifying feature is the revival in the business done with British Possessions in South Africa, which extends to other developments of the metal industries. In unwrought steel the exports last March reached a total of £207,577, against £125,476 for March of 1886. The United States is again responsible for the greatly increased business, having taken a value of £135,939, against £42,009 in March of last year. For the three months, the total value was £551,821, against £275,359. Of this amount the United States have had no less than £354,924, as compared with £92,508 for the first quarter of 1886.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE quarterly meeting of the Cleveland iron trade was held at Middlesbrough on Tuesday last; but owing to the Easter holidays the attendance was poor, and scarcely any business was done. Merchants as well as makers are now assuming an attitude of reserve, which causes prices to remain firm, at about the same level as prevailed during last week. For prompt delivery not less than 34s. 6d. per ton is the present ruling quotation, and some sales were effected on Tuesday at a slightly higher figure. For delivery over the remainder of the half year 35s. is named, but consumers are waiting to see what the immediate future brings forth before committing themselves further. The price of forge iron is 33s. per ton.

The demand for Cleveland warrants is again quiet. The price current at Glasgow on Tuesday last was 34s. 6d. per ton, as against 35s. a week previously. Middlesbrough holders will not, however, accept any reduction.

There is no change to report in respect of the finished iron trade. The demand continues slack, and prices are extremely low. Orders for bar iron are fairly numerous, but not more than £4 15s. per ton free on trucks, less 2½ per cent. discount, can be obtained.

The holidays have to some extent interfered with shipments; they are, however, now proceeding satisfactorily. Pig iron exports between the 1st and the 9th inclusive reached 18,516 tons, and manufactured iron and steel 12,447 tons.

The accountant of the Cleveland Ironmasters' Association has just issued a certificate, showing that the net average price realised for Cleveland pig iron during the first quarter of the present year was 32s. 5·2d. per ton. The wages of miners will in consequence be advanced 2½ per cent.

The value of goods exported from Middlesbrough—exclusive of coal and coke—during the month of March was £172,845 being an increase of £28,747 when compared with March, 1886. The goods shipped at Newcastle were of the value of £164,823, or £8022 less than from Middlesbrough.

The Cleveland Ironmasters' statistics for March were issued on the 4th inst. They show that of the 155 furnaces built only 91 were in blast. Of these fifty-one were making Cleveland and the remainder hematite, speigel, and basic iron. The total quantity of Cleveland iron made was 111,650 tons, and of other kinds, 99,974 tons. The output of iron of all kinds was 211,624, an increase of 26,137 tons upon the output for February. The stock in Messrs. Connal and Co.'s store was at the end of the month 323,923 tons, or 11,535 tons more than on the 28th of February. The total stock in the whole district on the 31st of March was 636,155, which represents a decrease of 15,222 tons.

A gigantic meeting of the Northumberland strike hands was held on Easter Monday at Horton, near Cramlington, for the purpose of considering what aid or comfort they could get in their present difficulties, by entertaining Socialistic theories. The attendance was estimated at 6000 or 7000, including many women, who seem almost as ardent and enthusiastic as the men. The first resolution, which was carried unanimously, was directed against the local coalowners, whose conduct in attempting to reduce wages was stigmatised as infamous; and towards interesting working men throughout the country, so that they might contribute more largely towards the continuance of the strike. The second resolution, which was moved by Mr. Hyndman, and carried with only one dissentient, pledged the meeting to "organise for a free labour system, in which the land, capital, and all industrial resources shall be owned by the community and used in co-operation for the good of all." There seems no doubt that these preposterous notions are for the moment favourably regarded by the usually shrewd and sensible Northumbrians, and if so, they may lead to future mischief. The Socialistic orators who addressed the meeting seemed equally hostile to landed, to manufacturing, and to trading capitalists. They regard them all as simply parasites, monopolising the instruments and opportunities of industry, and applying to their own advantage the wealth which should belong to manual labourers, chiefly or solely. The old-fashioned idea that a capitalist is simply a person who himself, or whose forefathers or friends, have, on the whole, spent less than they have earned, is never mentioned, and does not seem ever to have occurred to these gentlemen. Nor do they remind their hearers of the fact that if capitalists did what enormous numbers of working-men do, viz., spend every Saturday night all the money they have in the world, and even get into debt as far as ever they can get credit, they would immediately come down to a dependent condition. Nor are they ever heard to tell the poor, foolish, suffering, miners that their only hope is to imitate capitalists instead of abusing them. If they were to avoid strikes, keep at work on the best terms obtainable, spend every week something less than they earn—if any of them did this, nothing could prevent such from becoming capitalists too, and so being lifted above want and distress. They would certainly then be subject to Socialistic vituperation, but would be in a position not to mind it.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

BUSINESS was suspended from Thursday of last till Tuesday of the present week, and the holidays were thus for the first time kept in the iron market at the same time as in England. The same arrangement was carried out in the Stock and Royal Exchanges, and the advantage of the change is great in comparison with the old plan of keeping open when business is stopped in England, and closing for the spring holidays at a time when the markets are open across the border. This week the iron trade has been without much animation. The volume of trade continues very limited. Both the home and export demand for pig iron are unsatisfactory. Two furnaces have been put out of blast since last week, and there are ten fewer in operation than there were at this date last year. Yet it is believed that the output is still in excess of current requirements. Considerable additions continue to be made to the stock in the warrant stores. The past week's pig iron shipments from Scotch ports aggregated 6970 tons, as compared with 7031 in the corresponding week of 1886.

In the warrant market speculative business has been limited in Scotch, Cleveland, and Cumberland iron alike, and the prices have a drooping tendency.

The current market values of makers' iron are as follows:—Gartsherrie, f.o.b. at Glasgow, No. 1, 48s. 3d., No. 3, 43s. 3d.; Coltness, 54s. 6d. and 45s.; Langloan, 50s. 6d. and 46s.; Summerlee, 53s. and 43s. 6d.; Calder 51s. 6d. and 42s. 6d.; Carnbroe, 44s. 6d. and 41s.; Clyde, 47s. and 42s; Monkland, 43s. and 39s. 6d.; Govan, at Broomielaw, 43s. and 39s. 6d.; Shotts, at Leith, 49s. and 45s.; Carron, at Grangemouth, 52s. and 44s. 6d.; Glengarnock, at Ardrossan, 48s. and 42s.; Eglinton, 43s. and 39s.; Dalmellington, 44s. 6d. and 41s.

The week's arrivals of Cleveland pig iron at Grangemouth were 7030 tons, as compared with 6062 in the corresponding week of last year.

A very good shipment of Glengarnock basic steel took place last week at Ardrossan, 1008 tons billets having been despatched coastwise.

The iron and steel goods shipped from Glasgow in the past week, in addition to pig iron, were a marine engine, valued at £11,500, despatched to China; half-a-dozen locomotives, with duplicates, £10,000, for Bombay; machinery, £2100; sewing machines, £1401; steel goods, £10,100, of which £5930 were slabs, billets, and blooms for Baltimore; £1560 billets and plates for Halifax; and smaller quantities of goods elsewhere; general iron manufactures, £16,100, of which £3550 were sheets, bars, tubes, and pipes for Calcutta, £3300 ditto for Melbourne, £2840 plates, bars, and tubes for Italy.

The coal trade is busy, and although the shipments have been interrupted to some extent this week by the holidays they have been somewhat large. The supplies are now ample for shipment and home consumption, and the prices are therefore somewhat difficult to maintain.

It is doubtful whether the efforts that are being made to arrange a sliding scale for the regulation of the colliers' wages and the prevention of strikes will be successful. Many of the best type of working miners are in favour of such an agreement, but unfortunately the paid leaders of the men have taken up an attitude of opposition to such an arrangement. They object to the colliers working twelve, or even eleven days a fortnight, on the ground that they would put out too much coal, with which the market would be flooded, and both wages and prices reduced in consequence. On this account they are now agitating for a five days' week, and also endeavouring to get the ironstone miners to join the movement for an advance of wages.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

SLACKNESS prevails in most of the Welsh industries, tin-plate being, perhaps, the one showing most life.

Coal is duller than ever again, and prices drooping. Possibly the holidays may account for some degree of dulness, but certainly not for all.

The keen competition raging amongst coalowners is shown by the quantity of coal from Monmouthshire that is sent into Cardiff. Monmouthshire coalowners, in opposing the Cardiff and Monmouthshire Bill, said that the legitimate port for their coals was Newport. If this be so, why is so much now sent to Cardiff? I might name a dozen firms whose trucks are well represented at Roath sidings; and as this coal is offered for 1s. less than Cardiff coal, the situation is not improved.

Prices of best steam on Saturday were 8s., Rhondda is offered for 8s. 6d., and this coal, No. 3, hitherto has been very firm at 8s. 9d. f.o.b. at Cardiff. Small steam shows a better condition, and prices, from being drooping at 4s., are now again up to 4s. 6d. This is due to the small demand for large coal. Another industry linked with coal, that of pitwood, is beginning to suffer again. In one week prices fell from 1s. to 1s. 6d., and present market price is only 14s. 6d. to 14s. 9d.

House coal prospects at Pontypridd are not so gloomy as one would imagine, a property containing 250 acres being now in the market. The Gowerton—Swansea—colliery plant is to be disposed of next week. This week a large mechanical and engineering works and foundry near Pontypridd will be brought to the hammer, and, in face of the improving district, will certainly command a good deal of attention.

The Midland Great Western Railway of Ireland are asking for tenders for 30,000 tons best Welsh coal.

The most prominent feature at the Monmouthshire and Glamorgan works is the make of bars for tin-plate; rails are not in good demand, though makers are fixed in price. One of the principal managers told me a few days ago, our price is so-and-so, and if buyers won't give, we won't make, but keep the men going at something else. There is no falling off in the consignments of foreign ore, and a good deal has come to hand of late. Llynvi and Blaenavon have been large purchasers.

Repairs are going on at Treforest Steel works, and I hear that as soon as possible a restart will be made. Mr. W. F. Lewis, one of the principal proprietors, has, I regret to hear, been ordered abroad on account of indifferent health.

Tin-plate has shown more firmness during the last few days, and it cannot be denied but that a pleasant change has come over the condition of things. A few weeks lately buyers pressed their orders upon the attention of makers at every price but reasonable ones. If needy makers offered ordinary coke at 12s. 6d., they were met with tenders for 12s. 3d., and in some cases 12s. 4½d. was accepted. Now buyers are conceding 12s. 9d., and best brands are selling more freely at 13s. Bessemer steel plates with coke tinning range from 13s. to 14s. Wasters of this class are sold at 12s. 6d.

Siemens are advancing. Little can be had under 13s. 6d., and the best are sold at 14s. 6d. In all respects, considering that Monmouthshire plates are now competing with Swansea, the trade really looks healthy.

Newport coasting trade, coal, showed only 21,000 tons last week. At Swansea exports and imports gave a fair amount of briskness to the port.

In Penarth Roads a ship has been sunk for some time, imperilling navigation, especially as the buoy fixed over it has been blown off. It is expected that this week the "torpedo" will be put to work.

A new dock in connection with Grangetown, Cardiff, and the canal is being floated with good promise. It is intended, I hear, for the timber trade chiefly, which is increasing.

Gloucester must do something with its arrangements at Sharpness if it is to retain anything of its old timber connection. There are rumours afloat that this is intended.

AMERICAN NOTES.

(From our own Correspondent.)

New York, April 1st.

Rail brokers in this city report inquiries from south-western and north-western railroad builders for large supplies of rails. The St. Paul, Minneapolis, and Manitoba Railroad Company has purchased 30,000 tons of English rails, and two or three other north-western companies are in the market, or shortly will be, for from 50,000 to 60,000 tons of English rails, for delivery in that section. Makers of bridge-building materials have inquiries this week for 20,000 tons of bridge iron, part of it for elevated railroad work. A company has been organised to build an underground railway in Philadelphia, and also an elevated road.

The demand for foreign material is very light: receipts are heavy. Large supplies of ore are being received from Cuba and Spain. It is probable that within thirty days a renewal of American demand for British products will be developed. American foundry iron is selling at 21 dols. to 22 dols., and forge iron at from 18 dols. to 19 dols. Plate iron is 2½c., but this price is shaded where large orders are placed. The sheet mills and pipe mills are crowded with orders, and prices are very firm for both large and small lots. Every indication points to a renewal of heavy demand, especially because of the heavy railway building that is being and will be prosecuted in all sections of the country. Ship lots of scrap are offered at 23 dols.; steel blooms, 30 dols. to 30·50 dols. Slabs and billets are 32 dols. to 32·50 dols.; 20 per cent. spiegeleisen, 27·50 dols. 5000 tons of Bessemer pig have been ordered for Boston delivery at 21 dols. Small lots of copper are selling quotations 10½c. Exports since January 1st, 1,060,000 lb., as against 4,566,000 lb. at the same date last year.

NEW COMPANIES.

The following companies have just been registered:—

Beaconsfield Waterworks Company, Limited.

This company proposes to construct, maintain, and work waterworks at Beaconsfield (Griqualand West), Cape of Good Hope, or elsewhere in South Africa. It was registered on the 5th instant, with a capital of £200,000, in 175,000 ordinary and 25,000 deferred shares of £1 each. The subscribers are:—

	Shares.
W. G. Soper, Bury-street, St. Mary Axe, merchant	1
F. L. Thom, 8, Addison-road	1
T. Allen, C.E., Thurlow, Clapham	1
H. Palmerstone, J.P., Newton House, Teddington	1
A. Fraser, Ipswich, merchant	1
G. F. Rogers, 5, Great Winchester-street, electrical engineer	1
J. Sievewright, 72, New Bond-street, late general manager South African Telegraphs	1

The number of directors is not to be less than five, nor more than seven; the subscribers are to appoint the first; qualification, £250 in shares or stock. After 6 per cent. per annum dividend is paid (free of income-tax), the board will be entitled to £1500, to be increased to £2000 after payment of 8 per cent. dividend in any year, with a further sum of £500 for each 1 per cent. dividend in excess of 10 per cent. per annum.

Home and Export Screw Cork Bottling Company, Limited.

This company proposes to acquire the rights and interests of Charles Mackey Taylor and Anthony Percival Turner to the letters patent, No. 8625, dated 16th July, 1885, for improvements in bottle stoppers, and in certain patent rights for the same invention granted abroad. It was registered on the 4th inst., with a capital of £25,000, in £1 shares, with the following as first subscribers:—

	Shares.
*E. P. Bull, Eastcheap-buildings, fruit broker	1
*N. D. Caralampi, Albert-gate Mansions, merchant	1
*C. E. B. Sanders, Chigwell, Essex, accountant	1
H. B. Altwater, Rosebank, Epping	1
W. F. Altwater, 75, Mark-lane, wine merchant	1
F. W. Turner, 33, Grosvenor-road, Highbury New Park, secretary to a company	1
A. W. Rixon, 10, Austinfriars, solicitor	1

The number of directors is not to be less than three, nor more than six; qualification, £100 in shares; the first three subscribers and Messrs. C. M. Taylor and A. P. Turner are the first directors. The company in general meeting will determine remuneration.

Johore Company, Limited.

This company proposes to acquire property in Johore, or elsewhere in Malay Peninsula or Archipelago, and to cultivate tobacco, pepper, sugar, fibre indigo, gambier, and other produce. It was registered on the 1st inst. with a capital of £600,096, divided into 60,000 ordinary shares of £10 each, and 96 deferred or founders' shares of £1 each. The subscribers are:—

	Shares.
*F. C. Rasch, J.P., Danbury, Essex	100
*Lord Augustus Loftus, G.C.B., 9, Queen's-gate-place	100
*A. Suart, 29, Great St. Helen's, shipowner	100
*E. J. Gray, 37a, Mincing-lane, colonial broker	100
F. G. Dawson, Dunton House, Gravesend, shipper	100
B. Bromhead D. Sayle, 17, Fore-street, merchant	100
J. Edwards, Beechwood, Eastbourne	100
A. Cheyne, Thatched House Club	100
J. H. Burt, 1a, Laurence Pountney-hill, iron merchant	100
W. Ephraim Death, 20, Bucklersbury, engineer	100
J. W. Braithwaite, Ecclesbourne, Southsea	100

The number of directors is not to be less than three, nor more than seven; qualification, 100 ordinary shares; the first are the subscribers denoted by an asterisk and Messrs. Martin H. Pirie, 20, Grafton-street, and Hamilton Dunlop, of 72, Bishopsgate-street; remuneration, £500 per annum each, and £250 per annum extra for the chairman, and in addition one-twentieth of the net profits of any year in which 15 per cent. dividend is paid.

London Battery Company, Limited.

This is the conversion to a company of the electrical business carried on at 83a, Farringdon-street, by Mr. A. W. Armstrong, trading as the London Battery Company. It was registered on the 4th inst., with a capital of £10,000, in £5 shares. The subscribers are:—

	Shares.
A. W. Armstrong, 83a, Farringdon-street, electrical engineer	1
*G. Shenton, 17, Craven-street, W.C.	1
*J. Armstrong, Park Hill, Clapham	1
J. W. Watts, 74, Chesilton-road, Fulham, clerk	1
F. C. Howard, 34, Fopstone-road, S.W.	1
E. J. Burcombe, 13, Scawfell-street, Hackney, clerk	1
*B. Hallett, 5, Bentinck-terrace, Regent's Park	1

The number of directors is not to be less than two, nor more than five; qualification for ordinary directors, 200 shares. The company in general meeting will determine remuneration.

Ocean Coal Company, Limited.

This company was registered on the 1st inst., with a capital of £800,000, in £10 shares, to carry on business as colliery proprietors, coal and coke merchants, coal washers and coke manufacturers. The subscribers are:—

	Shares.
*D. Davies, Broninon, Glandman, Montgomeryshire	1
*E. Davies, Plas Dinian, Montgomeryshire	1
*A. Howell, Berriew, Montgomeryshire	1
*M. Joseph, M.E., Cardiff	1
W. Griffith, Dolgelly, solicitor	1
*T. Webb, Cardiff, colliery proprietor	1
*W. Jenkins, Treorkey, mining engineer	1

The number of directors is not to be less than five, nor more than eight; qualification, 50 shares; the first are the subscribers denoted by an asterisk, and Messrs. E. S. Hett and D. C. Scott. The company in general meeting will determine remuneration.

Patent Safety Lamp Attachment Company, Limited.

This company proposes to carry on business as lamp attachment and extinguisher makers, and for such purposes will adopt an unregistered agreement of the 28th of February, for the purchase of certain inventions referred to therein. It was incorporated on the 2nd inst., with a capital of £2000, in £1 shares. The subscribers are:—

	Shares.
E. Hurd, 61, St. Mary Axe	1
H. D. Cunningham, New Barnet, engineer	1
J. H. Brodie, 61, St. Mary Axe, merchant	1
R. H. Cunningham, 4, Billiter-street, merchant	1
A. E. Cunningham, 19, Burlington-chambers	1
T. D. Plews, 2, Randolph-crescent, Clifton-gardens	1
T. G. Rogers, Loughton, Essex	1

Registered without special articles.

Provincial Gas and Lighting Works, Limited.

This company proposes to construct and maintain works for the manufacture of gas and electricity, and to carry on business as coal and coke merchants and dealers in building materials. It was registered on the 4th inst., with a capital of £20,000, divided into 25 founders' shares of £1 each, and 799 ordinary shares of £25 each. The founders' shares will be entitled to one-half of the net profits remaining after payment of £7 per cent. per annum dividend on the ordinary shares. The subscribers are:—

	Shares. Founders'.	Ord.
Hy. Hughes, 23, Martin's-lane, Cannon-street	2	4
J. H. Taylor, 5, Tokenhouse-yard, stockbroker	2	4
E. R. Painter, 156, Larkhall-lane, Clapham, accountant	2	4
R. S. Mayne, 156, Larkhall-lane, Clapham, accountant	11	2
H. Arms, 95, Devonport-road, Shepherd's Bush, railway traffic manager	2	4
J. A. Songest, 17, Upham Park-road, Chiswick	2	4
E. J. Robinson, 7, John-street, Adelphi, surveyor	2	4
J. Bull, New Lodge, Clapham Park, architect	2	4

The remuneration of the board is not to exceed £2 2s. for each attendance at a board or committee meeting, and such further sum as the company in general meeting may determine. Most of the regulations of Table A apply.

Pure Alcohol Company, Limited.

This company proposes to acquire patents relating to processes or apparatus for distilling, refining, rectifying or purifying alcohols, or other spirits, and especially the patents of Ivar Axel Ferdinand Bang and Marie Charles Alfred Ruffin. It was registered on the 4th inst., with a capital of £525,000, in shares of £10 each, 50,000 of which are ordinary shares and 25,000 deferred; the former to be entitled to 10 per cent. per annum preference dividend. The subscribers are:—

	Ord. Shares.
L. A. Taybert, St. Stephen's Mansions, Bayswater	1
V. Muller, 35, Half-Moon-street, Piccadilly	1
P. Cherademe, 35, Half-Moon-street, Piccadilly	1
T. Bang, 66, Coleman-street	1
A. Ruffin, 66, Coleman-street	1
George Earl Church, Dashwood House, engineer	1
C. M. Vergo, 32, Montague-square, Hyde Park	1

The number of directors is not to be less than three, nor more than seven; qualification, 50 shares; the subscribers are to appoint the first; remuneration, £1500 per annum.

The American Exhibition.—The *Times* is requested by the United States Legation to say that the statement which appeared on the 12th inst. in a London newspaper, to the effect that the President of the United States will open the American Exhibition at London by telegraph on the 9th of May, is erroneous, neither the President nor the Government of the United States having any connection whatever with the Exhibition.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

Application for Letters Patent.

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

2nd April, 1887.

4921. Rotary Engine, S. Tetley, Elland.
4922. Binocular Eye Protector, C. Latham and L. Kennedy, London.
4923. Gas Engines, T. Sturgeon, London.
4924. Machines for Filling Bottles, R. L. Howard, London.
4925. Spring Saddles for Velocipedes, J. Harrington, London.
4926. Reproducing Writings, W. C. Hall, London.
4927. Street Paving, J. Wilson, Glasgow.
4928. Horseshoe, G. Ellis, London.
4929. Type-writer, B. Baden-Powell, London.
4930. Railway Sleepers and Chairs, J. G. Crampton, London.
4931. Regulating a Battery, M. Bailey and J. Warner, London.
4932. Appointment Register, J. Morgan, London.
4933. Imitation Leather Covers, A. J. Boult.—(*F. H. Lieker, Canada.*)
4934. Bins for Storing Grain in Bulk, J. Wilson, Liverpool.
4935. Locking Devices, A. J. Boult.—(*J. H. Westman, Canada.*)
4936. Washing Sand, J. S. Gardner, Liverpool.
4937. Drain Traps, A. J. Boult.—(*J. Maguire and R. Carrol, Canada.*)
4938. Stretching the Wires of Pianofortes, A. J. Cresswell, London.
4939. Brakes for Road Vehicles, A. J. Boult.—(*G. C. Boden, United States.*)
4940. Self-acting Mechanism, R. Wallwork, Manchester.
4941. Comfortables, H. E. Newton.—(*F. L. Palmer, United States.*)
4942. Stop-cocks, R. T. Baines, London.
4943. Blind Regulator, A. Kingshott, London.
4944. Indicating the Arrival of Trains, A. Kingshott, London.
4945. Separating Cotton Waste, &c., H. A. Davis, London.
4946. Moulds for Casting Diamond Tools, R. Haddan.—(*T. A. Jackson, United States.*)
4947. Automatic Steam Damper Regulators, R. Haddan.—(*W. Noyes, United States.*)
4948. Utilising the Heat of Exhaust Steam, R. Haddan.—(*J. J. Imbs, France.*)
4949. Buoyant Cable, A. N. Wood, London.
4950. Corn Planter, H. Kendall and T. L. Magruder, London.
4951. Stove Pipe Drum, W. W. Horn.—(*K. W. Lotz, United States.*)
4952. Application to Tea and other Bags for Purposes of Denoting Life Insurance, A. W. Foster and L. Oxford, London.
4953. Bleaching Fibrous Substances, A. Brin and L. Q. Brin, Westminster.
4954. Japanning, &c., various Articles, F. Crane, London.
4955. Couplings for Railway Vehicles, H. H. Lake.—(*J. H. Ehlers, Germany.*)
4956. Harvesting Machines, J. Howard, E. T. Bousfield, and G. Gibbs, London.
4957. Hand Litter for the Conveyance of Sick and Injured Persons, E. C. Hammond, London.
4958. Feed-water Measurer for Marine and other Steam Engines, J. Heslop, London.
4959. Oil Lamps, C. Warren, London.
4960. Boxes for Matches, E. W. Jones and T. H. Norman, London.
4961. Spinning Yarns from Flax, &c., A. T. Lawson, London.
4962. Broughams, &c., W. Botwood, Ipswich.

4th April, 1887.

4963. Steam Boiler and other Furnaces, J. Bancroft and W. Wild, Manchester.
4964. Waterproofing Leather, &c., J. N. Pickering, Sheffield.
4965. Regulating the Supply of Feed-water to Steam Engines, A. MacLaine, Belfast.
4966. Pumping Engines, W. H. Bailey, Manchester.
4967. Working Drop Boxes of Looms for Weaving, A. Sowden, Halifax.
4968. Loom Shuttle Tongues or Skewers, E. Booth, Manchester.
4969. Urinals, J. Shanks, Glasgow.
4970. Roasting Coffee, B. Tupholme, Sheffield.
4971. Dry Grinding, &c., Machines, W. Barraclough, Glasgow.
4972. Healds for Weaving, J. Parkington, Manchester.
4973. Vessels for Containing Aerated Waters, J. Nixon and J. Royle, Manchester.
4974. Glass Sleepers, D. Rylands, Barnsley.
4975. Casting and Cooling Glass Sleepers, D. Rylands, Barnsley.
4976. Pans for Heating Oil, &c., J. V. Wilson, Manchester.
4977. Driving Mechanism of Velocipedes, H. Pipe, London.
4978. Holder for Electric Lamps, F. T. Schmidt, Bradford.
4979. Pistons, R. Welford, Sunderland.
4980. Making and Breaking Electrical Circuits, F. T. Schmidt, Bradford.
4981. Washing Wool and other Fibres, D. and H. Smith, Bradford.
4982. Corrugated Bottom Grate for Ranges, &c., M. Bousfield, Leeds.
4983. Clubs for Playing the Game of Hockey, F. H. Ayres, London.
4984. Carrying Bobbins, J. V. Eves and S. Hanna, Belfast.
4985. Duplex, &c., Range, J. Thompson, Kendal.
4986. Buffers for Railway Rolling Stock, T. Wass and P. Wheeler, Birmingham.
4987. Copying Music, W. H. Stevens, Leicester.
4988. Sewing, &c., Machines, A. J. Boult.—(*J. H. Whitney, United States.*)
4989. Concentrating Liquids, D. Simpson, Edinburgh.
4990. Steam Boilers and Furnaces, J. W. Walters, London.
4991. Automatic Fire-extinguisher, H. N. Morgan, London.
4992. Dog Carts, A. G. Margetson and W. S. Hek, London.
4993. Coating Plates with Tin, &c., W. H. Rickard and T. J. Rickard, Newport, Mon.
4994. Connecting-rods, H. Bracewell, J. Bulcock, and C. Smith, Burnley.
4995. Combined Christmas-card and Post-card, &c., W. Rainey, Sevenoaks.
4996. Inkstands, A. Hillgren, London.
4997. Doors and Windows for the Prevention of Draughts, F. E. Pontifex, London.
4998. Attaching, &c., the Lateral Movement of Telescopic Sights, W. J. Jeffery, London.
4999. Making Designs of Crocodile and other Skins, H. J. Bovill and J. A. Broder, Chiswick.
5000. Fire Improver, J. L. Lobley, London.
5001. Adjustment of Bearings, &c., J. Whitehead, London.
5002. Lime Blasting Operations in Mines, E. Morris, London.
5003. Pads for Absorbing the Periodical Discharges of Women, C. D. Mayer, London.
5004. Fastening the Ends of Wires, &c., R. W. James and W. Sturcke, London
5005. Steam or Power Pumps W. Clarke and J. B. Furneaux, London
5006. Steam Pumps, W. Clarke and J. B. Furneaux, London.
5007. Pipes, J. Schuller, London.
5008. Scutching Machines, V. Stekl, London.
5009. Charging, &c., Chemicals and Liquids used in Secondary Batteries, J. T. Armstrong, London.
5010. Multiple Cylinder Engines, the Hon. R. C. Parsons, London.
5011. Bottles for containing Aerated or Gaseous Liquids, H. Barrett, London.
5012. Artificial Fuel, G. F. Redfern.—(*A. Robert, Belgium.*)
5013. Liquid Meters, G. Teideman, London.
5014. Foot or Base for Crutches, &c., R. Willis, London.
5015. Steam and other Motive-power Engines, W. Ross, London.
5016. Scissors, &c., B. Neumann and E. Kühne, Glasgow.
5017. Dredging by Centrifugal Pumps and Equivalent Water-raising Apparatus, C. A. Jensen.—(*J. Welman, New Zealand.*)
5018. Syringe or Enema Pipes, A. J. Meyer, London.
5019. Stoppers for Bottles, J. Schlieselhuber and J. B. Pfeiffer, London.
5020. Air Feeds for Paraffine and other Lamps, S. Rozinay, London.

5th April, 1887.

5021. Clod Crusher, I. Morris, Bloxwich.
5022. Brooms, &c., S. Hall, Leeds.
5023. Burnisher, M. A. Appleton and F. A. Binney, Manchester.
5024. Cleaning Clothes, J. Petty, Skipton-in-Craven.
5025. Electric Cables, T. H. Dunham, London.
5026. Burning Liquid Hydrocarbons, W. G. Bussey, London.
5027. Bats, D. Allport, London.
5028. Oil Cans, W. W. Oldfield, Glasgow.
5029. Zinc, R. Hannan and M. Milburn, Glasgow.
5030. Closing Bottles, J. Cammack and H. M. Greer, Liverpool.
5031. Tea Bin, R. Ludlow, Birmingham.
5032. Eye Shades, G. P. Lempriere, Birmingham.
5033. Printing Machine, T. Johnson and G. Gledhill, Halifax.
5034. Winch, S. Howarth, Burton-on-Trent.
5035. Valve, H. Jefferies, Stourport.
5036. Meliorator E. G. Lakeman, Modbury.
5037. Locks, G. Asher and J. Buttress, Birmingham.
5038. Hair-brushing, G. E. Frith, Eastbourne.
5039. Treating Fibres, W. B. Nation and J. J. Worswick, London.
5040. Rope Grip, J. Williams, Walsall.
5041. Treating Fibres, W. B. Nation and J. J. Worswick, London.
5042. Billiard Tables, W. Buttery, London.
5043. Hammer, E. de Pass.—(*M. Humpfner, Germany.*)
5044. Fire-lichter, W. R. A. Cole, London.
5045. Heating Carriages, W. Taylor, Halifax.
5046. Purifying Gas, J. M. A. Fournier, London.
5047. Type-writer, W. P. Thompson.—(*J. S. Jurey, United States.*)
5048. Brick Machines, C. L. Emens, London.
5049. Indigo, S. J. Simpkin, London.
5050. Sewing-machines, A. Schofield and McIlvenha, London.
5051. Handles for Canes, G. Müller, London.
5052. Hydrocarbon Engines, E. Crowe, Banbury.
5053. Bats, A. J. Altman, London.
5054. Ladders, W. C. Fletcher, London.
5055. Davits, C. Douglas, Sunderland.
5056. Watches, A. H. Potter, London.
5057. Racks, T. Coulthard and J. Bradshaw, London.
5058. Steps, W. C. Bruce and W. David, London.
5059. Haulage-clips, J. Powell, R. S. Jordan, and G Golightly, London.
5060. Screw-nuts, Messrs. Bayliss, Jones, and Bayliss and R. Howarth, London.
5061. Combined Cee and Elliptic Carriage Springs, J. Ivall, London.
5062. Lotion for the Treatment of Foot Rot in Sheep, W. Hunsley, London.
5063. Stitching together Sheets of Cardboard, J. Wetter.—(*C. L. Larch and Co., Saxony.*)
5064. Supporting Apparatus for Lamps or Candles, C. Bachoffner, London.
5065. Steam Tricycles, L. D. Copeland, London.
5066. Grape Sugar, A. Seyberlich and A. Trampedach, London.
5067. Producing Copies of Writings, &c., E. de Zuccato, London.
5068. Small-arms, G. G. M. Hardingham.—(*F. von und zu Zwergern, L. Dill, and A. Strauss, Germany.*)
5069. Supporting Trees, H. P. F. Jensen, London.
5070. Spinners' Card Room Cans, T. Brown and W. Pickstone, London.
5071. Holding Sliding Sashes at Various Heights, H. Livesey, London.
5072. Oilers, T. B. Wilkinson and J. L. Cutler, London.
5073. Measuring and Filling Bottles, F. Foster, London.
5074. Channels for Cable Tramways, &c., J. Biggs, London.
5075. Pencil Sharpeners, H. Hewitt, London.
5076. Extinguishing Lamps, F. Marshall, London.
5077. Looping Mechanism for Sewing Machines, A. Anderson.—(*J. G. Greene, United States.*)
5078. Button-hole Sewing Machines, A. Anderson.—(*J. G. Greene, United States.*)
5079. Harrows, F. Nishwitz, London.
5080. Producing Photographic Impressions, J. J. E. Mayall, London.
5081. Embossing Metal, &c., W. E. Hickling, London.
5082. Engraving on Wood, Metal, &c., W. E. Hickling, London.
5083. Metal Sleepers for Rail and Tramways, F. H Gill, London.
5084. Washing Machines, W. N. Twelvetrees and C. Stephens, London.
5085. Flexible Gas Tubing, D. W. Sugg, London.
5086. Anti-vibrator for Bicycles, &c., R. Thackray, Bradford.
5087. Sash Fastener for Windows, W. Townend and F. Ullathorne, Bradford.
5088. Covered Buttons, G. Heidmann, E. Hottges, and C. Egen, London.
5089. Holders for Matches, &c., T. J. Hewson, London.
5090. Supporting Stockings, H. H. Lake.—(*C. N. Chadwick, United States.*)
5091. Steam Boiler and other Furnaces, H. H. Lake.—(*R. L. Walker, United States.*)
5092. Switches for Electrical Purposes, B. Egger, London.
5093. Circular Knitting Machines, P. Haddan.—(*J. B. Schroeder, United States.*)
5094. Curved Pipes, R. Haddan.—(*Messrs. Oldenhoff and Uhlig, Germany.*)
5095. Gas Engines, J. Y. Johnson.—(*La Société des Tissages et Ateliers de Construction Diederichs, France.*)
5096. Dynamo Electric Machinery, G. Kapp, London.

6th April, 1887.

5097. Preparation of Vegetable Fibres, R. H. Collyer, London.
5098. Detecting the Removal of Leaves or Documents when Bound together, J. H. Betteley and R. J. Rastrick, London.
5099. Felt, &c., Hats, W. H. Blackwell, Lancashire.
5100. Wood Planing Machines, T. N. Robinson, Manchester.
5101. Weighing Apparatus, J. C. Watkins and M. and J. Fidler, Bradford.
5102. Spinning and Winding Yarn, D. Maitland, Castleton.
5103. Admitting Air to Lamps, E. J. Shaw, Walsall.
5104. Envelopes, B. C. Fryer, Bradford.
5105. Shuttles, &c., for Power Looms, H. Fildes Cheshire

5106. SECURING the HEADSTOCKS of SELF-ACTING MULES, B. Morton, Manchester.
5107. BANDS for PACKING HATS, J. E. Ogden, Manchester.
5108. DRAIN GULLEYS, J. McN. Rimington, Newcastle-on-Tyne.
5109. PRODUCING BASIC SULPHO-CYANIDES of ALUMINIUM, &c., J. Hauff, Manchester.
5110. CLOCK ESCAPEMENTS, W. H. Douglas, Birmingham.
5111. FASTENING BROOM HANDLES into BROOM HEADS, W. P. Fox, Sheffield.
5112. MAKING STEEL PIPES, J. Riley, Glasgow.
5113. WASHING, &c., WOVEN FABRICS, D. Stewart and R. Walker, Glasgow.
5114. COOKING RANGES, D. Cowan, Glasgow.
5115. STOVES, D. Cowan, Glasgow.
5116. JOINT for CONNECTING METALLIC TUBES or PIPES, N. G. Haran, Glasgow.
5117. DISENGAGING SHIPS' BOATS, A. Macpherson, Glasgow.
5118. CLEANING BOOTS, &c., W. Jack, Monquhitter.
5119. MAKING ROPES, &c., A. James, Birmingham.
5120. SUPPLYING a CIGARETTE, &c., by DROPPING a HALFPENNY into a RECEPTACLE, R. S. Smith, Nottingham.
5121. BAGS for FLOUR, L. Gunn, London.
5122. THERMO-ELECTRIC ELEMENTS, G. E. Dorman, Stafford.
5123. TENT PEGS, G. H. Stuart and R. P. Bradbury, Liverpool.
5124. EVAPORATING LIQUORS containing SALTS, G. I. J. Wells.—(*S. Pick, Galicia.*)
5125. THERMO-ELECTRIC ELEMENTS, G. E. Dorman, Stafford.
5126. CHECKING the RECEIPT of MONEY, J. M. Black, London.
5127. SHAPING, CUTTING, &c., CIGARETTES, O. Melachrino, London.
5128. ELECTRICAL ARC LAMPS, A. Grundy, London.
5129. VELOCIPEDES, J. M. Taylor, London.
5130. FURNISHING ELECTRIC POWER at a DISTANCE, E. A. Williams, London.
5131. CO-ACTING APPARATUS for RAILWAY SIGNALS, J. Cockburn, New Malden.
5132. LACING STUDS, W. R. Comings, London.
5133. STOPPER for SCREW-NECKED BOTTLES, A. Johns, Manchester.
5134. STEAM, &c., PRESSURE VALVES, A. G. Brown, London.
5135. COMPOUND ENGINES, A. G. Brown, London.
5136. PENCIL SHARPENER, S. F. Rhodes, London.
5137. ELECTROPATHIC BELT, H. J. Dale, London.
5138. CHAIN FASTENERS for DOORS, &c., H. E. Hutchins, London.
5139. FLUSHING APPARATUS, P. Born.—(*L. Maring, Switzerland.*)
5140. GALVANIC BATTERIES, W. H. Quarterman, London.
5141. BISCUIT for HORSES, &c., A. Thorpe, London.
5142. DIE for MAKING EYE-BARS, J. F. Kingsley, London.
5143. REVOLVING SHUTTLES in SEWING MACHINES, R. Haddan.—(*F. Engel, Germany.*)
5144. DISPLAYING ADVERTISEMENTS, &c., S. Townsend, London.
5145. WATER MOTORS, S. S. Allin, London.
5146. GLOVES, L. P. Guignié, London.
5147. CUTTING FILES, A. Dixon and J. Reid, London.
5148. PREPARING FIBROUS SUBSTANCES for SPINNING, W. Clissold, London.
5149. SEAMING MACHINES, B. Hague, London.
5150. WASHING WOOL, J. and W. McNaught, London.
5151. MECHANISM for GRINDING DRILLS, W. Ford-Smith, London.
5152. COMPOSITION for FASTENING WOOD, &c., to IRON DECKS, &c., G. F. H. and R. I. Clark, London.
5153. COVERING IRON DECKS with WOOD, G. F. H. and R. I. Clark, London.
5154. REGENERATIVE GAS LAMPS, S. Chandler, sen., S. Chandler, jun., and J. Chandler, London.
5155. PORTLAND CEMENT, J. W. Hooton, London.
5156. BELT PULLEYS, A. B. Perkins, Bradford.

7th April, 1887.

5157. SAFETY VELOCIPEDES, J. Strobel, London.
5158. MARKING SOAP, H. W. Lowden, Reigate.
5159. TRICYCLES, J. Parr, Leicester.
5160. PREPARING FRAMES, S. Dyer, Belfast.
5161. SMOKE CONSUMING APPARATUS, J. W. Hartley, Stoke-on-Trent.
5162. STEEL PINNED COVERING for RAG MACHINES, T. W. Harding, Leeds.
5163. MEASURING CLOTH, J. L. Stewart, S. Greenwood, and J. Overend, Bradford.
5164. CUTTING STONE, F. Butterfield, London.
5165. KILN FURNACES, J. Davies, Manchester.
5166. ANILINE DYEING, J. Davies, Manchester.
5167. FLOWER HOLDER, C. J. Bosanquet and W. A. Tomlinson, Lincoln.
5168. FORCE PUMPS, J. Weir, Glasgow.
5169. COOKING RANGES, J. C. Parker, Glasgow.
5170. DYEING HANKS of YARN, J. M. Hampson, Manchester.
5171. PAPER HANGINGS, N. W. and R. N. Helme, and R. Stockdale, Manchester.
5172. CROCHET NEEDLES, C. R. Greenhill, Redditch.
5173. SPRINGS, &c., G. Salter and J. Walker, Birmingham.
5174. LATCHES, A. Foster, Wolverhampton.
5175. MACHINE for SIZING WORSTED WARPS, R. Gledhill, Bradford.
5176. PADLOCKS, D. and I. Waine, Birmingham.
5177. PISTONS, J. Rimmer, Sheffield.
5178. LOCK NUTS, E. C. Ibbotson, Sheffield.
5179. DROPPING SEMI-LIQUID SUBSTANCES in the MANUFACTURE of CONFECTIONS and the like, R. Morton, Glasgow.
5180. SECURING CORKS in MINERAL WATER BOTTLES, G. S. V. and F. G. V. Godfrey, London.
5181. MEASURING the FLOW of LIQUIDS in PIPES, E. F. Deacon, Liverpool.
5182. DEPOSITING TANKS for WATER PURIFICATION, &c., T. W. Barber, London.
5183. ASCERTAINING the SPEED of TRAVEL of SHOT, G. T. Teasdale-Buckell, London.
5184. BOOT and SHOE MACHINERY, W. Ross and J. Bilbie, London.
5185. FASTENERS for SCARFS, &c., A. Rhodes, London.
5186. BRUSH-HOLDERS for DYNAMO-ELECTRIC MACHINES, A. P. Trotter and W. T. Goolden, London.
5187. FLEXIBLE WOOD COVER for BLOTTING or other BOOK, F. J. Smythson, London.
5188. SYPHON WATER-WASTE PREVENTER, M. Syer, London.
5189. FLUID METERS, A. Schmid, London.
5190. EXTERNAL STOPPERS for BOTTLES, J. A. Latham, London.
5191. SIGNALLING APPARATUS for RAILWAY TRAINS, F. W. Haller, H. Rosenthal, and L. Volger, London.
5192. WALL POCKET, A. Tuck, London.
5193. GENERATION and DISTRIBUTION of ELECTRICITY, G. A. Grindle, London.
5194. MILLINERY TRIMMINGS, A. Tompkin, London.
5195. COLLECTING the DROPPINGS of HORSES in STREETS, L. H. Phillips, London.
5196. BRACE or TROUSER SUSPENDERS, R. Lewis, London.
5197. SAFETY HYDROCARBON and other OIL LAMPS, S. A. Johnson and W. R. Oswald, London.
5198. TUBE CUTTERS, A. J. Marquand and S. Williams, London.
5199. DISTRIBUTION of ELECTRICAL ENERGY for PURPOSES of LOCOMOTION, W. Lowrie and C. J. Hall, London.
5200. SMOOTHING TEXTILE FABRICS, J. L. Anderson, London.
5201. ORNAMENTAL CLOISONNE-MOSAIC WORK, C. J. Heaton, London.
5202. MECHANICAL MOTION for TARGETS, &c., J. S. Fairfax, London.
5203. GAS ENGINES, A. C. and J. Sterry, London.
5204. WATER-CLOSETS, &c., G. Price, London.
5205. TREATMENT of FABRICS, H. H. Lake.—(*La Société Gillett et Fils, France.*)
5206. INCANDESCENT GAS-BURNERS, F. L. Rawson and C. S. Snell, London.
5207. MOUNTING and WORKING DISAPPEARING GUNS, A. Moncrieff and W. Anderson, London.
5208. SECURING RAILS, &c., to SLEEPERS, H. Lindsay-Bucknall, London.
5209. WRENCH for AXLE CAPS and NUTS, W. March, London.
5210. SUBJECTING the PERSON to ELECTRIC CURRENTS, A. Serraillier, London.

9th April, 1887.

5211. DISINFECTING APPARATUS, N. A. and L. A. Skelsey, Dewsbury.
5212. DYEING APPARATUS, A. Goldthorp, Wakefield.
5213. WINDOW-BLIND ROLLER ENDS, C. Homer, Birmingham.
5214. SELF-CLOSING BRACELETS, H. Drew, Germany.
5215. SAFETY PETROLEUM LAMPS, F. J. Wehner, Germany.
5216. PERAMBULATOR BRAKE, T. F. Simmons, London.
5217. CUTTING CHAFF, J. Keeble and C. E. Mumford, Bury St. Edmunds.
5218. CORD HOLDERS for WINDOW BLINDS, T. Hughes, Birmingham.
5219. BOXING, &c., GLOVES, &c., J. Boultbee, Birmingham.
5220. TOWELS, &c., G. W. and E. Wilson and F. Nelson, Manchester.
5221. VENTILATING LEATHER, J. Eaton and W. J. Battersby, Manchester.
5222. COMPASS and WRITING PENCIL, J. Satchwell, Birmingham.
5223. LOCKS for VEHICLES, &c., H. P. Lavender, Wednesbury.
5224. FORE-END FASTENINGS for SMALL-ARMS, J. Cox, Birmingham.
5225. HAND FIRE EXTINGUISHERS, J. E. Long, London.
5226. STEEL or METAL BARROWS, &c., J. McMenemy, Glasgow.
5227. FIRE EXTINGUISHERS, J. H. Lynde, Manchester.
5228. SOCKETS for ELECTRIC COLLAR LAMPS, W. H. Bayley, Walsall.
5229. VENTILATORS, H. Waddington, Accrington.
5230. ADVERTISING and ILLUMINATION, G. Quarrie, Birmingham.
5231. SHEET METAL STRUCTURES, W. Orr and P. S. Brown, Glasgow.
5232. GAS LAMPS, A. W. Clark, Glasgow.
5233. IRONING MACHINES, W. Browning, Farnworth-in-Widnes.
5234. VENTILATORS for CHIMNEYS, J. Bousfield, York.
5235. DAMP DETECTOR and HYGROMETER, F. W. Beck, East Grinstead.
5236. FIXING SADDLES upon HORSES, &c., W. K. Paterson, Cork.
5237. HANDLES of BICYCLES, &c., W. K. Paterson, Cork.
5238. SAFETY STIRRUP IRON, T. J. Haslam, Dublin.
5239. PICKING BANDS for LOOMS, J. Forrest and J. Dawson, Blackburn.
5240. DUPLEX WATERING POT, D. Arkinstall, Birmingham.
5241. STEP-LADDERS, J. W. Midgley, Skipton-in-Craven.
5242. RIBBED STOCKINGS, W. J. Ford, New Humberstone.
5243. SAFETY PIN, G. W. Herbert and S. Guinery, Birmingham.
5244. WEIGHING BALANCES, Sir W. Thompson, Glasgow.
5245. DOOR FASTENINGS, T. Perry and Son and R. Noake, London.
5246. CROSS SLEEPERS, A. F. L. Bernard, London.
5247. STRAIGHTENING STEEL WIRE, &c., A. Crossley and J. Hirst, London.
5248. BICYCLES, &c., J. Rushton, London.
5249. TAPE MACHINES, F. Woodward, London.
5250. TREATMENT, &c., of ALKALI, A. Shelmerdine, Liverpool.
5251. COMBINATION VALVE, G. E. Wright, Birmingham.
5252. FACILITATING COMMUNICATION by SPEECH between ROOMS, &c., H. P. F. Jensen, London.
5253. REGULATING the DISCHARGE of RAIN-WATER from ROOFS, J. G. Killey, London.
5254. TEETH of CARDING MACHINES, &c., M. Duesberg-Delrez, London.
5255. VAPOUR, W. D. Priestman and S. Priestman, London.
5256. LUBRICATING APPLIANCES for PLUMMER-BLOCKS, W. Spannuth, London.
5257. DIALKYLISED AMIDOBENZOPHENONES, C. D. Abel.—(*The Farbwerke vormals Meister, Lucius and Brüning, Germany.*)
5258. COMBINATION TOOL for OPENING OYSTERS, W. Clark.—(*M. A. Panon and A. E. D. Floran de Villepigue, France.*)
5259. OBSTETRICAL SUPPORTER, W. Clark. —(*J. J. Stephens and E. Scully, United States.*)
5260. RECEIVING COINS, E. Page, London.
5261. VALVES and VALVE GEARING, H. H. Lake.—(*H. R. Fay, United States.*)
5262. LITHOGRAPHIC and LETTERPRESS ROLLERS, W. Simmons and G. W. Simmons, London.
5263. MUSIC STOOLS, M. Carbonel, London.
5264. VELOCIPEDES, W. Smith and G. Hicking, London.
5265. INDICATING APPARATUS for RAILWAY TRAINS, G. A. Nussbaum, London.
5266. POINTS for TRAMWAYS, W. E. Kenway, London.
5267. TREATING TEA LEAVES, &c., W. H. Gilruth, London.
5268. TUBES without SEAM, W. von Flotow and H. Leidig, London.
5269. PAPER, G. Pitt.—(*R. P. Pictet and G. L. Brélaz, Switzerland.*)
5270. UTILISING the WASTE of FLOUR-MILLS, L. Rappaport, London.

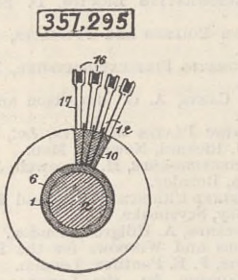
SELECTED AMERICAN PATENTS.

(From the United States' Patent Office Official Gazette.)

357,295. COMMUTATOR FOR DYNAMO-ELECTRIC MACHINES, *G. Westinghouse, jun., and A. Schmid, Pittsburgh, Pa.—Filed July 31st*, 1886.

Claim. — In a commutator for dynamo-electric machines, the combination of the segments forming the commutator, said segments being provided with

357,295



arms for connection with the wires of the armature, and insulating sheets arranged between the segments, said sheets projecting outwardly between the arms of the segments, substantially as set forth.

357,308. REVERSE GEAR FOR STEAM ENGINES, *G. W. Cushing, St. Paul, Minn.—Filed September 23rd*, 1886.

Claim.—The combination of a reverse lever, a toothed quadrant, a bearing journalled on the reverse lever, a thumb latch or shifting lever pivotted to the reverse lever and coupled to the bearing, a worm fixed upon a shaft mounted in the bearing, a worm-wheel fixed upon a shaft journalled on the reverse lever, a spur pinion fixed upon the worm-wheel shaft and engaging the teeth of the quadrant, and a spring which exerts tension upon the worm-shaft bearing to normally

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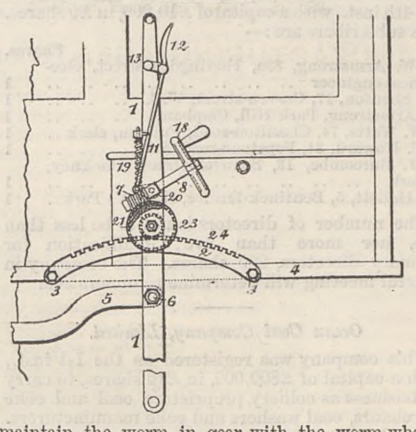

maintain the worm in gear with the worm-wheel, substantially as set forth.

357,413. HYDRAULIC RAM, *J. Richards, San Francisco, Cal.—Filed July 14th*, 1886.

Claim.—(1) The combination, with the escape valve of a hydraulic ram, of a deflecting shield, and a chamber for receiving weights formed integral with said shield and secured together therewith to the valve-stem, substantially as described. (2) The combination, with a double-seated valve, of a deflecting shield secured to the valve stem, a chamber for receiving weights also secured to said stem, and a fulcrumed

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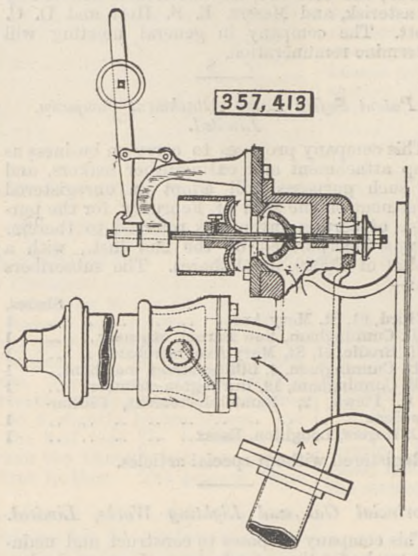
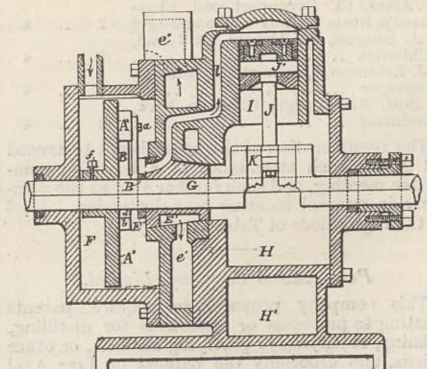


arm carrying a weight and engaging said stem, substantially as and for the purposes described. (3) The combination of the escape chamber having upper and lower openings, the double-seated valve within said chamber, the weight holder secured to the stem of said valve, and the weighted lever, all arranged to operate as described.

357,423. STEAM ENGINE, *W. Steers, Battleborough, Vt. —Filed January 30th*, 1886.

Claim.—(1) In steam engines, the conical valve E, having inlet and exhaust ports, in combination with the valve plate A^1, the connecting-rod C, weight A, and spring B, and the plate A^{11}, to which they are attached, and cut-off D, secured to the shaft G, substantially as and for the purpose described. (2) In a steam-engine, the combination of the conical valve

357,423

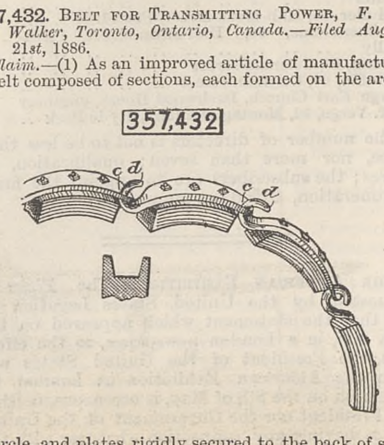


E, having inlet and exhaust ports, the valve plate A^1, having three inlet and three exhaust ports, as described and shown, the weight A, connecting-rod C, and plate A^{11}, and three steam cylinders with their inlet and exhaust passages, and three connecting-rods united on one crank shaft, substantially as described.

357,432. BELT FOR TRANSMITTING POWER, *F. M. Walker, Toronto, Ontario, Canada.—Filed August 21st*, 1886.

Claim.—(1) As an improved article of manufacture, a belt composed of sections, each formed on the arc of

357,432

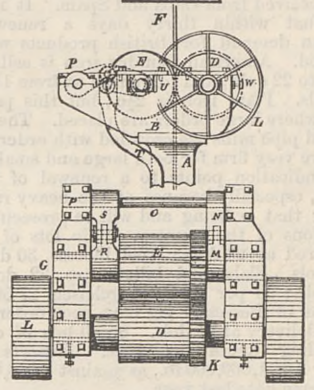


a circle, and plates rigidly secured to the back of said sections and formed on the arc of a circle, the said plates being flexibly connected together, substantially as described. (2) As an improved article of manufacture, the belt described, the same consisting of a plurality of leather sections, A, each formed on the arc of a circle, and a plurality of metal plates, one for each section, said plates being formed each on the arc of a circle and rigidly secured to the sections A, and with eyes *c* and hooks *d*, said hooks being bent downwardly into the space between said sections and detachably connecting the same together, substantially as described.

357,433. LIFTING DEVICE FOR DROP HAMMERS, *W. S. Ward, Plantsville, Conn.—Filed Nov. 23rd*, 1886.

Claim.— The herein described improvement in drop lifters, consisting in the combination of a frame, revolving cylinder D, arranged upon a shaft supported in said frame, a second cylinder E, arranged upon a shaft supported in bearings movable toward and from the said cylinder D, a pair of toggles at each end of

357,433



said cylinder E, one link of each pair hung upon the axis of the said cylinder, the other link of each pair hung upon a fixed bearing in the frame, and a rod extending from the joint of the said toggles, substantially as described, and whereby, through the said rod, the said toggles may be extended or contracted to correspondingly force the said cylinder E toward or from the cylinder D.

357,511. THROTTLE VALVE, *J. J. Tonkin, Oswego, N.Y.—Filed October 16th*, 1886.

Claim.—(1) In combination with the steam chest of an engine, a slide valve having both ends extending beyond the steam ports of the cylinder and provided with an exhaust passage at the centre, and with internal steam passages extending through the central portion of the valve over the exhaust passage and through the ends at the side facing the valve seat, a concave supplemental valve seat of semicircular form in cross-section on the aforesaid valve, ports in said supplemental valve seat communicating with the internal steam passages of the slide valve, and an

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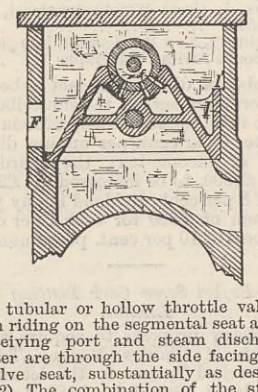

oscillatory tubular or hollow throttle valve of cylindrical form riding on the segmental seat and having a steam receiving port and steam discharge ports, which latter are through the side facing the supplemental valve seat, substantially as described and shown. (2) The combination of the steam chest, having the steam inlet port F in one side and a smooth face I^1, on the opposite side, and the valve spanning the steam chest and provided with the breast I, bearing on the face I^1, substantially as and for the purpose set forth.

357,603. HOSE OR PIPE COUPLING, *R. E. Ismond, Chicago, Ill.—Filed August 7th*, 1886.

Claim.—(1) In a hose coupling, the combination of *facsimile* pieces, each complete without movable parts and provided with a forwardly-projecting claw, and a recess on one side of the coupling piece and behind the claw, so that the parts are locked together when

357,603

the claws engage the recess. (2) In a hose-coupling, the combination of *facsimile* interlocking pieces having meeting surfaces at an angle oblique to their length, and each provided with a claw and a recess on one side thereof, as and for the purpose set forth. (3) In a hose coupling, the combination of *facsimile* interlocking pieces meeting on a line oblique to their length, and provided each with a claw and recess on one side thereof, and on its engaging surface with a pin and a curved groove, as shown.

357,658. SCALE BEAM, *F. M. Ferrell, Toccopola, Miss. —Filed May 5th*, 1886.

Claim.—In a weighing scale, the combination of a scale beam having the scale *a*, indicating pounds, and inscribed with scales *c d e*, &c., aligning with

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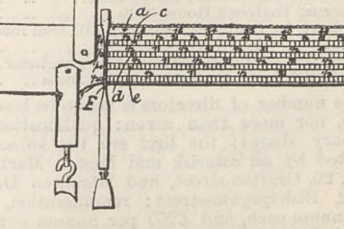

scale *a* and indicating fractional parts of the weight indicated on the scale *a*, and the sliding weight link F on the scale beam, for the purpose set forth, substantially as described.